THE UNIVERSITY of ADELAIDE

THE DEVELOPMENT AND TESTING OF AUSTRALIAN PREHOSPITAL CARE QUALITY INDICATORS

By

Robin Pap

Submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy in Medicine

May 2022

JBI

School of Public Health

Faculty of Health and Medical Science

Abstract

Background: The traditional function of ambulance services was to provide rapid transport of patients to hospital. Correspondingly, prehospital care quality has historically been measured using simple and evidence-poor indicators forming a deficient reflection of the true quality of care and providing little direction for quality improvement efforts. Prehospital care is the term used throughout this thesis describing the care and services provided by modern ambulance services. It does not imply that all patients will be transported to a hospital. Modern Australian prehospital care provided by ambulances services involves the delivery of complex mobile healthcare for patients across the lifespan presenting with a range of injuries and illnesses of varying acuity as well as transport or referral to a hospital, transport or referral to other appropriate ongoing care, or discontinuation of care when there is no need for any follow-on healthcare. Measurement of quality is central to quality assurance and quality improvement in healthcare. Measurement starts with the development of quality indicators (QIs) against which performance can be gauged. QIs need to parallel the developments of healthcare systems and services. Thus, the aim of this research was to develop and test prehospital care QIs for the Australian setting.

Methods: This is a thesis by publication which presents a research project containing three studies. First, a scoping review was conducted in accordance with JBI methodology to locate, examine, and describe the international literature on indicators used to measure prehospital care quality. Second, a modified RAND/UCLA appropriateness methods (RAM) was undertaken to develop a suite of prehospital care QIs and to assess the QIs for validity. Preparatory work for the expert consensus process included streamlined evidence syntheses guided by the JBI approach for rapid reviews and evidence summaries. Finally, an explanatory sequential mixed methods study was conducted to test the prehospital care QIs

for acceptability. Details of the methods utilised in each of the studies are described in the scoping review protocol (manuscript 1), the study protocol (manuscript 3) as well as the methods sections of the other manuscripts.

Results: The scoping review identified a total of 17 attributes of prehospital care quality and its findings suggested that quality in this setting is characterised by timely access to appropriate, safe, and effective care, which is responsive to patients' needs and efficient and equitable to populations. A total of 526 QIs were identified, comprising 283 (53.8%) clinical QIs and 243 (46.2%) organisational/system QIs. QIs relating to out-of-hospital cardiac arrest (OHCA) (n=57; 10.8%) and time intervals (n=75; 14.3%) contributed the most. Most QIs were process indicators (n=386, 73.4%).

Systematic preparation of the QIs produced a suite of 111 QIs within a guiding framework and with supporting evidence summaries for consideration by the nine-member expert panel participating in the modified RAM. An additional six QIs were proposed by panel members. Of the 117 QIs, 84 (72%) were rated as valid, including 26 organisational/system QIs across 7 subdomains and 58 clinical QIs within 10 subdomains. Most of the valid QIs were process indicators (n=62; 74%). Structural and outcome QIs were less common (n=13; 15% and n=9; 11%, respectively). Non-exclusively, 18 (21%) QIs described access to healthcare, 21 (25%) detailed elements of safety and 64 (76%) identified aspects contributing to effective prehospital care. With consideration of best available evidence the expert panel did not deem any indicator describing general time intervals, such as response time, as valid.

Paramedics and ambulance services managers participating in the initial quantitative survey of the explanatory sequential mixed methods study generally rated the acceptability of the 84 QIs highly. Analysis of qualitative data gathered in the subsequent semi-structured interviews suggested a positive association between acceptability and other key characteristics of QIs. Clarity, scientific validity, practicality, and meaningfulness positively affected acceptability

amongst the nine participants. To be acceptable, outcome indicators needed to be attributable to prehospital care. QIs which described time interval targets needed to be specific about time-sensitive interventions. Participants considered the proposed suite of QIs to be reflective of their professional values and qualities, in part explaining the high acceptability ratings. However, participants expressed some scepticism about the use of patient experience and satisfaction as valid QIs to evaluate prehospital care quality.

Conclusion: There is growing interest and understanding about the importance of the measurement of prehospital care quality. The validity and acceptability of evaluating timeliness as an indicator of prehospital care quality in specific time-sensitive patients remains self-evident but fixating on response time targets in general cannot comprehensively evaluate modern prehospital care quality. This research systematically developed and tested prehospital care QIs for the Australian setting. Systematically developed QIs possessing key characteristics appear to be more acceptable to prehospital care providers. Before implementation, there may be a need to subject these QIs to further testing.

Table of contents

List of abbreviations

ACS	Acute coronary syndrome
EMS	Emergency medical services
OHCA	Out-of-hospital cardiac arrest
PCCD	Pelvic circumferential compression device
QI	Quality indicator
RAM	RAND/UCLA appropriateness method
RAND	Research and Development
UCLA	University of California, Los Angeles

N.B. This list does not necessarily include abbreviations used within the publications of this thesis.

List of tables

N.B. This list does not include tables embedded within the publications of this thesis.

Research outputs during candidature

Publications related to this thesis

Pap R, Simpson P, Stephenson M, Lockwood C. Acceptability of prehospital care quality indicators for the Australian setting: an explanatory sequential mixed methods study. *(Submitted for publication)*

Pap R, Lockwood C, Stephenson M, Simpson P. The development of prehospital care quality indicators for the Australian setting: a modified RAND/UCLA appropriateness method. EMJ. 2021;0:1-6

Pap R, McKeown R, Lockwood C, Stephenson M, Simpson P. Pelvic circumferential compression devices for prehospital management of suspected pelvic fractures: a rapid review and evidence summary for quality indicator evaluation. Scand J Trauma Resusc Emerg Med.2020;28(65)

Pap R, Lockwood C, Stephenson M, Simpson P. Development and testing of Australian prehospital care quality indicators: study protocol. BMJ Open. 2020;10:e038310

Pap R, Lockwood C, Stephenson M, Simpson P. Indicators to measure prehospital care quality: a scoping review. JBI Database of Systematic Reviews and Implementation Reports. 2018;16(11): 2192-223

Pap R, Lockwood C, Stephenson M, Simpson P. Indicators to measure prehospital care quality: a scoping review protocol. JBI Database of Systematic Reviews and Implementation Reports. 2017;15(6):1537-42

Presentations related to this thesis

- Joanna Briggs Institute HDR Research Symposium, Adelaide, 2021, online oral presentation
- Australian and New Zealand College of Paramedicine Research Symposium, Melbourne, 2019, oral presentation
- IHI/BMJ International Forum on Quality and Safety in Healthcare, Melbourne, 2018, poster presentation
- Joanna Briggs Institute HDR Research Symposium, Adelaide, 2017, oral presentation
- Paramedics Australasia International Conference, Auckland, 2016, poster presentation
- Joanna Briggs Institute HDR Research Symposium, Adelaide, 2016, oral and poster presentation
- Council of Ambulance Authorities (CAA) Conference, Brisbane, 2016, poster presentation

Successful research grants related to this thesis

- HDR Research Grant – Australasian College of Paramedicine, 2021 ($3,500.00)
- Research grant – Australian and New Zealand College of Paramedicine, 2018 ($4,000.00)

Other publications and book chapters during candidature

Mckenzie R, **Pap R**, Hardcastle T. Development of a checklist for auditing completion of Patient Report Forms: a Delphi study. African J Emerg Med; 2022 *(in press).*

Simpson P, **Pap R**. Chapter 15: Structured reviews including umbrella reviews, scoping

reviews, rapid reviews, and narrative reviews. In: Olaussen A, Bowles KA, Lord B, Williams B, editors. Introducing, designing, and conducting research for paramedics. Chatswood: Elsevier; 2022 *(in press).*

Birtill M, King J, Jones D, Thyer L, **Pap R**, Simpson P. The use of immersive simulation in paramedicine education: a scoping review. Interact Learn Environ; 2021

Morris D, Fierravanti G, Schrieber A, Johnson S, Bartolo D, Hipsley K, Somani T, **Pap R**, Agho K, Thyer L, Simpson P. The Impact of a Novel Operational Readiness Response Model on the Environmental Cleanliness of Emergency Ambulances. Prehosp Emerg Care. 2021.

Pearce J, **Pap R**, Moher D, Williams J, Simpson P. Protocol for development of a consensus-based reporting guideline extension for pre-hospital case reports (PREHOSPITAL-CARE). Australas J Paramed. 2021;18.

Pap R, Simpson P. Interpersonal Communication and Patient-Focused Care. In: Williams B, Ross L, editors. Paramedic Principles and Practice ANZ – A Clinical Reasoning Approach, 2nd ed. Chatswood: Elsevier; 2020. p. 63-75.

Lockwood C, Borgess dos Santos K, **Pap R**. Practical guidance for knowledge synthesis: scoping review methods. Asian Nurs Res. 2019;13(5):287-94.

Pap R, van Loggerenberg C. A comparison of airway management devices in simulated entrapment-trauma: a prospective manikin study. Int J Emerg Med. 2019;12(1):15.

Pap R, Shabella L, Morrison A, Simpson P, Williams D. Teaching improvement science to paramedicine students: Protocol for a systematic scoping review. Syst Rev. 2018;7(1):1–6.

Statement of original authorship

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

The author acknowledges that copyright of published works contained within the thesis resides with the copyright holder(s) of those works.

I also give permission for the digital version of my thesis to be made available on the web, via the University's digital research repository, the Library Search and also through web search engines, unless permission has been granted by the University to restrict access for a period of time.

I acknowledge the support I have received for my research through the provision of an Australian Government Research Training Program Scholarship.

Student Signature: Date: 18 May 2022

COVID-19 impact statement

The COVID-19 pandemic had considerable impact on planned research activities of this PhD, in particular study 3. As described in the study protocol (chapter 3), the original objective of study 3 was to test the prehospital care QIs deemed valid in study 2 for acceptability as well as feasibility and reliability. Assessing if the application of certain QIs is feasible and to what extent a measurement using these QIs is reliable requires access to ambulance services' information systems and hence their participation. Before the COVID-19 pandemic, two Australian state/territory ambulance services expressed interest in participating by testing the QIs for feasibility and reliability as part of study 3. However, in 2021 the study coincided with the delta-variant COVID-19 wave. Unfortunately, yet understandably, the unprecedented healthcare demands and associated increases in workload meant that the services had to withdraw. Several alternative approaches to conduct the study were explored but all lacked sufficient rigour to produce valid and meaningful results. Therefore, we placed emphasis on testing the QIs for acceptability. Despite a strong and extended recruitment drive, a smaller number of participants was recruited for the initial survey of this study than initially intended. It is highly likely that this was caused by a lack of capacity to participate in research amongst exhausted and fatigued frontline healthcare workers. On a more personal note, the COVID-19 pandemic also had significant impact on my full-time work as lecturer in paramedicine. This affected my PhD research which on several occasions had to be put aside to prioritise work contributing to managing what can only be described as a major crisis in the academic sector.

Acknowledgements

The completion of this thesis could not have been accomplished without the support and assistance of many people. First and foremost, I would like to thank my principal supervisor Associate Professor Dr Craig Lockwood, co-supervisor Dr Matthew Stephenson, and external co-supervisor Associate Professor Dr Paul Simpson for their time, guidance, support, and patience through each stage of the process.

I thank the staff at JBI for their support and for facilitating the biannual research symposia which have always helped me stay inspired to learn and progress my research endeavours. I would also like to thank Western Sydney University and in particular the School of Health Sciences for enabling me to complete this thesis whilst working as a full-time academic.

I would like to thank Mr James Pearce for his contributions as second reviewer in the initial scoping review and all participants of studies 2 and 3. This research would not have been possible without your commitment of time and effort.

I acknowledge the Australian Government for my Research Training Programme Scholarship and am grateful for the financial support provided through two research grants from the Australasian College of Paramedicine (ACP).

Last but certainly not least, I would like to thank my wonderful wife Shanon J. Stanley for her unwavering support and patience and our beautiful daughter Lucy for the love, light and laughter she brings into our everyday lives.

Chapter 1: Introduction

1.1 Background and rationale

The research presented in this thesis relates to the field of prehospital care provided by ambulance services and to what constitutes high-quality prehospital care in Australia. The research builds on the premise that without measurement it is difficult to assure or improve quality, and that measurement starts with the development of high-quality quality indicators (QIs) against which performance can be evaluated. This chapter provides pertinent background information, outlines the need for this research, and provides and overview of how this thesis is structured as well as its philosophical foundations.

1.1.1 What is prehospital care and how is it provided in Australia?

The term 'prehospital care' is not specific about the service providing such care, and the prefix 'pre-' implies that the care pathway of all patients who receive prehospital care will at some point reach a hospital. For the purpose of this program of research, however, prehospital care was confined to the care and services provided specifically by ambulance services. Further, it is understood that not all patient managed by ambulance services require transport to a hospital. Some patients are transported or referred to other, more appropriate healthcare facilities, and others yet may not need any follow-on healthcare at all. Thus, prehospital care is the term used throughout this thesis describing the care and services provided by modern ambulance services.

Ambulance services, or synonymously emergency medical services (EMS), have traditionally been categorised based on the qualifications of their clinicians. The Anglo-American system is predominantly staffed by paramedics and other, non-physician clinicians such as

emergency medical technicians (EMT), whereas the Franco-German system employs physicians who are assisted by paramedics and/or EMTs to provide prehospital care.[1] Ambulance services worldwide and the prehospital care they provide have evolved significantly over the past few decades.[2] Whilst they continue to fulfil their traditional role of providing care and transport to an emergency department for those suffering life-threatening illness or injury, models of care have progressed considerably. Modern prehospital care may include extensive emergency, urgent, and non-emergency mobile healthcare and the facilitation of access to a hospital or other, more appropriate healthcare facility with a concomitant requirement for continuity of care.[3,4] Thus, in an effort to optimise holistic and seamless patient care, ambulance services are increasingly integrated into healthcare systems. In light of the above considerations and for the purpose of this thesis, prehospital care is defined as the care and services that ambulance services provide for patients with real or perceived emergency, urgent, or non-emergency care needs from the time point of telephone access until care is concluded or until arrival and transfer of care to a hospital or other healthcare facility.[5]

In Australia, prehospital care is provided mainly by jurisdictional state/territory ambulance services forming an essential part of the national health system.[6] In 2020/21, these ambulance services consisted of an operational workforce of 16,678 staff (total full time equivalent) and responded to over 4 million incidents (158.7 per 1,000 population).[7] Supplementing the government services are a growing number of private medical services which provide non-emergency patient transport and on-site medical assistance at sporting or entertainment events, industrial sites, and primary healthcare settings. Australian ambulance services predominantly operate paramedic systems with physicians forming part of the response to

critically injured patients or retrieval work only in select areas of service-delivery in some jurisdictions.

Paramedicine, the healthcare discipline of paramedics, can be described as a domain of practice and health profession that specialises across a variety of settings including, but not limited to, emergency and primary care.[8] In Australia, paramedicine became a nationally registered healthcare profession in 2018.[9] Besides ambulance services, there is a range of different clinical settings where paramedics may work such as hospitals and clinics, and several non-clinical roles they may pursue including education, leadership, public health and research.[8] Clinically there are opportunities for paramedics to advance by progressing to intensive care paramedic, retrieval paramedic, or extended care paramedic levels.[4]

Similarly to healthcare services anywhere, Australian ambulance services are under pressure to maintain high-quality patient care in an environment with mounting complexity.[10] Despite a net loss in overseas migration in 2020/21, Australia's population is growing and presents an increasing potential pool of patients.[11] Consequently, the demand for ambulance services has expanded in the past five years.[7] Australia's ageing population, the rise in chronic disease, and the impact of the COVID-19 pandemic, especially during waves of infection, have also increased requests for ambulance services.[12] Growth and aging of Australia's population mean that the trend in climbing demand is projected to continue over the next five years.[12]

1.1.2 Why should healthcare quality be defined and measured?

Although a definition of quality must be in place prior to its measurement, it is useful to outline why quality should be measured before explaining the need to define it. Over the past four decades, growing demand for healthcare, the emergence of more informed and active

health consumers, rising costs, and evidence of variation in access to healthcare and clinical practice have increased interest in healthcare quality.[13–16] Often a significant feature of healthcare organisations' mission and vision statements, commonly found embedded in professional registration standards and accreditation criteria, and regularly listed high up on agendas (usually associated with plans for improvement), 'quality' has become a priority in contemporary healthcare industries, including ambulance services.[17–19] Without robust measurement it is impossible to assess the quality of healthcare services objectively with methodological rigour and validity, or to evaluate if quality improvement activities actually have their desired effect or if there are adverse results from making changes.[20] Measuring healthcare quality forms the initial step in numerous quality assurance and improvement processes.[21] More specifically, public reporting, accreditation, audit and feedback, and other quality assurance and improvement initiatives rely on valid assessment of the quality of care and services provided. Whilst measurement will not automatically result in quality assurance or improvement, it is the first crucial step in identifying areas performing well and those requiring attention, and in monitoring the effectiveness of improvement activities.[22]

Before measuring quality, defining it, especially with its conceptualisation in a particular setting, is critical.[21,23] Similar to measurement conducted for the purpose of scientific research, without understanding of how investigators define key concepts, it would be nearly impossible to understand the meaning of their findings and conclusions.[24] Avedis Donabedian, often recognised as a pioneer in the field of healthcare quality, reasoned that "*to proceed to measurement without a firm foundation of prior agreement on what quality consists in is to court disaster.*"[25(p1743)] Definitions of quality and especially their components or attributes allow them to be operationalised in the form of quality frameworks, which are essential for the development of a balanced suite of QIs.

Defining healthcare quality, either generally or by describing its various dimensions, is exceptionally challenging and is subject to perpetual debate amongst healthcare providers and researchers alike.[23,26–29] What makes it so hard to obtain consensus on a definition is that quality means different things depending on the perspectives from which the concept is viewed (e.g., provider versus consumer), the setting in which healthcare is provided (e.g., prehospital versus in-hospital), and how much emphasis these different perspectives or settings place on each of various quality dimensions.[26,30–32] It follows that systematic development tools to measure prehospital care quality needs to start with an exploration of what quality means in this particular context.

1.1.3 What are quality indicators and how should they be developed?

Quality indicators may be described as explicitly defined and measurable aspects of health care services which serve as measurement tools to monitor, evaluate, and improve the quality of patient care, clinical support services, and organisational function that affect patient outcomes.[33,34] Considerable confusion exists about terms used to describe tools to assess healthcare quality because different organisations and individuals often mean different things when using them. In particular, the terms ‘measure’ and ‘indicator’ are often used interchangeably. However, it can be posited that whilst a measure can quantify whatever is being assessed, indicators are by their very nature indicative of the attribute of interest but are not direct measures of it.[35,36] In healthcare, meaningful indicators are routinely turned into measures which, especially when combined with standards, can be used to evaluate the quality of care and service-delivery. A review criterion, commonly used for accreditation assessments, is similar to an indicator but is used specifically to determine retrospectively whether the element of care occurred or not. Table 1.1 provides definitions and examples of these terms.

Table 1.1 Definitions and examples of indicators, measures, criteria, and standards

Term	Definition	Example
Indicator	A quality indicator is a measurable element of health care services for which there is evidence or consensus that it can be used to assess the quality, and hence change in quality.[37]	A patient who presents with signs and/or symptoms of acute coronary syndrome is administered 300mg aspirin orally, unless contraindicated.
Measure	An expression of an indicator as a proportion, rate, ratio, or mean value for a sample population. (Measures are different to indicators. Indicators are by their very nature indicative of performance or quality, but are not direct measures of it.[35])	The proportion of patient who present with signs and symptoms suggestive of acute coronary syndrome who are administered 300mg aspirin orally**,** unless contraindicated.
Standard	The level of compliance with a criterion or indicator.[37,38] A target standard is set prospectively and stipulates the level that an organisation must strive to meet.[34] An achieved is measured retrospectively and shows an organisation's achievement.[34]	Target standard: 95% of patients with signs and symptoms suggestive of acute coronary syndrome should be administered 300mg aspirin orally**,** unless contraindicated. Achieved standard: 90% of patients with signs and symptoms suggestive of acute coronary syndrome were administered 300mg aspirin orally**,** unless contraindicated.
Review Criterion	Systematically developed statement or question relating to a single act of medical care that is so clearly defined that it is possible to determine retrospectively whether the element of care occurred or not.	If a patient presented with signs and symptoms suggestive of acute coronary syndrome, was 300mg aspirin administered orally**,** unless contraindicated?

mg milligrams

Approaches to developing QIs can be categorised into non-systematic and systematic methods.[34] Whilst still potentially useful, non-systematic methods produce QIs without consideration of relevant research findings. For example, a healthcare service might develop a local QI and perform associated measurement based on a critical adverse event.

As far as possible QI development should be systematic, meaning QIs are based directly upon high-quality scientific evidence such as that produced by rigorously conducted experimental studies and systematic reviews.[37,39] When such high-quality evidence is scarce or altogether absent, QI development should involve the systematic combination of best available evidence with expert consensus.[34] Considering the close link between clinical practice guidelines and

clinical QIs, systematic methods may also include evidence-based guideline-derived development.[40,41] Furthermore, in light of the highly contextual nature of quality, QIs should not simply be transferred between different systems or settings without an intermediate, equally systematic process.[42–44] Systematic development will ensure that QIs are valid; That is, indicators accurately represent the concept being assessed, i.e., quality, in a particular context. Besides validity, there are a number of other desirable characteristics that QIs should possess and should be tested for prior to their implementation.[45] These include acceptability, feasibility, and reliability.[34,46–48]

1.1.4 Why is there a need to systematically develop and test prehospital care quality indicators in Australia?

A wide range of healthcare QIs exist,[21] but comparatively few have been developed specifically for prehospital care.[29] Furthermore, of these prehospital care QIs many are non-systematically developed and often characterised by a historical focus on operational aspects such as response times.[29] Although Australian state/territory ambulance services develop service-specific QIs, the quality of care delivered to Australian residents across the various jurisdictions is measured in accordance with a national performance indicator framework.[7] The measures therein are focused on response times, patient satisfaction, workforce, and a small number of clinical conditions, including cardiac arrest and pain management. Considering the evolution of prehospital care, these measures do not reflect the breadth and complexity of care and services that modern ambulance services provide. There is a need for a contemporary and meaningful suit of prehospital care QIs that Australian ambulance services can utilise.

1.2 Research aim and objectives

1.2.1 Research aim

The overall aim of this research was to develop and test prehospital care quality indicators for the Australian setting.

1.2.2 Research objectives

To achieve the research aim, the following research objectives were be addressed:

- To locate, examine, and describe the international literature on indicators used to measure prehospital care quality.
- To develop a suite of prehospital care QIs for the Australian setting and to assess the QIs for validity.
- To test the previously assessed prehospital care QIs for acceptability.

1.3 Thesis overview

This PhD thesis in publication format consists of 6 chapters encompassing 6 publications (Table 1.2). Chapter 2 includes a scoping review and its preceding protocol that addressed the first research objective. The review, published in the *JBI Database of Systematic Review and Implementation Reports* (as was the protocol), describes the international literature on indicators used to measure prehospital care quality. The review found paucity in research aiming to specifically define prehospital care quality but identified and described the attributes of generic healthcare quality definitions that appear in the literature in the prehospital context. Whilst there is growing interest in developing prehospital care QIs, the review findings suggested a need for validation of existing QIs and systematic *de novo* development of QIs addressing broader aspects of prehospital care.

Chapter 3 provides an overview of the methods used in this research in the form of a protocol addressing research objectives 2 and 3 published in *BMJ Open*. Publication of the protocol in a high-ranking journal was considered important by the PhD candidate and supervisors as it subjected the proposed methods to a robust peer review process, made information available which is routinely only publicised in trial registries, and in doing so facilitated transparency.

Chapter 4 includes two publications presenting the work constituting the development of QIs in this body of research. A manuscript published in the *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine* provides an exemplar rapid review and evidence summary for QI development. This is a comprehensive published example of how evidence should be summarised for perusal by an expert panel evaluating validity during systematic development of QIs. The second manuscript in this chapter, published in the *Emergency Medicine Journal,* presents study 2 of the project which comprised a Research And Development (RAND)/University of California, Los Angeles (UCLA) Appropriateness Method, or RAM, an evidence-informed expert consensus process to identify QIs valid for the evaluation of Australian prehospital care. The study demonstrates that with consideration of best available evidence a substantial proportion of QIs scoped and synthesised from the international literature are valid for use in the Australian prehospital care context.

Chapter 5 presents the results relating to research objective 3 and includes a manuscript under peer review at the time of thesis submission. The study used an explanatory sequential mixed methods design aimed at evaluating the acceptability of the QIs deemed valid in the preceding study. The findings of this study suggest that the proposed suite of QIs is generally acceptable to Australian prehospital care providers.

Finally, Chapter 6 summarises the key findings of the thesis, highlights its strengths and acknowledges several limitations. Additionally, the chapter discusses recommendations based on the key findings as well as considerations for further research.

Table 1.2 Thesis structure

Chapter	Contents	Objectives
Chapter 1	Introduction	• Describe the background and rationale of the thesis. • State the aim and research objectives of the thesis. • Provide an overview of the structure of the thesis. • Position the thesis philosophically.
Chapter 2	Scoping Review Manuscript 1: *Indicators to measure prehospital care quality: a scoping review protocol* [49] Manuscript 2: *Indicators to measure prehospital care quality: a scoping review* [29]	• (Research objective 1) Locate, examine, and describe the international literature on indicators used to measure prehospital care quality.
Chapter 3	Methods Manuscript 3: *Development and testing of Australian prehospital care quality indicators: study protocol* [50]	• Detail the methods of the thesis.
Chapter 4	Evidence-Informed Expert Consensus Process Manuscript 4: *Pelvic circumferential compression devices for prehospital management of suspected pelvic fractures: a rapid review and evidence summary for quality indicator evaluation* [51] Manuscript 5: *The development of prehospital care quality indicators for the Australian setting: a modified RAND/UCLA appropriateness method* [52]	• Provide an exemplar rapid review and evidence summary for QI evaluation. • (Research objective 2) Develop a suite of prehospital care QIs and to assess the QIs for validity.
Chapter 5	Testing for acceptability	• (Research Objective 3) Test the prehospital care QIs deemed valid in study 2 for acceptability.

	Manuscript 6: *Acceptability of prehospital care quality indicators for the Australian setting: an explanatory sequential mixed methods study*	
Chapter 6	Discussion and conclusion	• Summarise key findings of the thesis. • Examine the strengths and limitations of the thesis. • Discuss recommendations based on key findings. • Discuss considerations for further research.

QI Quality indicator; RAND Research and Development; UCLA University of California, Los Angeles

1.4 Philosophical foundations

Systematic investigation into a complex concept such as 'quality' and the development of indicators of its presence presents several challenges. As described in this chapter, the concept of quality is by and large easy to grasp but difficult to describe and define. Besides its highly contextual nature, what contributes further to the complexity of quality (and consequently indicators thereof) is that it may be shaped by both objective and subjective knowledge. In the context of healthcare, it would be hard to dispute the link between robust scientific evidence (such as that produced by rigorously conducted randomised controlled trials and systematic reviews) and quality of care. Although the incorporation of scientific evidence in both a definition of quality and in the development of QIs is imperative, healthcare quality and evidence-based healthcare are by definition not entirely synonymous.[23] Additionally, as outlined above, high-quality evidence may be scarce or absent in certain healthcare settings and disciplines such as prehospital care and paramedicine. Consequently, the development and testing of QIs requires philosophical assumptions to be flexible and adaptive considering both concrete and objective certainties as well as subjective perspectives. In other words, researchers need to focus on the research questions and embrace

plurality of methods in an effort to answer them. Pragmatism, as a research paradigm, offers a proposition that investigators should deploy that philosophical and methodological approach that works best for a particular research problem.[53] Emphasis is placed on the research questions rather than on the methods and as such multiple methods and/or mixed methods are routinely utilised.[54–56]

RAM, a systematic method for combining scientific evidence with collective opinion of experts, was used to investigate research objective three.[57] RAM is based on the Delphi method which was developed at RAND in the 1950s.[58] Ontologically, the Delphi method has roots in the philosophy of John Locke, Immanuel Kant, and Georg W.F. Hegel who, besides empirical data, placed emphasis on the views and opinions of people in considering what reality is.[59] Furthermore, intended for practical research which could be used to inform practice, the Delphi method was developed in accordance with the epistemological assumptions consistent with John Dewey's pragmatism.[60] Dewey's pragmatism creates connections between the objectivity and generalisability embedded in the postpositivist paradigm while incorporating a focus on subjective human experiences and contextual truths characteristic of the interpretive paradigm.[61] Pragmatism is evident in RAM as it aims to combine best available evidence with expert opinion. Summarising the best available evidence by means of a rapid review (rather than a more time-consuming systematic review) demonstrates an equally pragmatic approach.

Similarly, the pragmatist paradigm is maintained in the final study of the thesis utilising a two-staged explanatory sequential mixed methods research design.[56,62] Although not the only approach, the one most commonly associated with mixed methods research is pragmatism.[63] Here pragmatism is evident in the guidance from appropriate research paradigms depending

on the stage of the study and more importantly its specific objective. In the initial stage collecting quantitative data to evaluate how acceptable QIs are, a postpositivist position was taken, whereas the subsequent collection of qualitative data was performed with a constructivist view aimed at understanding the initial quantitative results.[56]

Chapter 2: Scoping review

2.1 Overview

Chapter 1 argues that there is a need for systematic development of prehospital care QIs in Australia. As explained, an important precursor to this work was to clarify how the concept of quality in the context of prehospital care is defined. Furthermore, it was essential to examine what kinds of indicators exist as many of them, subjected to an appropriate and systematic intermediate process, may be suitable for the Australian setting. Studying the international literature also facilitated an understanding of the processes that have been used to develop prehospital care QIs and what the characteristics of existing QIs are.

This chapter reports the methods and results of a scoping review of international literature on indicators used to measure prehospital care quality. It addressed research objective 1 by mapping the attributes that have been used to define or describe the concept of quality in the context of prehospital care provided by ambulance services and charting existing prehospital care QIs as well as their development processes and key characteristics. In light of this objective, a scoping review was considered the most appropriate type of review.

The methods were developed *a priori* and published in *JBI Database of Systematic Reviews and Implementation Reports* in 2017. The resultant review formed the first study of this PhD project and created the foundations for the program of research. Titled 'Indicators to measure prehospital care quality: a scoping review' it was published in the same journal in 2018

2.2 Manuscript 1

Statement of Authorship

Title of Paper	Indicators to measure prehospital care quality: a scoping review protocol
Publication Status	☑ Published ☐ Accepted for Publication ☐ Submitted for Publication ☐ Unpublished work written in manuscript style
Publication Details	Pap R, Lockwood C, Stephenson M, Simpson P. Indicators to measure prehospital care quality: a scoping review protocol. JBI Database of Systematic Reviews and Implementation Reports. 2017;15(6):1537-42

Principal Author

Name of Principle Author (Candidate)	Robin Pap		
Contribution to Paper	Principle author responsible for the design of the study and writing up of the manuscript.		
Overall percentage (%)	85%		
Certification	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature		Date	01 February 2022

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);
ii. permission is granted for the candidate in include the publication in the thesis; and
iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Assoc Prof Craig Lockwood		
Contribution to Paper	Principally supervised development of work, helped in defining inclusion and exclusion criteria, and in manuscript evaluation.		
Signature		Date	01 February 2022

Name of Co-Author	Dr Matthew Stephenson		
Contribution to Paper	Co-supervised development of work, helped in defining inclusion and exclusion criteria, and in manuscript evaluation.		
Signature		Date	01 February 2022

Name of Co-Author	Assoc Prof Paul Simpson		
Contribution to Paper	Co-supervised development of work, helped in defining inclusion and exclusion criteria, and in manuscript evaluation.		
Signature		Date	01 February 2022

LIBRARY NOTE:

The article on pages 16-21 has been removed due to copyright.

It is also available online to authorised users at:
https://doi.org/10.11124/JBISRIR-2016-003141

2.3 Manuscript 2

Statement of Authorship

Title of Paper	Indicators to measure prehospital care quality: a scoping review
Publication Status	☑ Published ☐ Accepted for Publication ☐ Submitted for Publication ☐ Unpublished work written in manuscript style
Publication Details	Pap R, Lockwood C, Stephenson M, Simpson P. Indicators to measure prehospital care quality: a scoping review. JBI Database of Systematic Reviews and Implementation Reports. 2018;16(11): 2192-223

Principal Author

Name of Principle Author (Candidate)	Robin Pap		
Contribution to Paper	Principle author responsible for the design, data extraction, data synthesis, interpretation of results and writing up of the manuscript.		
Overall percentage (%)	85%		
Certification	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature		Date	01 February 2022

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);
ii. permission is granted for the candidate in include the publication in the thesis; and
iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Assoc Prof Craig Lockwood		
Contribution to Paper	Principally supervised development of work, helped in data synthesis and presentation, and in manuscript evaluation.		
Signature		Date	01 February 2022

Name of Co-Author	Dr Matthew Stephenson		
Contribution to Paper	Co-supervised development of work, helped in data synthesis and presentation, and in manuscript evaluation.		
Signature		Date	01 February 2022

Name of Co-Author	Assoc Prof Paul Simpson		
Contribution to Paper	Co-supervised development of work, helped in data synthesis and presentation, and in manuscript evaluation.		
Signature		Date	01 February 2022

LIBRARY NOTE:

The article on pages 23-54 has been removed due to copyright.

It is also available online to authorised users at:
https://doi.org/10.11124/JBISRIR-2017-003742

2.4 Summary

Although scarce, the literature included in this published scoping review suggests that prehospital care quality is characterised by timely access to appropriate, safe, and effective care, which is responsive to patients' needs and efficient and equitable to populations. Considering the multidimensionality of quality, it is important to recognise these various attributes when developing a holistic and balanced suite of QIs. Combined with systems-based frameworks, such as the widely used structure-process-outcomes model developed by Donabedian,[64] they can provide a useful taxonomy for QI categorisation.

The review also showed that there is rising interest in how prehospital care quality can be measured. A total of 526 QIs were charted addressing clinical and non-clinical elements of prehospital care provided by ambulance services. However, the relative overrepresentation of QIs relating to time intervals and resource deployment highlights the historical focus on response times and other time intervals. Most of the charted QIs were process-type indicators. This was unsurprising since meaningful outcome-type indicators are inherently difficult to develop in prehospital care, given the short duration of patient interaction. For a process-type indicator to be a valid QI though, it needs to align to a desirable outcome. Similarly, a valid structural QI is one for which there is evidence that the described structural component increases the likelihood of achieving a desirable outcome or related process.[65]

The scoping review presented in this chapter located, examined, and described the international literature on indicators used to measure prehospital care quality and in doing so addressed research objective 1. Its findings led to the development of a protocol for the next studies of the research project, which is presented in Chapter 3.

Chapter 3: Methods

3.1 Overview

The scoping review presented in the preceding chapter constituted the basis for the overall research project. By charting the attributes of prehospital care quality and characteristics of prehospital care QIs broad categories were established as a starting point for a QI taxonomy. The review also identified an initial list of potential QIs. This groundwork led to the development of methodological approaches for the subsequent studies. Chapter 3 provides an overview of these methods utilised to develop and test QIs for the Australian setting in the form of a study protocol published in *BMJ Open* in 2020. The protocol describes the methods of the three studies (in this publication referred to as phases) of the research project with an emphasis on planned work, i.e., studies/phases 2 and 3, and discusses them in light of the knowledge gained from the scoping review and anticipated real and potential limitations. As outlined in the COVID-19 impact statement on page xii of the thesis' preamble, study 3 had to be amended to focus purely on testing the QIs for acceptability. Further details of the methods utilised in each study are described in the relevant publications incorporated into the subsequent chapters.

3.2 Research ethics

The studies in this thesis were approved by the University of Adelaide Human Research Ethics Committee (Ref: H-2017-157). A copy of the Ethics Committee letter of approval is contained in Appendix A.

3.3 Manuscript 3

Statement of Authorship

Title of Paper	Development and testing of Australian prehospital care quality indicators: study protocol
Publication Status	☑ Published ☐ Accepted for Publication ☐ Submitted for Publication ☐ Unpublished work written in manuscript style
Publication Details	Pap R, Lockwood C, Stephenson M, Simpson P. Development and testing of Australian prehospital care quality indicators: study protocol. BMJ Open. 2020;10:e038310

Principal Author

Name of Principle Author (Candidate)	Robin Pap		
Contribution to Paper	Principle author responsible for the design of the study and writing up of the manuscript.		
Overall percentage (%)	85%		
Certification	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature		Date	01 February 2022

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);
ii. permission is granted for the candidate in include the publication in the thesis; and
iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Assoc Prof Craig Lockwood		
Contribution to Paper	Principally supervised development of work, helped in selecting appropriate study designs and in manuscript evaluation.		
Signature		Date	01 February 2022

Name of Co-Author	Dr Matthew Stephenson		
Contribution to Paper	Co-supervised development of work, helped in selecting appropriate study designs and in manuscript evaluation.		
Signature		Date	01 February 2022

Name of Co-Author	Assoc Prof Paul Simpson		
Contribution to Paper	Co-supervised development of work, helped in selecting appropriate study designs and in manuscript evaluation.		
Signature		Date	01 February 2022

BMJ Open

Development and testing of Australian prehospital care quality indicators: study protocol

Robin Pap ,[1,2] Craig Lockwood,[1] Matthew Stephenson,[1] Paul Simpson[2]

To cite: Pap R, Lockwood C, Stephenson M, *et al*. Development and testing of Australian prehospital care quality indicators: study protocol. *BMJ Open* 2020;**10**:e038310. doi:10.1136/bmjopen-2020-038310

► Prepublication history for this paper is available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2020-038310).

Received 05 March 2020
Revised 28 April 2020
Accepted 10 June 2020

[1]JBI, University of Adelaide, Adelaide, South Australia, Australia
[2]School of Health Sciences, Western Sydney University, Sydney, New South Wales, Australia

Correspondence to
Robin Pap;
r.pap@westernsydney.edu.au

ABSTRACT

Introduction Historically, ambulance services were established to provide rapid transport of patients to hospital. Contemporary prehospital care involves provision of sophisticated 'mobile healthcare' to patients across the lifespan presenting with a range of injuries or illnesses of varying acuity. Because of its young age, the paramedicine profession has until recently experienced a lack of research capacity which has led to paucity of a discipline-specific, scientific evidence-base. Therefore, the performance and quality of ambulance services has traditionally been measured using simple, evidence-poor indicators forming a deficient reflection of the true quality of care and providing little direction for quality improvement efforts. This paper reports the study protocol for the development and testing of quality indicators (QIs) for the Australian prehospital care setting.

Methods and analysis This project has three phases. In the first phase, preliminary work in the form of a scoping review was conducted which provided an initial list of QIs. In the subsequent phase, these QIs will be developed by aggregating them and by performing related rapid reviews. The summarised evidence will be used to support an expert consensus process aimed at optimising the clarity and evaluating the validity of proposed QIs. Finally, in the third phase those QIs deemed valid will be tested for acceptability, feasibility and reliability using mixed research methods. Evidence-based indicators can facilitate meaningful measurement of the quality of care provided. This forms the first step to identify unwarranted variation and direction for improvement work. This project will develop and test quality indicators for the Australian prehospital care setting.

Ethics and dissemination This project has been approved by the University of Adelaide Human Research Ethics Committee. Findings will be disseminated by publications in peer-reviewed journals, presentations at appropriate scientific conferences, as well as posts on social media and on the project's website.

Strengths and limitations of the study

- ► The scoping review, which was used to establish a preliminary list of prehospital care quality indicators (QIs), used systematic methods.
- ► By incorporating systematically synthesised literature into the expert consensus process, it will be evidence informed.
- ► Selection of an Australian prehospital care expert panel will ensure that validity of proposed QIs is evaluated with contextual considerations.
- ► Testing of candidate QIs will involve the participation of paramedics and ambulance services.
- ► Considering the relatively young age of the paramedicine discipline, the evidence supporting many of the QIs is expected to be weak.

INTRODUCTION

The quality and safety of healthcare is on the agenda in any modern healthcare organisation, including ambulance services. Strategies to continuously improve the quality of service should primarily be based on information about the level of quality produced by the healthcare organisation.[1] Indicators of desirable structures, processes and outcomes allow the quality of care and services to be measured. This assessment can be facilitated by systematically developing quality indicators (QIs) that describe the performance that should occur, and then measuring and monitoring whether a service's operations and patient care are consistent with these indicators.[2] Thus, an indicator may be defined as an explicitly described and measurable element of healthcare services and, as far as possible, should possess the fundamental characteristics of clarity, validity, acceptability, feasibility and reliability.[3] A QI is an indicator for which there is evidence or consensus that it can be used to assess the quality, and hence measure changes in quality over time.[4]

For the purpose of this project, the context of prehospital care is limited to the healthcare services provided by ambulance services. Historically, the function of ambulance services was primarily one of transport; paramedics would provide only stabilising care to patients with high-acuity presentations before transporting to an emergency department. However, ambulance service models of care have evolved considerably. Contemporary prehospital care involves provision of often complex 'mobile healthcare' to patients

across the lifespan presenting with injury or illness across the spectrum of acuity. An increasingly aged population and an increased incidence of chronic disease have led to a substantial increase in non-emergency, or 'low acuity' presentations for whom the traditional emergency department disposition may not be most appropriate.[5 6] Ambulance services now play a key role in integrated healthcare frameworks, with transport to an emergency department being one of many disposition outcomes following care from paramedics alongside referral into primary and community-based healthcare. On the other verge of the patient spectrum, ambulance services continue to provide critical care and transport for those suffering life-threatening illness or injury.[6 7] Therefore, this project adopts the definition of prehospital care previously developed which encompasses this range of patients seen by ambulance services: Prehospital care is the care that ambulance services provide for patients with real or perceived emergency or urgent care needs from the time point of emergency telephone access until care is concluded or until arrival and transfer of care to a hospital or other healthcare facility.[8 9]

Similarly to many other countries, Australia has measures in its national performance indicator framework for ambulance services that track the quality of care delivered to its residents across the various jurisdictions.[10] However, the scope of current measurement is limited. For example, a short response time interval may be an important indicator in certain, time-critical patient cohorts[11–13]; however, its validity as a holistic prehospital care QI is questionable.[14 15] Response times and other similarly simple QIs have predominated in ambulance services' performance reports since they are easily measured and readily understood by the public and policymakers alike.[16] With increasing research activity and the recent commencement of national registration of paramedics in Australia, a timely need to expand the nationally used indicators of prehospital care quality exists. Both, an expanding evidence-base and regulations which primarily ensure patient and community safety, ultimately aim to protect and continuously improve the quality of prehospital care. Meaningful measurement based on systematically developed QIs not only produces data to ensure the maintenance of quality, it also provides information on whether or not change is effective in achieving improvement.

This paper reports the context and methods for a project on development and testing of prehospital care QIs. The primary aim of the project is to develop and test QIs for the Australian prehospital care setting. To achieve this, the project addresses the following objectives:

1. To map the attributes or dimensions of 'quality' in the context of prehospital care and explore indicators that have been developed internationally to measure prehospital care quality.
2. To develop prehospital care QIs for the Australian setting and to evaluate their validity.
3. To test selected candidate prehospital care QIs for acceptability, feasibility and reliability.

METHODS AND ANALYSIS

This project consists of three phases (figure 1): an initial scoping review addressing objective 1; evidence-informed development of prehospital care QIs and an evaluation of their validity using an expert consensus process (modified RAND/UCLA Appropriateness Method (RAM)) to address objective 2; and finally, a mixed methods approach (explanatory sequential design) to test the QIs as detailed in objective 3.

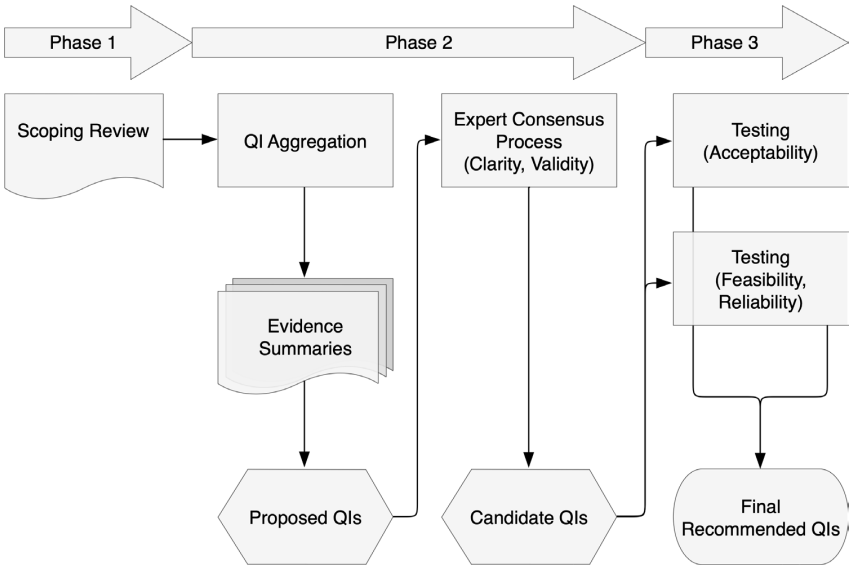


Figure 1 Flow diagram detailing the three phases of the project. QI, quality indicator.

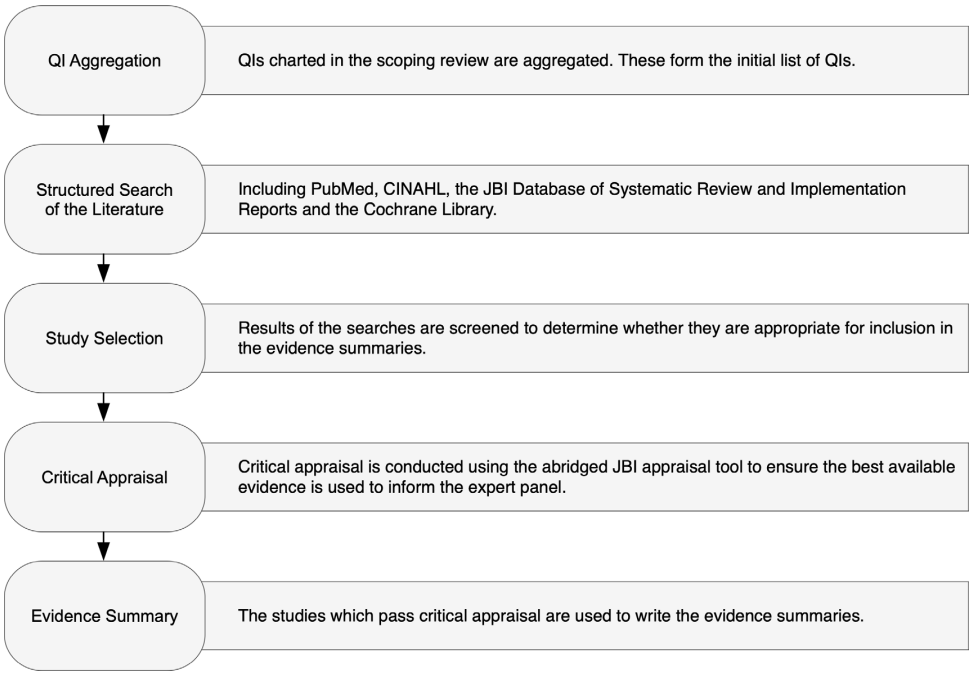


Figure 2 The evidence summary development process (adopted from Munn *et al*[21]). JBI, Joanna Briggs Institute; QI, quality indicator.

Phase 1: scoping review

This phase has been completed and involved preparatory work in the form of a scoping review.[17] The purpose of the review was to map the attributes of 'quality' in the context of prehospital care and to chart existing international prehospital care QIs. The review employed the Joanna Briggs Institute (JBI) methodology for conducting scoping reviews.[18] The objectives, inclusion and exclusion criteria, and methods were specified in advance and documented in a protocol.[19]

The review's systematic search confirmed paucity in the literature that defines prehospital care quality or examines which dimensions of generic healthcare quality definitions are important in prehospital care. However, synthesis of included articles suggested that timely access to appropriate, safe and effective care which is responsive to a patient's needs and efficient and equitable to populations is reflective of high-quality prehospital care. There is growing interest in developing QIs to evaluate prehospital care. In total, the review charted 526 QIs addressing clinical and non-clinical aspects of ambulance services providing prehospital care. The scoping review highlighted the need for validation of existing prehospital care QIs and de novo QI development.

Phase 2: evidence-informed expert consensus process

Phase 2 will comprise an evidence-informed expert consensus process to optimise the clarity of QIs and evaluate which are valid for the measurement of prehospital care quality in Australia. Preparative work will involve aggregating the dimensions of prehospital care quality and the prehospital care QIs charted in phase 1, as well as compliling evidence summaries to inform the expert panel. There are practical advantages, including the critical appraisal of QIs, in aggregating multiple dimensions of quality into a smaller number of principal dimensions.[20] Campbell and colleagues[20] argued that there are two overarching dimensions of quality of care: access and

Table 1 Example of search terms/filters used in PubMed

Concept	[1] Prehospital care	[2] QI
Search terms	Ambulances[mh] OR Emergency Medical Technicians[mh] OR Air Ambulances[mh] OR paramedic*[tiab] OR ems[tiab] OR emt[tiab] OR prehospital[ti[ab] OR pre-hospital[tiab] OR first responder*[tiab] OR emergency medical technician*[tiab] OR emergency services(tiab] OR ambulance*[tiab]	(QI related search terms)
Search filter	[1] AND [2], English only; Systematic Reviews and Meta-Analyses/Meta-Synthesis only (Change to '[1] AND [2], English only' if no or poor-quality Systematic Reviews and Meta-Analyses/Meta-Synthesis are identified)	

QI, quality indicator.

effectiveness. Aggregation of attributes of prehospital care quality into these two key dimensions has previously been performed by Owen.[9]

The development of the evidence summaries to inform the expert panel of best available evidence for each QI will be guided by the JBI approach for rapid reviews and evidence summaries.[21] Figure 2 provides a diagrammatic outline of the rapid review and evidence summary process.

Literature searches will be undertaken in the following databases: PubMed, CINAHL, the JBI Database of Systematic Reviews and Implementation Reports and the Cochrane Library. Table 1 details an example of search terms used. Generally, terms related to prehospital care will be combined with QI specific terms. Development of the terms related to prehospital care will be guided by search filters created by Olaussen *et al*.[22] Only English language papers will be included for pragmatic reasons. Searches will not be limited by date. The search will also include backtracking of references. In line with JBI's approach to evidence summaries,[21 23] the best available evidence will be incorporated in each summary. This means that lower-level evidence will be included only when no systematic reviews are located. The JBI levels of evidence are detailed in table 2.

Following the search, titles and abstracts will be screened. If potentially eligible, the full text of the papers will be read to determine whether the article should be

Table 2 JBI levels of evidence for effectiveness, diagnosis and meaningfulness[23]

	Study designs		
Level of evidence	**Effectiveness**	**Diagnosis**	**Meaningfulness**
1	Experimental designs including:	Studies of test accuracy among consecutive patients:	Qualitative or mixed-methods systematic review
	a. Systematic review of randomised controlled trials (RCTs)	a. Systematic review of studies of test accuracy among consecutive patients	
	b. Systematic review of RCTs and other study designs		
	c. mRCTs	b. Study of test accuracy among consecutive patients	
	d. Pseudo-RCTs		
2	Quasi-experimental designs including:	Studies of test accuracy among non-consecutive patients:	Qualitative or mixed-methods synthesis
	a. Systematic review of quasi-experimental studies	a. Systematic review of studies of test accuracy among non-consecutive patients	
	b. Systematic review of quasi-experimental and other lower study designs		
	d. Quasi-experimental prospectively controlled study	b. Study of test accuracy among non-consecutive patients	
	e. Pretest post-test or historic/retrospective control group study		
3	Observational—Analytical designs including:	Diagnostic case-control studies:	Single qualitative study
	a. Systematic review of comparable cohort studies	a. Systematic review of diagnostic case-control studies	
	b. Systematic review of comparable cohort and other lower study designs		
	c. Cohort study with control group	b. Diagnostic case-control study	
	d. Case controlled study		
	e. Observational study without a control group		
4	Observational—Descriptive designs including:	Diagnostic yield studies:	Systematic review of expert opinion
	a. Systematic review of descriptive studies	a. Systematic review of diagnostic yield studies	
	b. Cross-sectional study	b. Individual diagnostic yield study	
	c. Case series	b. Individual diagnostic yield study	
	d. Case study		
5	Expert opinion and bench research including:	Expert opinion and bench research:	Expert opinion
	a. Systematic review of expert opinion	a. Systematic review of expert opinion	
	b. Expert consensus	b. Expert consensus	
	c. Bench research/single expert opinion	c. Bench research/ single expert opinion	

JBI, Joanna Briggs Institute.

Table 3 Abridged quality appraisal criteria for JBI evidence summaries[21]

Type of study/ evidence	Quality appraisal criteria
Systematic review	Is the review question clearly and explicitly stated?
	Was the search strategy appropriate?
	Were the inclusion criteria appropriate for the review question?
	Were the criteria for appraising studies appropriate?
	Was critical appraisal by two or more independent reviewers?
	Were there methods used to minimise error in data extraction?
	Were the methods used to combine studies appropriate?
Quantitative evidence	Was there appropriate randomisation?
	Was allocation concealed?
	Was blinding to allocation maintained?
	Was incompleteness of data addressed?
	Were outcomes reported accurately?
Qualitative evidence	Was the research design appropriate for the research?
	Was the recruitment strategy appropriate for the research?
	Were data collected in a way that addressed the research issue?
	Has the relationship between researcher and participants been considered?
	Was the data analysis sufficiently rigorous?

JBI, Joanna Briggs Institute.

included in the applicable evidence summary. Full-text reading will involve an assessment of internal validity using an abridged critical appraisal tool (table 3). The rapid reviews and evidence summaries that will be developed for this study will have several limitations. The more a rapid review adheres to the methodological rigour of systematic reviews, the longer it will take to complete.[21 24 25] Therefore, the less time is taken to complete a rapid review the less thorough it will be. The JBI approach to evidence summaries aims for a rapid development cycle.[21] This method is considered suitable for the purpose of this project considering the limited resources and time available. These restrictions also mean that there will be only one researcher to screen, select, appraise and summarise the evidence and no peer review will be undertaken which may inevitable introduce increased risk of bias and error.

An Australian prehospital care expert panel of 7–15 members will be recruited. Panellists must have perspectives and areas of expertise in Australian paramedicine, prehospital care, ambulance service leadership and management, quality improvement, performance/quality measurement and patient perspective. There are 8 state/territory-based ambulance services, 1 paramedicine professional associations and 18 universities offering paramedicine programmes. These institutions will be contacted and asked to nominate experts for participation in the study. The nomination process will require the nominator making a project information and nomination form available to the nominee for perusal and signature. Self-nomination will be allowed. The completed forms and attached curriculum vitae (CV) will be emailed to the lead investigator. The research team will select expert panel members based on information provided in the forms and attached CV. This is a confidential process and only the researchers will peruse the completed forms and CV. The main selection criteria to be considered will be acknowledged leadership in paramedicine, absence of conflicts of interest and geographic diversity (ideally at least one panellist from each state/territory). A RAM will be applied. RAM is a formal panel judgement process which systematically and quantitatively combines available scientific evidence with expert opinion by asking panel members to rate, discuss and then re-rate the items of interest.[26] For the purpose of this project, the original method will be modified in the following ways:

- Evidence summaries instead of systematic reviews: As described in the RAM user's manual,[27] the critical review of the literature summarising the best available scientific evidence is a fundamental initial step to inform panel members and as a resource to facilitate resolving any disagreements. The manual suggests that a systematic review is a good way to conduct a RAM literature review.[27] Due to the rigorous methods applied when conducing a full systematic review, however, they can take an extensive amount of time to complete.[28] It is anticipated that it will not be feasible to conduct systematic reviews for all QIs within the time and resources available for this project. Instead, to assist panel members in rating the validity of the QIs, evidence summaries will be compiled as described above for those QIs where published research evidence exists.
- Opportunity for expert panel members to suggest additional QIs: In addition to rating the proposed QIs, panel members will also be invited to suggest additional QIs. This is optional but considered important, especially if expert panel members feel that the proposed QIs do not sufficiently address vital aspects of prehospital care essential for quality measurement in the Australian context.
- Online rating and discussions instead of a postal rating sheet and face-to-face meeting: In anticipation of geographically distant locations of potential expert panel members in Australia, the second round will be conducted online. This has been found feasible in other studies using the method among geographically distributed participants.[29]

The consensus method will be a two-round online process. The online process will be designed on Qualtrics (Qualtrics, Provo, Utah, USA). In round one, panellists will be asked to separately rate the clarity and validity of each QI on scales from 1 to 9. To improve clarity, panellist will have the opportunity to make suggestions on changing the wording of the QIs. Panellists will also have an opportunity to suggest additional QIs, ideally supported by best available evidence. For the assessment of the QIs' validity, panellist will be asked to consider the summarised evidence as well as their own knowledge and experience. In round two, panellists will join an asynchronous online discussion platform (Kialo, Brooklyn, New York, USA) moderated by one of the researchers. Discussions will be informed by individualised and anonymised results from the first round consisting of each panellist's own rating compared with the frequency distribution for the ratings, the overall panel median and the mean absolute deviation around the median. Panellists will have an opportunity to discuss each QI before re-rating its validity.

Data analysis will be performed using Microsoft Excel V.2019 (Microsoft, Richmond, Washington, USA) and in accordance with the RAM.[27] To proceed to the third and final phase of the project, there needs to be consensus that the QI is valid in the Australian prehospital care context. Validity will be signalled by a final panel median score of greater than or equal to seven with no disagreement. The definition of disagreement will depend on the number of panellists.

Phase 3: mixed methods

In this final phase, focus will be shifted from evaluating which QIs are valid to assessing which QIs are useful. As such, this phase is based on pragmatism as a philosophical foundation.[30] Taking a social science theory perspective informed by reviews and frameworks of acceptability as a criterion for evaluating performance measures,[31–33] phase 3 will involve the successional collection of quantitative and qualitative data to facilitate integrated interpretations and conclusions about the acceptability of the candidate QIs. Feasibility and reliability will be investigated in the same fashion. Thus, this phase will see the utilisation of explanatory sequential designs as illustrated in figure 3. The choice of mixed methods is in line with broad consensus that the rationale for a mixed approach must be a pragmatic one.[34]

Target participants for part 1 will be Australian paramedics and ambulance service managers, the individuals and representatives of services whose quality of prehospital care would be measured after implementation of the QIs. Based on the Australian registered paramedic population of approximately 17 000,[35] and using a sample size estimation with a CI of 95% and margin of error of 8%, an ideal sample size of 149 will be required for the survey (part 1A). The survey will be disseminated through Australian paramedicine professional associations and social media. Participants will be asked to complete an anonymous online non-validated survey instrument purpose-built for this project (designed on Qualtrics; Qualtrics, Provo, Utah, USA). The survey will collect basic demographic data such as gender, age, paramedic qualification, years of experience in paramedicine, employment location and role. Depending on the number of candidate QIs stemming from the phase 2 of the project, the survey will consist of all or a random sample of the QIs. Using a five-point Likert scale, participants will be asked to rate the acceptability of each QI ranging from very unacceptable to very acceptable. At the end of the survey, participants will be asked if they would like to volunteer to partake in the subsequent semistructured interviews (part 1B). It will be made clear that by participating in part 1B, anonymity cannot be maintained. However, information gathered in this part will be kept confidential. Quantitative data analysis will be performed using Microsoft Excel 2019 (Microsoft, Richmond, Washington, USA). Non-parametric procedures, based on the median, as well as distribution-free methods such as tabulations,

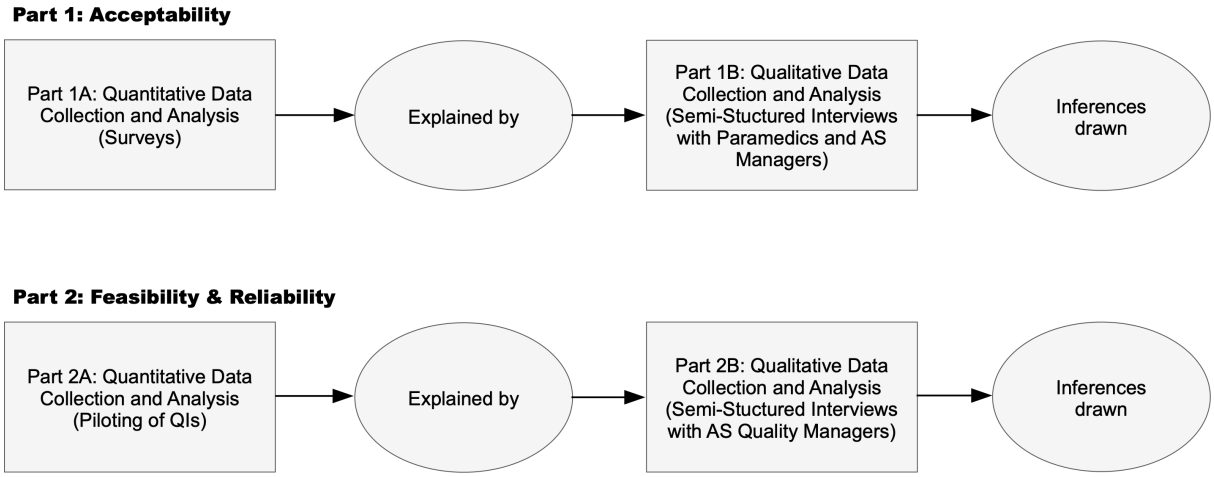


Figure 3 Explanatory sequential design of phase 3. AS, ambulance service.

Box 1 Questions set a priori in the interview guide for phase 3, part 1B

Opening
1. How long have you been involved in the ambulance service and what roles have you held?

Transition
1. What makes a quality indicator acceptable or not acceptable?

Key
1. How acceptable did you find the quality indicators in general?
2. How well do you think the quality indicators align to professional standards and values?
3. Clinician: Would you agree for your clinical practice to be measured and evaluated using these quality indicators? Manager/Supervisor: Would you agree to measure and evaluate the clinical practice of the staff you are supervising by using these quality indicators?

Closing
1. Is there anything you would like to add?
2. Do you have any questions about the interview or the research?

Box 2 Questions set a priori in the interview guide for phase 3, part 2B

In relation to specific QIs
1. Do you think the target population is well described?
2. Is the numerator and denominator sufficiently defined?
3. Are the exclusions clear?
4. (In the pilot results form, it was indicated that IT/software is insufficient. What would need to be done to upgrade the system/software? Are there any barriers to this?)
5. (In the pilot results form, it was indicated that data is not available from existing sources. What would need to be done to obtain the required data? Are there any barriers to this?)
6. Is the data consistent with repeated measurements?
7. Do you think the indicator measures an aspect of your service that occurs often enough to detect clinically (or other) important changes?
8. (In the pilot results form, it was indicated that piloting the indicator was not successful in producing an accurate reflection of (Ambulance Service name) performance. What made the results unreliable/imprecise? What would need to be changed to make it reliable/precise?)
9. Are the results understandable?
10. Do you believe using this indicator as a quality improvement tool induces risk of data manipulation?

Closing
1. Is there anything you would like to add?
2. Do you have any questions about the interview or the research?

frequencies, contingency tables and chi-squared statistics will be used for analysing these data.[36 37] Analysed data from part 1A will inform the development of a semistructured interview guide for part 1B. The interview guide will also contain some a priori questions (box 1). Questions will be open-ended and aimed at facilitating the explanation of what makes QIs acceptable or unacceptable and how the candidate QIs align to professional standards and values. To ensure diversity in the participants and to optimise credibility of results, maximum variation sampling will be used in part 1B.[38 39] This will be achieved by combining self-selected participants with purposeful recruitment of individuals meeting demographic criteria poorly accounted for in the self-selected cohort. Targeted recruitment will be done through the professional networks of the researchers. Interviews will be conducted in English by the principle investigator (RP) and recorded for transcription. During and immediately after, field notes will be taken. Qualitative data will be collected until saturation is achieved,[40] and descriptive approaches will be taken by conducting content analyses using Nvivo V.12 (QRS International, Doncaster, Australia).[41 42] This will involve disassembling the data through coding, reassembling the coded data by putting it into context with each other to create categories and ultimately themes, and finally interpreting the data thereby drawing analytical conclusions.[43 44] Several techniques will be used to enhance trustworthiness; these will include prolonged engagement, triangulation of recorded interviews, transcripts and field notes, and member checking.[45]

For part 2, voluntary participation of Australian state/territory ambulance services and their quality managers will be sought. The research team will make direct contact with the ambulance services to enquire about interest in participating. There are eight jurisdictional ambulance services in Australia and participation of as many as possible will be pursued. Depending on the number of candidate QIs stemming from phase 2 of the project, participating ambulance services will be asked to pilot all or a random sample of the QIs (part 2A). A questionnaire will collect service-describing data on variables such as size, call volume, datasets and quality measurement/management/improvement practices, and elicit details about the feasibility and reliability of measuring ambulance service performance using the candidate QIs. Quantitative data analysis will be performed using Microsoft Excel V.2019 (Microsoft, Richmond, Washington, USA). Similar to part 1, summarised results from part 2A will inform the development of a semistructured interview guide for part 2B. This guide will also contain some a priori questions (box 2). Questions will be open-ended and aimed at facilitating the explanation of what makes QIs feasible or unfeasible, especially from a non-technical perspective. Data collection during the interviews and subsequent processing and analysis will be conducted using the same approach described for part 1 above.

Patient and public involvement

Neither patients nor the public have been involved in the design of this project. The findings of the project will be made available to patients and the general public as part of the dissemination strategy. Future research may evaluate patient and public perceptions of the QIs.

DISCUSSION

Not only is there rising demand for ambulance services but also increasing requirements to improve, maintain and evidence quality of care. QIs are often selected arbitrarily[46 47]; however, there appears to be growing interest in finding better ways to measure the quality of prehospital care provided by ambulance services.[17] Measurement using intelligent and meaningful QIs over time is key to understanding variation and ultimately where and how to conduct improvement efforts.[48] The QIs which will be developed in this project provide a mechanism to appraise Australian ambulance services' performance and a framework to direct, monitor and demonstrate quality improvement efforts. Essential for the development of QIs is a definition of quality. Proceeding to develop indicators for the measurement of quality without understanding and consensus on what the concept of quality entails is unlikely to result in meaningful assessment of quality.[49] Indicators can be developed using non-systematic and systematic methods.[3] Non-systematic methods are relatively quick; however, they tend not to incorporate all available evidence during their development. Systematically developed QIs are ideally based on high-level scientific evidence or they are derived from evidence-informed guidelines.[3 50] In areas or disciplines with limited scientific evidence, such as paramedicine, it may be necessary to combine the available evidence with expert consensus.[51]

A good QI needs to possess certain attributes which will assure that it can be used to make an accurate and fair judgement about quality. QIs should be valid, acceptable, feasible and reliable and must therefore be assessed or tested for these attributes before implementation. A good QI also has clear meaning which enables what is being assessed to be precisely attributable to that indicator.[3 52] In other words, a clear QI is one which is free of ambiguity, inaccuracy or imprecision. Validity is arguably the most important property of a QI. In science, validity refers to the degree to which evidence and theory support the interpretation of scores entailed by proposed uses of an instrument.[53] Thus, in the quality measurement context, validity refers to the degree to which evidence and theory support the expected interpretation of measured elements of practice performance related to the QIs. In more simple terms, validity refers to the extent to which the given statement represents high-quality care and would therefore be an endorsed indicator of quality. When assessing the validity of QIs, careful consideration of the intended context is important.[54–56] While there are considerable benefits in using work from other locations, QIs cannot simply be transferred directly between different settings without an intermediate process to allow for variation in professional culture and clinical practice.[57] As such, rating the validity of QIs entails as much assessment of whether they represent high-quality care as it does of how contextually applicable they are. Therefore, a method of group consensus using current scientific evidence in conjunction with Australian expert opinion to develop the clarity and assess the contextual validity of proposed QIs is deemed to be the approach of choice for this particular phase of the project. Several consensus processes have been used for the development of QIs. The original RAM was developed in the mid-1980s by the RAND Corporation in collaboration with the University of California Los Angeles (UCLA) as an instrument to facilitate the measurement of medical and surgical intervention appropriateness.[27] RAM has been used extensively as a method of QI development,[3 52 58 59] including QIs to evaluate prehospital care.[9]

Acceptability refers to the quality of being satisfactory or agreeable in terms of professional standards and values. If the aim of measurement is to provide direction for quality improvement, then the QIs need to be interpretable and meaningful to the audience, that is, clinicians and managers. However, the benefit of assessing QIs for acceptability extends beyond their development and testing. Measurement provides information to direct improvement efforts and is thus central to quality improvement.[3 47 60–63] Involvement of clinicians and managers in the development of indicators is likely to improve their uptake and contributes to sustainability in quality improvement.[32] Measurement of the quality of care may also serve as or contribute to performance appraisal systems. In this instance, user acceptance of such systems may be a critical criterion to ensure the successful implementation.[32] Feasibility and reliability relate to the measurability of a QI. Testing QIs for these attributes is critical and ensures that implementation and sustained measurement is successful. Feasibility relates to the availability or attainability of accurate data and whether these data are realistically collectable.[52] Feasibility thus encompasses technical and non-technical aspects of data collection and analysis. A feasible QI also facilitates measurement which is applicable to quality improvement, sensitive to improvement over time and useful for decision-making.[64] Reliability, in this instance, is closely related to precision and refers to the consistency of scores across replications of a testing procedure.[65] Testing reliability intends to assess whether the QIs are non-erroneously reproducible and for any errors to be identified.[52] A reliable QI facilitates measurement which has low inter-rater or intrarater variation and suitable for statistical analyses.[64]

To test if and to what extent the QIs are acceptable, feasible and reliable, a mixed methods approach will be used. The reason for mixing both types of data is that neither quantitative nor qualitative methods alone would suffice to adequately capture the complex issue of QI acceptability, feasibility and reliability. Combined, quantitative and qualitative methods can complement each other and thus provide a more comprehensive picture of a research problem.[66] More specifically, by applying a sequential explanatory mixed methods design, quantitative data and results will provide a general initial outline of how acceptable, feasible and reliable the QIs are, while the subsequent qualitative data and its analysis will explain those statistical results by exploring the participants' views regarding the QIs in more depth. Although

results of the quantitative and qualitative aspects will be integrated, priority will be given to the quantitative or the qualitative side during the analysis depending on which aspect is expected to require more emphasis.[67] Therefore, in part 1 (acceptability), more emphasis will be placed on the qualitative component to thoroughly understand why certain QIs are deemed acceptable or not acceptable. Whilst part 2 (feasibility and reliability) will require more focus on the quantitative aspect, non-technical facilitators and barriers to feasibility will be explained through data analysis of the information obtained from participants.

There are a number of anticipated real and potential limitations. First, the preliminary scoping review bears inherent and specific limitations. Scoping reviews methods do not include an appraisal of quality or risk of bias when selecting studies for inclusion. The scoping review conducted for this project included articles written in English only and therefore the search performed may not have been exhaustive. Second and similarly, rapid reviews also have intrinsic limitations concerning their scope, comprehensiveness and rigour. However, considering the large number of QIs for which evidence needs to be identified and the time it would take to conduct systematic reviews, the rapid review and evidence summary approach is most appropriate. Third, while there are clear advantages of conducting online expert panels (eg, more efficient use of the experts' time and making online discussions anonymous and thus reduce possible biases based on participant status or personality),[29 68] this approach may also potentially present limitations. Unfamiliarity, technical issues or general dislike of online tools could decrease levels of engagement and interactions among the expert panel. This may undermine the expert panel members' willingness to participate and affect the quality of discussions and outputs.[69] Lastly, it is unlikely that all Australian state/territory ambulance services will be able or willing to participate in the final phase of the project. These services have significant differences in aspects such as size, clinical practice, data management, etc. Thus, the smaller the number of services that will participate, the less generalisable the results will be.

ETHICS AND DISSEMINATION

The project will be conducted in accordance with the National Health and Medical Research Council National Statement on Ethical Conduct in Human Research, as well as the approved research proposal. This project has been approved by the University of Adelaide Human Research Ethics Committee (Approval Number H-2017-157). It is supported through an Australian Government Research Training Programme Scholarship and in part by a research grant from the Australasian College of Paramedicine.

The scoping review has been published.[17] Further findings of the project will be communicated using a comprehensive dissemination strategy. This strategy includes several different forms of dissemination to reach out to individuals and stakeholder groups at the national and international level. More specifically, this will involve publishing in peer-reviewed journals and presenting at national and international conference presentations, posting on social media sites such as Twitter, making announcements on the project's website (www.aspire-project.net) and emailing study findings to participants and appropriate stakeholders.

Twitter Robin Pap @robin_pap

Contributors RP is the guarantor. RP incepted the project and prepared the manuscript. CL, MS and PS reviewed drafts to help refine the manuscript. All authors have read and approved the final draft.

Funding This project is supported by an Australian Government Research Training Program Scholarship. This project is in part supported by a research grant from the Australasian College of Paramedicine (ACP).

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

ORCID iD

Robin Pap http://orcid.org/0000-0002-7058-0341

REFERENCES

1 Donabedian A. *An introduction to quality assurance in healthcare*. Oxford: Oxford University Press, 2003.
2 Mainz J. Defining and classifying clinical indicators for quality improvement. *Int J Qual Health Care* 2003;15:523–30.
3 Campbell SM, Braspenning J, Hutchinson A, *et al*. Research methods used in developing and applying quality indicators in primary care. *BMJ* 2003;326:816–9.
4 Lawrence M, Olesen F. Indicators of quality in health care. *Eur J Gen Pract* 1997;3:103–8.
5 Lowthian JA, Cameron PA, Stoelwinder JU, *et al*. Increasing utilisation of emergency ambulances. *Aust Health Rev* 2011;35:63–9.
6 Paramedics Australasia. Paramedicine role descriptions [online], 2012. Available: https://www.paramedics.org
7 von Vopelius-Feldt J, Benger J. Who does what in prehospital critical care? an analysis of competencies of paramedics, critical care paramedics and prehospital physicians. *Emerg Med J* 2014;31:1009–13.
8 Sayre MR, White LJ, Brown LH, *et al*. The national EMS research agenda. *Prehospital Emerg Care* 2002;6:1–43.
9 Owen RC. *The development and testing of indicators of prehospital care quality [dissertation]*. Manchester: University of Manchester, 2010.
10 Australian Government Productivity Commission - Steering Committee for the Review of Government Service Provision. Report on Government Services - Chapter 11: Ambulance services [online], 2020. Available: https://www.pc.gov.au/research/ongoing/report-on-government-services/2019/health/ambulance-services
11 Studnek JR, Garvey L, Blackwell T, *et al*. Association between prehospital time intervals and ST-elevation myocardial infarction system performance. *Circulation* 2010;122:1464–9.
12 Takahashi M, Kohsaka S, Miyata H, *et al*. Association between prehospital time interval and short-term outcome in acute heart failure patients. *J Card Fail* 2011;17:742–7.
13 Byrne JP, Mann NC, Dai M, *et al*. Association between emergency medical service response time and motor vehicle crash mortality in the United States. *JAMA Surg* 2019;154:286–93.
14 Blanchard IE, Doig CJ, Hagel BE, *et al*. Emergency medical services response time and mortality in an urban setting. *Prehospital Emerg Care* 2012;16:142–51.
15 Pons PT, Haukoos JS, Bludworth W, *et al*. Paramedic response time: does it affect patient survival? *Acad Emerg Med* 2005;12:594–600.

16 Durham M, Faulkner M, Deakin C. Targeted response? an exploration of why ambulance services find government targets particularly challenging. *Br Med Bull* 2016;120:35–42.
17 Pap R, Lockwood C, Stephenson M, *et al*. Indicators to measure prehospital care quality: a scoping review. *JBI Database System Rev Implement Rep* 2018;16:2192–223.
18 Aromataris E, Munn Z. JBI Manual for Evidence Synthesis [online], 2020. Available: https://synthesismanual.jbi.global/
19 Pap R, Lockwood C, Stephenson M, *et al*. Indicators to measure pre-hospital care quality: a scoping review protocol. *JBI Database System Rev Implement Rep* 2017;15:1537–42.
20 Campbell SM, Roland MO, Buetow SA. Defining quality of care. *Soc Sci Med* 2000;51:1611–25.
21 Munn Z, Lockwood C, Moola S. The development and use of evidence summaries for point of care information systems: a streamlined rapid review approach. *Worldviews Evid Based Nurs* 2015;12:131–8.
22 Olaussen A, Semple W, Oteir A, *et al*. Paramedic literature search filters: optimised for clinicians and academics. *BMC Med Inform Decis Mak* 2017;17:1–6.
23 Joanna Briggs Institute. The JBI Approach [online], 2017. Available: http://joannabriggs.org/jbi-approach.html
24 Ganann R, Ciliska D, Thomas H. Expediting systematic reviews: methods and implications of rapid reviews. *Implement Sci* 2010;5:1–10.
25 Wyer PC, Rowe BH. Evidence-based reviews and databases: are they worth the effort? developing evidence summaries for emergency medicine. *Acad Emerg Med* 2007;14:960–4.
26 Nair R, Aggarwal R, Khanna D. Methods of formal consensus in classification/diagnostic criteria and Guideline development. *Semin Arthritis Rheum* 2011;41:95–105.
27 Fitch K, Bernstein SJJ, Aguilar MDD, *et al*. The RAND/UCLA appropriateness method user's manual [online], 2001. Available: http://www.rand.org
28 Borah R, Brown AW, Capers PL, *et al*. Analysis of the time and workers needed to conduct systematic reviews of medical interventions using data from the prospero registry. *BMJ Open* 2017;7:e012545.
29 Khodyakov D, Hempel S, Rubenstein L, *et al*. Conducting online expert panels: a feasibility and experimental replicability study. *BMC Med Res Methodol* 2011;11:174–82.
30 Perla RJ, Provost LP, Parry GJ. Seven propositions of the science of improvement: exploring foundations. *Qual Manag Health Care* 2013;22:170–86.
31 Levy PE, Williams JR. The social context of performance appraisal: a review and framework for the future. *J Manage* 2004;30:881–905.
32 Hedge JW, Teachout MS. Exploring the concept of acceptability as a criterion for evaluating performance measures. *Group Organ Manag* 2000;25:22–44.
33 Sekhon M, Cartwright M, Francis JJ. Acceptability of healthcare interventions: an overview of reviews and development of a theoretical framework. *BMC Health Serv Res* 2017;17:1–13.
34 Biesta G. Pragmatism and the philosophical foundations of mixed methods research. In: Tashakkori A, Teddlie C, eds. *SAGE handbook of mixed methods in social and behavioral research*. 2nd ed. Thousand Oaks: SAGE Publications, Inc, 2010.
35 Australian Health Practitioner Regulation Agency. Annual report 2018/19 our national scheme: for safer healthcare [online], 2019. Available: https://www.ahpra.gov.au
36 Sullivan GM, Artino AR. Analyzing and interpreting data from likert-type scales. *J Grad Med Educ* 2013;5:541–2.
37 Harpe SE. How to analyze Likert and other rating scale data. *Curr Pharm Teach Learn* 2015;7:836–50.
38 Creswell J, Clark P V. *Designing and conducting mixed methods research*. 2nd ed. Los Angeles: Sage Publications Inc, 2011: 457.
39 Palinkas LA, Horwitz SM, Green CA, *et al*. Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Adm Policy Ment Health* 2015;42:533–44.
40 Saunders B, Sim J, Kingstone T, *et al*. Saturation in qualitative research: exploring its conceptualization and operationalization. *Qual Quant* 2018;52:1893–907.
41 Sandelowski M. What's in a name? Qualitative description revisited. *Res Nurs Heal* 2010;33:77–84.
42 Vaismoradi M, Turunen H, Bondas T. Content analysis and thematic analysis: implications for conducting a qualitative descriptive study. *Nurs Health Sci* 2013;15:398–405.
43 Castleberry A, Nolen A. Thematic analysis of qualitative research data: is it as easy as it sounds? *Curr Pharm Teach Learn* 2018;10:807–15.
44 Erlingsson C, Brysiewicz P. A hands-on guide to doing content analysis. *African J Emerg Med* 2017;7:93–9.
45 Hadi MA, José Closs S. Ensuring rigour and trustworthiness of qualitative research in clinical pharmacy. *Int J Clin Pharm* 2016;38:641–6.
46 Jones P, Shepherd M, Wells S, *et al*. Review article: what makes a good healthcare quality indicator? A systematic review and validation study. *Emerg Med Australas* 2014;26:113–24.
47 Barr S. *Practical performance Measurment: using the PuMP blueprint for fast, easy and engaging KPIs*. Samford: PuMP Press, 2014: 356.
48 Siriwardena AN, Gillam S. Measuring for improvement. *Qual Prim Care* 2013;21:293–301.
49 Donabedian A. The quality of care: how can it be assessed? *J Am Med A* 1988;260:1743–8.
50 Kötter T, Blozik E, Scherer M. Methods for the guideline-based development of quality indicators–a systematic review. *Implem Sci* 2012;7:21.
51 Mainz J. Developing evidence-based clinical indicators: a state of the art methods primer. *Int J Qual Health Care* 2003;15 Suppl 1:5i–11.
52 Campbell SM, Kontopantelis E, Hannon K, *et al*. Framework and indicator testing protocol for developing and piloting quality indicators for the UK quality and outcomes framework. *BMC Fam Pract* 2011;12:85.
53 Krabbe PFM. *The measurement of health and health status: concepts, methods and applications from a multidisciplinary perspective*. San Diego: Elsevier Science & Technology, 2016: 380.
54 Delnoij DMJ, Westert GP. Assessing the validity of quality indicators: keep the context in mind! *Eur J Public Health* 2012;22:452–3.
55 Lawrence M, Olesen F. Indicators of quality in health care. *EurJ Gen Prac* 1997;3:103–8.
56 Frongillo EA, Baranowski T, Subar AF, *et al*. And Cross-Context equivalence of measures and indicators. *J Acad Nutr Diet* 2018:1–14.
57 Marshall MN, Shekelle PG, McGlynn EA, *et al*. Can health care quality indicators be transferred between countries? *Qual Saf Health Care* 2003;12:8–12.
58 Campbell SM, Braspenning J, Hutchinson A, *et al*. Research methods used in developing and applying quality indicators in primary care. *Qual Saf Health Care* 2002;11:358–64.
59 Campbell SM, Cantrill JA. Consensus methods in prescribing research. *J Clin Pharm Ther* 2001;26:5–14.
60 Siriwardena AN, Gillam S. *Quality improvement in primary care: the essential guide*. London: CRC Press, Taylor & Francis Group, 2014: 159.
61 Sollecito WA, Johnson JK. *McLaughlin and Kaluzny's continuous quality improvement in health care*. 4th ed. Burlington: Jones & Bartlett Learning, 2013: 619.
62 Lloyd R. *Quality health care: a guide to developing and using indicators*. Sudbury: Jones and Bartlett, 2004: 343.
63 Mainz J. Quality indicators: essential for quality improvement. *Inter J Qual Heal* 2004;16:i1–2.
64 Wollersheim H, Hermens R, Hulscher M, *et al*. Clinical indicators: development and applications. *Neth J Med* 2007;65:15–22.
65 American Educational Research Association, American Psychologial Association, National Council on Measurement in Education. *Standards for educational and psychological testing*. Washington: American Educational Research Association, 2014: 230.
66 Teddlie C, Tashakkori A. Overview of contemporary issues in mixed methods research. In: Tashakkori A, Teddlie C, eds. *SAGE Handbook of mixed methods in social and behavioral research*. 2nd ed. Thousand Oaks: SAGE Publications, Inc., 2010.
67 Onwuegbuzie A, Combs J. Emergent data analysis techniques in mixed methods research: a synthesis. In: Teddlie C, Tashakkori A, eds. *SAGE Handbook of mixed methods in social and behavioral research*. 2nd ed. Thousand Oaks: SAGE Publications, Inc., 2010.
68 Bowles KH, Holmes JH, Naylor MD, *et al*. Expert consensus for discharge referral decisions using online Delphi. *AMIA Annu Symp Proc* 2003:106–9.
69 Snyder-Halpern R, Thompson CB, Schaffer J. Comparison of mailed vs. internet applications of the Delphi technique in clinical informatics research. *Proc AMIA Symp* 2000:809–13.

3.4 Summary

This chapter described the methods used in the studies of this PhD project. Throughout, emphasis was placed on maintaining systematic and rigorous approaches. As detailed in Chapter 2, the initial scoping review utilised JBI methods for conducting scoping reviews. For the subsequent study presented in Chapter 4, an evidence informed expert consensus process was selected to address research objective 2 and thus develop a suite of prehospital care QIs and to assess them for validity. Preliminary work involved the systematic preparation of charted QIs within a clinical and non-clinical classification system, and a structure-process-outcome and access-safety-effectiveness taxonomy. A modified RAM involving a panel consisting of nine Australian experts facilitated a systematic intermediate process for assessing the clarity and validity of the proposed QIs and provided an opportunity for the development of additional QIs. Sensitive to the relatively young health care discipline of paramedicine in which high-quality evidence is scarce,[66–68] the process integrated *best available* evidence for the proposed QIs and combined this with expert opinion. Search, selection, and synthesis of best available evidence was undertaken using a streamlined rapid review approach to produce evidence summaries relating to the QIs and for consideration by the expert panel (Appendix D).

For the final study presented in Chapter 5, an explanatory sequential mixed methods design was employed to test the acceptability of prehospital care QIs assessed as valid, thus addressing research objective 3. A mixed methods approach was chosen in light of neither a purely quantitative nor entirely qualitative approach being sufficient to comprehensively explore the acceptability of the QIs. Quantitative data were obtained from 36 participants rating the acceptability of the QIs using a 5-point numerical rating scale in an online survey. Semi-structured interviews were subsequently conducted with a purposive sample of nine

survey participants to collected qualitative data. Integrated interpretations of the quantitative and qualitative data, with emphasis of the qualitative data, facilitated conclusions to be drawn about the acceptability of the QIs.

The methods for the individual studies are detailed in the relevant study chapters. The next chapter describes the development of evidence-informed Australian prehospital QIs.

Chapter 4: The development of Australian prehospital quality indicators

4.1 Overview

As explained in previous chapters, the systematic development of high-quality QIs requires rigorous methods. Similarly, whilst there are commonalities in QIs used internationally, they should not simply be transferred between countries or settings without a systematic intermediate process.[42] Basing QIs on underpinning evidence is fundamental to systematic development. When the scientific evidence base is insufficient, absent, or methodologically weak, as is the case in many areas of prehospital care, best available evidence needs to be combined with expert opinion.[34] Again, this process needs to utilise rigorous and reproducible methods to inform the expert panel of best available evidence and to assess their level of agreement.

After the establishment of an initial list of QIs in study 1, this chapter presents study 2 and the work undertaken to prepare for and conduct a modified RAM serving as a systematic method for transferring QIs to the Australian setting and adding new ones to establish a valid, comprehensive, and balanced suite of QIs. The chapter thus addresses research objective 2 which was to develop a suite of prehospital care QIs for the Australian setting and to assess the QIs for validity. Validity referred to the extent to which a QI represents high-quality prehospital care provided by Australian ambulance services and would thus be an endorsed indicator of quality in this context. To inform the expert panel, rapid reviews were conducted to summarise the best available evidence. These can be found in Appendix D.

For one, randomly selected QIs (QI-B.6.2), the rapid review and evidence summary prepared for the expert panel was extended to a publishable exemplar. Titled ‘Pelvic circumferential compression devices for prehospital management of suspected pelvic fractures: a rapid review and evidence summary for quality indicator evaluation’ it was published in the *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine* in 2020. The methods and results of the consensus process were published in a paper titled ‘The development of prehospital care quality indicators for the Australian setting: a modified RAND/UCLA appropriateness method’ in the *Emergency Medicine Journal* in 2021.

4.2 Manuscript 4

Statement of Authorship

Title of Paper	Pelvic circumferential compression devices for prehospital management of suspected pelvic fractures: a rapid review and evidence summary for quality indicator evaluation
Publication Status	☑ Published ☐ Accepted for Publication ☐ Submitted for Publication ☐ Unpublished work written in manuscript style
Publication Details	Pap R, McKeown R, Lockwood C, Stephenson M, Simpson P. Pelvic circumferential compression devices for prehospital management of suspected pelvic fractures: a rapid review and evidence summary for quality indicator evaluation. Scand J Trauma Resusc Emerg Med.2020;28(65)

Principal Author

Name of Principle Author (Candidate)	Robin Pap		
Contribution to Paper	Principle author responsible for the design, data extraction, data synthesis, interpretation of results and writing up of the manuscript.		
Overall percentage (%)	80%		
Certification	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature		Date	01 February 2022

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

iv. the candidate's stated contribution to the publication is accurate (as detailed above);
v. permission is granted for the candidate in include the publication in the thesis; and
vi. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Ms Rachel McKeown		
Contribution to Paper	Helped during the development of the search, verified extracted data, and evaluated the manuscript.		
Signature		Date	01 February 2022

Name of Co-Author	Assoc Prof Craig Lockwood		
Contribution to Paper	Principally supervised development of work and in manuscript evaluation.		
Signature		Date	01 February 2022

Name of Co-Author	Dr Matthew Stephenson		
Contribution to Paper	Co-supervised development of work and in manuscript evaluation.		
Signature		Date	01 February 2022

Name of Co-Author	Assoc Prof Paul Simpson		
Contribution to Paper	Co-supervised development of work and in manuscript evaluation.		
Signature		Date	

Pap et al. Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine (2020) 28:65
https://doi.org/10.1186/s13049-020-00762-5

Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine

REVIEW Open Access

Pelvic circumferential compression devices for prehospital management of suspected pelvic fractures: a rapid review and evidence summary for quality indicator evaluation

Robin Pap[1,2*], Rachel McKeown[2], Craig Lockwood[1], Matthew Stephenson[1] and Paul Simpson[2]

Abstract

Background: Pelvic fractures, especially when unstable, may cause significant haemorrhage. The early application of a pelvic circumferential compression device (PCCD) in patients with suspected pelvic fracture has established itself as best practice. Ambulance services conduct corresponding performance measurement. Quality indicators (QIs) are ideally based on high-quality evidence clearly demonstrating that the desirable effects outweigh the undesirable effects. In the absence of high-quality evidence, best available evidence should be combined with expert consensus.

Objectives: The aim of the present study was to identify, appraise and summarize the best available evidence regarding PCCDs for the purpose of informing an expert panel tasked to evaluate the validity of the following QI: A patient with suspected pelvic fracture has a PCCD applied.

Methods: A rapid review of four databases was conducted to identify relevant literature published up until 9 June 2020. Systematic reviews, experimental, quasi-experimental and observational analytic studies written in English were included. One author was responsible for study selection and quality appraisal. Data extraction using a priori extraction templates was verified by a second reviewer. Study details and key findings were summarized in tables.

Results: A total of 13 studies were assessed to be eligible for inclusion in this rapid review. Of these, three were systematic reviews, one was a randomized clinical trial (crossover design), two were before-after studies, and seven were retrospective cohort studies. The systematic reviews included mostly observational studies and could therefore not be considered as high-level evidence. Overall, the identified evidence is of low quality and suggests that PCCD may provide temporary pelvic ring stabilization and haemorrhage control, although a potential for adverse effects exists.

Conclusion: Given the low quality of the best available evidence, this evidence would need to be combined with expert consensus to evaluate the validity of a related quality indicator before its implementation.

Keywords: Pelvic fracture, Trauma, Prehospital care, Rapid review, Quality indicator

* Correspondence: r.pap@westernsydney.edu.au
[1]Joanna Briggs Institute, University of Adelaide, Adelaide, Australia
[2]School of Health Sciences, Western Sydney University, Sydney, Australia

Background

Exsanguinating haemorrhage is one of the leading causes of death in patients suffering major trauma [1]. Besides catastrophic external haemorrhage, blood loss may occur from thoracic, abdominal, pelvic or limb injuries. Any of these alone or in combination can produce significant hypovolemia. Especially injury to the bony pelvis with disruption of the pelvic ring and damage to adjacent blood vessels may cause severe bleeding and can be associated with considerable morbidity and mortality [2–4]. As substantial force is required to cause fracture of the pelvic ring, some of the most frequent mechanisms of this injury involve road traffic accidents, falls from height and localized crush injuries [5, 6]. However, in the elderly with osteoporosis, disruption of the pelvic ring can also occur from low-energy mechanism [7]. Pelvic ring fractures may be classified in a number of ways. Most commonly, the Tile [8] and Young-Burgess [9] classification systems are used. These divide pelvic ring injuries into various types based on stability/instability of the posterior sacroiliac complex (Tile type A: stable, Tile type B: rotationally unstable, Tile type C: vertically and rotationally unstable) and vector of injuring force (lateral compression types, anterior-posterior types, vertical shear types and combined mechanisms) respectively. Considering the potentially life-threatening haemorrhage associated with pelvic ring fractures, rapid identification and management are critical to optimize patient outcomes.

Historically, prehospital management in the form of pelvic binding was performed when inspection and palpation of the pelvis revealed deformity, instability and pain. However, the diagnostic reliability of identifying a pelvic fracture by physical examination is questionable, particularly in the patient with decreased level of consciousness [10–12]. Furthermore, manipulating and especially springing the pelvis carries significant risk of disrupting any clot that may have formed and thus interfering with any spontaneous haemostasis [11]. Therefore, the decision to apply a pelvic circumferential compression device (PCCD) in any blunt trauma patient with *suspected* pelvic ring fracture based predominantly on the mechanism of injury and any visual signs such as bruising around the pelvis is increasingly being advocated as best practice in the prehospital care [13–15]. As the name implies, the intended purpose of a PCCD is to wrap around and stabilize the pelvic ring thereby limiting haemorrhage from cancellous bone or venous sources. The placement of a PCCD on a patient with a mechanism of injury suggestive of pelvic ring disruption is now commonly regarded to be an indicator of high-quality prehospital trauma care [13–15]. As such, many ambulance services utilize this quality indicator (QI) in the measurement of their clinical performance [16].

A QI is an explicitly defined and measurable aspect of health care services indicative of a desirable structure, process or outcome [17]. That is to say, there is evidence and/or consensus that the indicator can be used to quantify the quality of service provided, and thus monitor changes in quality over time [18]. This measurement provides a tool to identify unwarranted variation, facilitate data-driven improvement efforts and assess their impact. Systematically developed QIs are ideally based on scientific evidence. This may stem from rigorously developed guidelines [19, 20], but preferably is based directly upon high-quality scientific evidence such as thoroughly conducted (trial-based) empirical studies or robust systematic reviews and meta-analyses of randomized controlled trials (RCT) [17, 21]. In areas or disciplines where such evidence is scarce, it may be necessary to combine the best available evidence with expert consensus [17, 22]. Since the methodical review of underpinning evidence is fundamental to the systematic development of quality indicators, the expert consensus process should also be evidence-informed. The RAND/UCLA appropriateness method (RAM) is a formal group judgement process developed in the 1980s by the Research and Development (RAND) Corporation and the University of California, Los Angeles (UCLA) [23]. It combines expert opinion and scientific evidence in the form of systematic literature reviews by asking panellists to rate, discuss, and then re-rate statements.

However, this prominent advantage that RAM has over other consensus processes may also be a deterring factor. A systematic review is conducted to provide the expert panel with all pertinent information that will guide evidence-based decision-making [23]. Due to the rigorous methods applied when conducing full systematic reviews, they can take an extensive period of time to complete [24, 25]. This may be particularly problematic when multiple areas are being covered, there is high complexity in the topic, or both. Rapid reviews are a form of knowledge synthesis in which components of the systematic review process are simplified or omitted to produce information in a more timely manner [26]. As such, rapid reviews may offer a time- and resource-efficient alternative to modify RAM and prevent a potentially protracted and misaligned decision timeline. Although the rapid review approach has several inherent limitations, it may be a suitable compromise to facilitate swift synthesis of available evidence and adequately inform decisions in a RAM expert consensus process.

The aim of the present study was to apply rapid review methods to identify, appraise and summarize the best available evidence regarding PCCDs and in doing so provide an evidence summary to inform an expert panel tasked to validate the QI used for the measurement of prehospital trauma care quality. More specifically, this

rapid review aimed to investigate current evidence for the effectiveness and safety of non-invasive PCCDs. This study forms part of a larger research project aimed at developing and testing prehospital care quality indicators for the Australian setting (https://www.aspireproject.net).

Methods

Preliminary work

As the initial part of the larger research project, a scoping review was conducted in accordance with Joanna Briggs Institute (JBI) methodology [16]. The scoping review's purpose was to map the attributes of 'quality' in the context of prehospital care, to chart existing international prehospital care QIs and explore their development processes. Identified QIs were categorized as either system/organizational/non-clinical (domain A) or clinical (domain B). Within these two domains, several subdomains were formed, including 'trauma care' (sub-domain B.6). QIs describing in one way or another the application of a PCCD in a patient with suspected pelvic fracture were identified in several included articles and aggregated into one single QI concisely describing the specific clinical intervention (Table 1). Furthermore, the QI was labelled as a process indicator according to Donabedian's model, and as a QI primarily addressing 'effectiveness', one of the attributes of 'quality' mapped in the review.

Rapid review

Literature search strategy

Guided by the approaches to rapid reviews and evidence summaries by JBI and the World Health Organization (WHO) [27], a rapid systematic literature review was conducted to develop a summary of the best available evidence concerning the placement of a PCCD in the prehospital environment. Systematic searches of four electronic databases (the Cochrane Library, the JBI Database of Systematic Reviews, PubMed and CINAHL) were conducted on 9 June 2020. No date range filters were set but the search was limited to studies involving human participants and written in English. Due to the small number of systematic reviews identified, the search was expanded to include lower levels of evidence [28]. Nevertheless, observational descriptive studies, case series and case reports were excluded, as were non-systematic literature reviews. The full search strategy is available in Appendix S1.

Table 1 The aggregated quality indicator originating, amongst others, from the preliminary scoping review

QI-B.6.2. A patient with suspected pelvic fracture has a pelvic circumferential compression device (PCCD) applied. (Process Effectiveness)

Study selection

One author (RP) carried out the literature search, screened the results by title and abstracts using Covidence (Covidence, Melbourne VIC, Australia), and performed full-text review of shortlisted articles based on pre-defined inclusion criteria. The pre-defined inclusion criteria were based on the following population, intervention, comparison, outcome, context, study design (PICOCS) criteria:

- Population: Trauma patients with suspected or confirmed pelvic fracture(s)
- Intervention: Application of a PCCD
- Comparison: No intervention (or wrapping sheet)
- Outcomes: Clinical endpoints and/or adverse effects
- Context: Emergency trauma care
- Study designs: Systematic review, experimental and quasi-experimental studies, and observational analytical studies.

Quality appraisal

Following the search, studies selected for retrieval were assessed for internal validity using applicable JBI critical appraisal checklists [27]. This risk-of-bias assessment was performed by one author (RP). The quality threshold scores on respective checklists was 7 out of 11 for systematic reviews, 8 out of 13 for randomized control trials, 6 out of 9 for quasi-experimental studies and 7 out of 11 for cohort studies. These scores equated to a minimum quality threshold of 60% which was deemed to indicate sufficient quality for the research to be included in the review.

Data extraction and synthesis

Data were extracted by one author (RP) and verified by another (RM) using a standardized extraction template created a priori in Microsoft Excel for Mac 2019 (Microsoft Corp., Richmond, WA, USA). For systematic reviews, the following data were extracted: author(s), year of publication, number of studies included their designs, whether meta-analysis was performed and key findings. For primary research studies, following data were extracted: author(s), year of publication, study objectives and design, number of participants, participant characteristics, device(s), and key findings. Each systematic review and primary study was assigned a level of evidence in accordance with JBI [28].

Results

Search and critical appraisal results

A total of 1194 potentially relevant records were identified through database searching (Fig. 1). Following the removal of 38 duplicates, 1156 records were retrieved for title and abstract screening. This found 1108 records

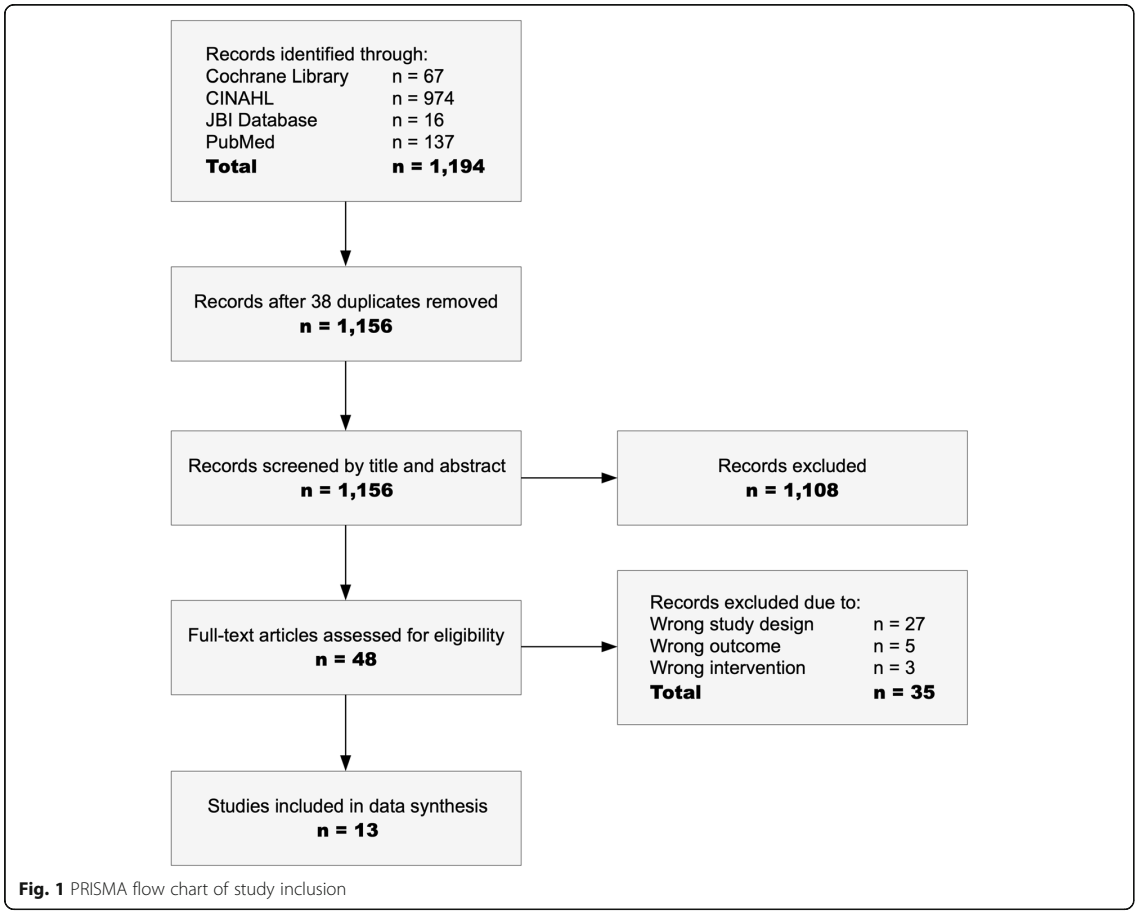


Fig. 1 PRISMA flow chart of study inclusion

to be incongruent with the inclusion criteria which were thus excluded and left 48 articles for full-text screening. Subsequently, 35 articles were excluded based on incompatibility with the review criteria which resulted in 13 articles being included for analysis in this rapid review. The 13 articles were critically appraised for methodological quality using applicable JBI critical appraisal tools. Based on the a priori minimum scores, all studies were included in this review.

Description of the studies and characteristics of the evidence

Three systematic reviews [29–31], one randomized clinical trial (crossover design) [32], two before-after studies [33, 34], and seven retrospective cohort studies [35–41] were included (Tables 2 and 3). For systematic reviews, the level of evidence was assigned with consideration of included studies which addressed physiological effects and clinical outcomes such as reducing bleeding and decreasing mortality. Similar to the hierarchical rating of outcomes according to importance performed in the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach [42], these outcomes were considered most critical and thus given priority over other, less important outcome measures such as biomechanical effects in determining evidence level.

Summary of the evidence and clinical bottom line

Tables 2 and 3 provide summaries of the included studies' findings. Generally, the evidence in support of the application of a PCCD in a patient with suspected or confirmed pelvic fracture is weak. Whilst three systematic reviews were identified, the design of included studies (mostly observational) in these reviews lowered their level of evidence. None of the systematic reviews included a meta-analysis of included studies. Bakhshayesh, et al. (2016) [29] explicitly stated that it was not possible to combine results due to heterogeneity amongst included studies. This heterogeneity is echoed in the primary clinical studies identified in this rapid review

Table 2 Summary of included systematic reviews

Author	Year of Publication	Number of studies included	Study designs	Total number of patients/ participants/ cases	Meta-analysis performed	Summary	LOE[a]
Bakhshayesh, et al. [29]	2016	16	One RCT, two before-after studies, four retrospective cohort studies and nine case series (including six cadaver studies)	1377	No	Included studies suggest that PCCDs are effective in reducing a pelvic ring fracture. PCCDs may contribute to favourable physiological effects during the early phase of resuscitation. However, study results are inconclusive and conflicting with regards to other outcome measures, i.e. mortality, hospital length of stay, and intensive care unit (ICU) length of stay. Almost all types of PCCDs may potentially cause pressure ulcers if used for extensive periods due to inevitable tension over bony prominences.	2
Cullinane, et al. [30]	2011	6	One before-after study, two retrospective cohort studies, three case series (including two cadaver studies)	460	No	This systematic review was conducted for the development of clinical guidelines for surgical and non-surgical management of haemorrhage in pelvic fractures. Those studies which were included to evaluate the role of non-invasive temporary external fixation devices suggest that temporary binders reduce pelvic volume and may improve biomechanical stability. The effectiveness of non-invasive temporary external fixation devices limiting haemorrhage is unclear. They do not seem to affect mortality. Pelvic binders may cause tissue trauma due to shearing forces during the application process and skin breakdown over bony prominences when used over prolonged periods.	3
Spanjersberg, et al. [31]	2009	17	One before-after study, one retrospective cohort study, five case series (including three cadaver studies), seven case reports, three opinions	250	No	The reviewers concluded that available studies suggest that PCCDs may facilitate reduction of fractures and associated haemorrhage. However, data concerning mortality is lacking. Although the literature suggests no life-threatening complications occur with the use of PCCDs, the nature, severity and rates of complications is not fully known. Most obvious is a certain risk of damage to skin and potential iatrogenic injury to internal organs.	3

LOE Level of Evidence; *PCCD* Pelvic Circumferential Compression Device; *RCT* Randomized Clinical Trial; [a]Based on included studies addressing physiological effects

making synthesis of results challenging. Furthermore, the limited clinical research is comprised predominantly of historical cohort studies, which induces inherent and considerable risk of bias.

Included studies which address the biomechanical effects of PCCDs indicate the devices facilitate a reduction in pelvic volume and improvement in biomechanical stability [29–31, 33, 34]. Of the included studies, several suggest that PCCDs, especially if applied early, may contribute to a variety of desirable physiological effects [29–31, 33, 37, 38, 40]. Yet, results concerning other, more critical outcome measures such as mortality and hospital or intensive care unit length of stay are ambivalent or conflicting [29–31, 35–37, 39, 41]. Three studies included sheet wrapping as an improvised method to stabilize the pelvic ring [38, 39, 41]. However, only one

Table 3 Summary of included primary clinical studies

Author	Year of publication	Study Design	Pertinent Objective(s)	Number of patients/ participants	Patients/participants and groups	Device(s)/ Intervention(s)	Results summary	LOE
Schweigkofler, et al. [35]	2019	Retrospective Cohort study	To evaluate the effects of early (prehospital) application of a PCCD on transfusion requirements and mortality.	64	Trauma patients with Tile B ($n = 31$; 48.4%) and Tile C ($n = 33$; 51.6%) unstable pelvic fractures. A PCCD was applied prehospitally in 37 patients (58%); 27 (42%) received no prehospital pelvic binding.	Unspecified PCCD	There were higher ISS scores (29.7 vs 24.2) and lower probability of survival (RISC-II Prognosis 81% vs 89%) in patient who had a PCCD applied, however this was not statistically significant. There was also higher risk for massive transfusion (TASH-Scores 10% vs 6%) and average number of PRBC units transfused (10.5 vs 7.5) in patient with PCCD, again without statistical significance though. There was no statistically significance difference in mortality (20% vs 13.3% respectively).	3
Agri, et al. [36]	2017	Retrospective Cohort study	To describe the correlation between pelvic binders and patient outcomes.	228	Adult (> 16 years) trauma patient with Tile A ($n = 52$; 22.8%), Tile B ($n = 71$; 31.1%) and Tile C ($n = 105$; 46.1%) pelvic fractures. Pelvic binders had been applied to in the field to 144 patients (63%) with comparable frequency among the three main fracture types ($p = 0.61$).	Unspecified PCCD (and AAE)	Tile C fractures were associated with higher transfusion requirements ($p < 0.0001$) and higher mortality ($p < 0.001$). There was no statistically significant difference in injury severity between patient with PCCD and those without (ISS 26 vs 29; $p = 0.99$). Pelvic binders were not associated with differences in PRBC transfusion requirements (0 vs 2; $p = 0.91$) or mortality rates at 48 h (23% vs 18%; $p = 0.5$) or 30 days (25% vs 11%; $p = 0.51$) compared to the absence of pelvic binders. There were also no statistically significant differences in SBP, HR, SI, lactate level, SBD or need for AAE. No differences were detected in any of these variables even when selecting unstable fracture types (B1, B3	3

Table 3 Summary of included primary clinical studies *(Continued)*

Author	Year of publication	Study Design	Pertinent Objective(s)	Number of patients/ participants	Patients/participants and groups	Device(s)/ Intervention(s)	Results summary	LOE
							and C) only.	
Hsu, et al. [37]	2017	Retrospective Cohort study	To compare the effects of early pelvic binding (based on suspicion of pelvic injury) with late pelvic binding (after fracture confirmation by radiography)	204	Trauma patients with a loss of consciousness or GCS < 13, SBP < 90 mmHg, fall from ≥6 m; injury to multiple vital organs, and suspected pelvic injury. Pelvic binders had been applied to 56 (27.5%) patients after confirmation of pelvic fracture and 148 (72.5%) patients with suspected pelvic injury.	SAM Pelvic Sling® II	There were no statistically significant differences in hospital LOS, ICU LOS, RTS, ISS score; percentage of SBP < 90 mmHg, GCS, percentage of AIS ≤3, angiography for AAE or mortality. However, those patients who received early pelvic binding had significantly less blood transfusion requirements (2462 ml vs 4385 ml; $p = 0.009$). Furthermore, uni- and multivariant regression analysis to adjust for confounders revealed significantly reduced mortality rates associated with early binding ($p = 0.030$ and $p = 0.039$ respectively).	3
Fu, et al. [38]	2013	Retrospective Cohort study	To evaluate the effects of PCCDs in patients with pelvic fractures who required transfer to trauma centres.	585	Patients with stable ($n = 450$; 76.9%) and unstable ($n = 135$; 23.1%) pelvic fractures who were transferred to a trauma centre within 24 h.	Unspecified PCCD or sheet wrapping	The patients with stable pelvic fracture who received pretransfer PCCDs ($n = 62$; 13.8%) required significantly fewer blood transfusions (120.2 ml vs 231.8 mL; $p = 0.018$), had shorter intensive care unit LOS (1.7 days vs 3.4 days; $p = 0.029$) and shorter hospital LOS (6.8 days vs 10.4 days; $p = 0.018$) compared with patients who did not receive the pretransfer PCCD. The patients with unstable pelvic fractures who received pretransfer PCCDs ($n = 91$; 67.4%) also required significantly fewer blood transfusions (398.4 ml vs 1954.5 ml; $p < 0.001$), shorter intensive care unit LOS (6.6 days vs 11.8 days; $p = 0.024$) and	3

Table 3 Summary of included primary clinical studies *(Continued)*

Author	Year of publication	Study Design	Pertinent Objective(s)	Number of patients/ participants	Patients/participants and groups	Device(s)/ Intervention(s)	Results summary	LOE
							shorter hospital LOS (9.4 days vs 19.5 days; $p = 0.006$) compared with patients who did not receive the pretransfer PCCD.	
Pizanis, et al. [39]	2013	Retrospective Cohort study	To compare transfusion requirements of PRBC, LOS, mortality and incidence of lethal pelvic bleeding between patients which were treated by circumferential sheets, binders and c-clamps.	192	Trauma patients with fractures or disruptions of the pelvic ring. (The median age of patients treated with binders was significantly lower than in those treated with sheets of c-clamps.) One-hundred-and-thirty-three patients (69%) were treated with c-clamp, 31 (16%) with sheets and 28 (15%) with binders.	Unspecified PCCDs, sheet wrapping and c-clamp	There were no statistically significant differences in PRBC requirements ($p = 0.26$), LOS ($p = 0.20$) or mortality ($p = 0.08$). However, wrapping sheets were associated with a significantly higher incidence of lethal bleeding compared to PCCD and c-clamp (23% vs 4% vs 8%; $p = 0.02$).	3
Knops, et al. [32]	2011	Randomized controlled trial	To quantify the pressure at the region of the greater trochanters and the sacrum, induced by PCCDs in healthy individuals.	80	Healthy individuals lying on a spine board and lying on a hospital bed.	Pelvic Binder®, SAM-Sling® and T-POD®	Whilst lying on a spine board, the maximum pressure on the skin at the area of the greater trochanter exceeded 9.3 kPa (tissue damage threshold) with all three devices. No correlations of maximum pressure with BMI, waist size, or age on a spine board at the area of the greater trochanter were observed, except with an increase in maximum pressure with age ($p = 0.031$) when using one of the devices (SAM-Sling®). Whilst lying on the hospital bed, considerable reductions in maximum pressure, were found with all devices, in most cases below 9.3 kPa.	1
Tan, at al [33].	2010	Before-after study	To measure the immediate biomechanical and hemodynamic effects of pelvic binding.	15	Patients with unstable pelvic fractures who presented to the emergency department and who did not receive prehospital pelvic binding.	T-POD®	Application of the PCCD reduced pubic symphyseal diastasis by 60% (range 24–92%, $p = 0.01$). Mean values of mean arterial pressures increased significantly from 64.7 to 81.2 mmHg	2

Table 3 Summary of included primary clinical studies *(Continued)*

Author	Year of publication	Study Design	Pertinent Objective(s)	Number of patients/ participants	Patients/participants and groups	Device(s)/ Intervention(s)	Results summary	LOE
							($p = 0.04$). Similarly, heart rates decreased significantly from 106 to 93 beats per minute ($p = 0.04$).	
Croce, et al. [40]	2007	Retrospective Cohort study	To compare the efficacy of pelvic binding to EPF.	186	Trauma patients with fractures or disruptions of the pelvic ring. Ninety-three patients (50%) were treated with EPF and 93 (50%) had the T-POD applied.	T-POD®	There were no differences in age or shock severity. Those patients who had a T-POD applied had significantly reduced 24-h (4.9 U vs 17.1 U; $p < 0.0001$) and 48-h transfusions (6.0 U vs 18.6 U; $p < 0.0001$). Compared to EPF, the T-POD also facilitated significantly decreased hospital LOS (16.5 days vs 24.4 days; $p < 0.03$). There was reduced mortality with the T-POD, however, this was not statistically significant (26% vs 37%; $p = 0.11$).	3
Ghaemmaghami, et al. [41]	2007	Retrospective Cohort study	To assess the effectiveness of early application of a PCCD when compared to no device.	236	Patients with pelvic fractures and at least one of the following risk factors: - unstable fracture - age > 55 years - hypotension One-hundred-and-eighteen patients (50%) were treated with the PCCD and 118 (50%) did not receive any standardized pelvic binding other than occasional sheet wrapping.	Unspecified PCCD	The two groups had similar fracture patterns, age, and injury severity. In the comparison of patients wo were treated with a PCCD with those who received no standardized pelvic binding, there were no significant differences in mortality (23% vs 23%; $p = 0.92$), need for AAE (11% vs 15%; $p = 0.35$), or 24-h transfusion (5.2 U vs 4.6 U; $p = 0.64$).	3
Krieg, et al. [34]	2005	Before-after study	To assess the effectiveness of a PCCD in reducing and stabilizing pelvic ring fractures.	13	Adult patients (> 16 years) with partially stable or unstable pelvic fractures with external or internal rotation pattern.	Unspecified PCCD	In patients with external rotation, the PCCD significantly reduced the pelvic width by 9.9 ± 6.0%. In patient with internal rotation, there was no significant over-pressurization due to application of the PCCD.	2

AAE Arterial Angio-Embolization; *AIS* Abbreviate Injury Score; *BMI* Body Mass Index; *EPF* External Pelvic Fixation; *GCS* Glasgow Coma Score; *HR* Heart Rate; *ICU* Intensive Care Unit; *ISS* Injury Severity Scale; *LOE* Level of Evidence; *LOS* Length of Stay; *PCCD* Pelvic Circumferential Compression Device; *PRBC* Packed Red Blood Cells; *RISC* Revised Injury Severity Classification; *RTS* Revised Trauma Score; *SBD* Standard Base Deficit; *SBP* Systolic Blood Pressure; *SI* Shock Index; *TASH* Trauma Associated Severe Haemorrhage

of these (Pizanis, at al. 2013) [39] compared this method to the application of a commercial PCCD and demonstrated benefits in using a PCCD over improvised pelvic binding in reducing mortality. The systemic reviews consistently report on potential adverse effects of PCCDs. These including mostly skin damage, myonecrosis and peroneal nerve palsy when used for extended periods of time, but also injury to internal organs as a result of shearing forces during the application process [29–31].

The clinical bottom line is that there is no high-level evidence that the application of a PCCD reduces haemorrhage or mortality in suspected or confirmed pelvic fractures. The best available evidence suggests that a PCCD provides temporary pelvic ring stabilization and can serve as an adjunct to early haemorrhage control. The application of PCCD carries a certain potential for iatrogenic harm, however, clinical benefits seem to outweigh this risk. Given the limited data to show undisputable benefit, further research on this topic is needed. In particular, there is a lack of research in the prehospital arena as well as studies which examine the effectiveness and safety of PCCDs in specific pelvic fractures types according to Young-Burgess classification as this mechanistic classification is more practical for the prehospital context.

Discussion

Patients suffering pelvic fractures are at risk of severe and potentially life-threatening bleeding [43, 44]. Especially patients with unstable pelvic fracture types are at high risk of exsanguinating haemorrhage [45, 46]. Palpation of the pelvis is unreliable in detecting instability and has been associated with dislodging clots and initiating further blood loss [47]. Therefore, in early major trauma care, the presence of pelvic disruption should be based on suspicion after consideration of the mechanism of injury rather than confirmation by physical examination. PCCDs have been shown to provide effective biomechanical reduction in partially stable and unstable pelvic fractures [48]. A clinically reasonable assumption is that the prompt application of a PCCD facilitates early stabilization of unstable fractures and thus leads to favourable physiological effects and ultimately desirable patient outcomes. This rapid review aimed to summarize current evidence for the effectiveness and safety of non-invasive PCCDs and identified several, albeit methodologically weak studies in support of the intervention. As such, this rapid review was unable to identify high-quality evidence and the best available evidence should be combined with expert consensus in a process such as RAM to assess the validity of the QI under discussion.

Health care quality measurement and improvement are complex endeavours. Considering the resources health care organizations invest in them and the potential adverse consequences if conducted poorly [49, 50], it is important to get it right from the start. Unfortunately, indicators are often chosen because the required data is easily attainable rather than because they are evidence-based [51]. When indicators are developed or transferred between health care systems, it is critical to review their supporting evidence and the quality thereof [52, 53]. A QI is preferably based on high-quality evidence clearly demonstrating that the desirable effects outweigh the undesirable effects. Such evidence is produced by large, thoroughly conducted RCTs that demonstrate consistent impressive benefits with limited adverse effects and minimal cost. In the absence of such high-quality evidence, best available evidence should be combined with expert consensus to assess the validity of the indicator. Therein lies the essence of a *quality* indicator and what distinguishes it from a *performance* indicator – a QI has scientific credibility, i.e. there is evidence and/or expert consensus that the indicator can be used to make a judgement about quality [17]. Not only are health care quality improvement managers increasingly required to deploy such scientific methods to develop measures of quality, but also they are required to do so in limited amounts of time [54]. This presents a potential misalignment between QI development and timelines set by organizational quality improvement needs [55, 56]. This paper presents an example of a fast-tracked systematic literature review methodology which balanced its scope against time and resource constraints, and in doing so may prevent protraction and provide a timely evidence summary to inform QI development. From inception to completion this rapid review took approximately 3 months; a relatively short timeframe compared to full systematic reviews which commonly take 12 to 24 months to complete [57, 58].

There are several significant limitations that the omission or simplification of systematic review methods induce. The search strategy was limited by restricting the number of databases consulted, excluding all non-English language papers, using more specific search terms and excluding lower levels of evidence. Databases were restricted in line with guidance for rapid reviews and evidence summaries by JBI. Whilst systematic reviewer and meta-analysts should conduct exhaustive searches in multiple databases, rapid reviews commonly omit several databases to focus on those expected to yield best results. This approach is justifiable by studies which have demonstrated only marginal improvement in relevant results by increasing the number of databases searched [59, 60]. The search for studies in rigorously conducted systematic reviews should not be restricted by language. Limiting results to those written in English inevitable introduces English language bias or Tower of Babel bias potentially leading to an over- or

underestimation of an intervention's effectiveness [61]. Reliable translation services, however, require time and financial resources making them a less suitable part of a rapid review search strategy. Optimal search strategies aim for maximum number of relevant references with minimal noise, i.e. best sensitivity and specificity. In this balance, rapid reviews commonly lean towards specificity. The search terms in this rapid review were more specific by using narrower MeSH terms (e.g. MH "pelvic fractures"), using Boolean operators to narrow MeSH headings (e.g. (pelvic bones [mh] OR pelvis [mh]) AND (fractures, bone [mh] OR wounds and injuries [mh]) and by avoiding less common keywords (e.g. splint). JBI evidence summaries are ideally based on several systematic reviews, however, when no systematic reviews are identified, lower levels of evidence are included [27]. This rapid review adopted the approach but leaned towards more comprehensive inclusion by lowering the methodological exclusion threshold to observational descriptive studies. Whilst data extraction was verified by a second reviewer, the preceding study selection and quality appraisal was performed by only one reviewer. Expediting the review process in this way is frequently done in rapid reviews, however, introduces considerable risk of bias and error.

Conclusion

This study provides an example of how the timely knowledge synthesis through the deployment of a streamlined rapid review approach can inform QI development. More specifically, the study has reviewed best available evidence regarding the application of a PCCD in patients with suspected pelvic fractures and summarized this into a synopsis for feasible consideration by an expert panel tasked to assess the validity of a related QI. The process of applying a PCCD is not clearly linked to desirable clinical outcomes and does carry a potential for iatrogenic harm. Nevertheless, the clinical benefits seem to outweigh risks. This best available evidence is of low quality strengthening the need for its perusal by an expert panel before possible QI implementation.

Supplementary information

Supplementary information accompanies this paper at https://doi.org/10.1186/s13049-020-00762-5.

Additional file 1.

Abbreviations

AAE: Arterial Angio-Embolization; AIS: Abbreviate Injury Score; BMI: Body Mass Index; CINAHL: Cumulative Index to Nursing and Allied Health Literature; EPF: External Pelvic Fixation; GCS: Glasgow Coma Score; GRADE: Grading of Recommendations Assessment, Development and Evaluation; HR: Heart Rate; ICU: Intensive Care Unit; ISS: Injury Severity Scale; JBI: Joanna Briggs Institute; LOE: Level of Evidence; LOS: Length of Stay; PCCD: Pelvic Circumferential Compression Device; PICOCS: Population, Intervention, Comparison, Outcome, Context, Study design; QI: Quality Indicator; RAM: RAND/UCLA Appropriateness Method; RCT: Randomized Controlled Trial; RISC: Revised Injury Severity Classification; RTS: Revised Trauma Score; SBD: Standard Base Deficit; SBP: Systolic Blood Pressure; SI: Shock Index; TASH: Trauma Associated Severe Haemorrhage; WHO: World Health Organization

Acknowledgements

The larger research project this study forms part of is supported by an Australian Government Research Training Program Scholarship.

Authors' contributions

RP is the guarantor. RP incepted the study. RP conducted the search and quality appraisal. RP and RM performed data extraction. All authors contributed intellectually to the manuscript approved its final version.

Funding

NA

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

The project this study forms part of has been approved by the University of Adelaide Human Research Ethics Committee (approval number H-2017-157).

Consent for publication

NA

Competing interests

The authors declare that they have no competing interests.

Received: 18 March 2020 Accepted: 3 July 2020
Published online: 13 July 2020

References

1. Pfeifer R, Teuben M, Andruszkow H, Barkatali BM, Pape HC. Mortality patterns in patients with multiple trauma: a systematic review of autopsy studies. PLoS One. 2016;11(2):1–9.
2. Ruatti S, Guillot S, Brun J, Thony F, Bouzat P, Payen JF, et al. Which pelvic ring fractures are potentially lethal? Injury. 2015;46(6):1059–63.
3. Hermans E, Biert J, van Vugt AB, Edwards MJR. Research on relation of mortality and hemodynamics in patients with an acute pelvic ring fracture. J Acute Dis. 2016;5(2):117–22.
4. Starr AJ, Griffin DR, Reinert CM, Frawley WH, Walker J, Whitlock SN, et al. Pelvic ring disruptions: prediction of associated injuries, transfusion requirement, pelvic arteriography, complications, and mortality. J Orthop Trauma. 2002;16(8):553–61.
5. Dalal SA, Burgess AR, Siegel JH, Young JW, Brumback RJ, Poka A, et al. Pelvic fracture in multiple trauma: classification by mechanism is key to pattern of organ injury, resuscitative requirements, and outcome. J Trauma - Inj Infect Crit Care. 1989;29(7):981–1002.
6. Schmal H, Markmiller M, Mehlhorn AT, Sudkamp NP. Epidemiology and outcome of complex pelvic injury. Acta Orthop Belg. 2005;71(1):41–7.
7. Tile M. Acute pelvic fractures: II. Principles of management. J Am Acad Orthop Surg. 1996;4(3):152–61.
8. Tile M. Pelvic ring fractures: should they be fixed? J Bone Jt Surg - Ser B. 1988;70(1):1–12.
9. Young JW, Burgess AR, Brumback RJ, Poka A. Pelvic fractures: value of plain radiography in early assessment and management. Radiology. 1986;160(2):445–51.
10. Grant PT. The diagnosis of pelvic fractures by "springing". Arch Emerg Med. 1990;7(3):178–82.
11. Lee C, Porter K. The prehospital management of pelvic fractures. Emerg Med J. 2007;24(2):130–3.
12. Sauerland S, Bouillon B, Rixen D, Raum MR, Koy T, Neugebauer EAM. The reliability of clinical examination in detecting pelvic fractures in blunt trauma patients: a meta-analysis. Arch Orthop Trauma Surg. 2004;124(2):123–8.

13. National Institute for Health and Care Excellence. Major trauma: assessment and management of major trauma - NICE Guideline NG39. London; 2016. Available from: https://www.nice.org.uk/guidance/ng39/evidence/full-guideline-pdf-2308122833.
14. Campbell J, Alson R, editors. International trauma life support for emergency care providers. 8th ed. Downer Grove, IL: ITLS - International Trauma Life Support; 2015. p. 432.
15. Joint Royl Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives. JRCALC Clinical Practice Guidelines 2019. Somerset: Class Professional Publishing; 2019. p. 724.
16. Pap R, Lockwood C, Stephenson M, Simpson P. Indicators to measure prehospital care quality: a scoping review. JBI Database Syst Rev Implement Reports. 2018;16(11):2192–223.
17. Campbell SM, Braspenning J, Hutchingson A, Marshall MN. Research methods used in developing and applying quality indicators in primary care. Qual Saf Heal Care. 2002;11:358–64.
18. Lawrence M, Olesen F. Indicators of quality in health care. Eur J Gen Pract. 1997;3(9):103–8.
19. Kötter T, Blozik E, Scherer M. Methods for the guideline-based development of quality indicators - a systematic review. Implement Sci. 2012;7(1):21.
20. Hutchinson A, McIntosh A, Anderson J, Gilbert C, Field R. Developing primary care review criteria from evidence-based guidelines: coronary heart disease as a model. Br J Gen Pract. 2003;53(494):690–6.
21. Mainz J. Defining and classifying clinical indicators for quality improvement. Int J Qual Heal Care. 2003;15(156):523–30.
22. Halcomb E, Davidson P, Hardaker L. Using the consensus development conference method in healthcare research. Nurse Res. 2008;16(1):56–71.
23. Fitch K, Bernstein SJJ, Aguilar MDD, Burnand B, LaCalle JRR, Lazaro P, et al. The RAND/UCLA appropriateness method User's manual; 2001. p. 109. Available from: http://www.rand.org.
24. Tricco AC, Antony J, Zarin W, Strifler L, Ghassemi M, Ivory J, et al. A scoping review of rapid review methods. BMC Med. 2015;13(224):1–15.
25. Grant MJ, Booth A. A typology of reviews: an analysis of 14 review types and associated methodologies. Health Inf Libr J. 2009;26(2):91–108.
26. Khangura S, Konnyu K, Cushman R, Grimshaw J, Moher D. Evidence summaries : a rapid review method. Syst Rev. 2012;1(10):20146–4053.
27. Munn Z, Lockwood C, Moola S. The development and use of evidence summaries for point of care information systems: a streamlined rapid review approach. Worldviews Evidence-Based Nurs. 2015;12(3):131–8.
28. Joanna Briggs Institute. The JBI Approach. 2017. Available from: http://joannabriggs.org/jbi-approach.html.
29. Bakhshayesh P, Boutefnouchet T, Tötterman A. Effectiveness of non invasive external pelvic compression: a systematic review of the literature. Scand J Trauma Resusc Emerg Med. 2016;24(1):1–9.
30. Cullinane DC, Schiller HJ, Zielinski MD, Bilaniuk JW, Collier BR, Como J, et al. Eastern association for the surgery of trauma practice management guidelines for hemorrhage in pelvic fracture-update and systematic review. J Trauma - Inj Infect Crit Care. 2011;71(6):1850–68.
31. Spanjersberg WR, Knops SP, Schep NWL, van Lieshout EMM, Patka P, Schipper IB. Effectiveness and complications of pelvic circumferential compression devices in patients with unstable pelvic fractures: a systematic review of literature. Injury. 2009;40(10):1031–5.
32. Knops SP, Van Lieshout EMM, Spanjersberg WR, Patka P, Schipper IB. Randomised clinical trial comparing pressure characteristics of pelvic circumferential compression devices in healthy volunteers. Injury. 2011;42(10):1020–6.
33. Tan ECTH, Van Stigt SFL, Van Vugt AB. Effect of a new pelvic stabilizer (T-POD®) on reduction of pelvic volume and haemodynamic stability in unstable pelvic fractures. Injury. 2010;41(12):1239–43.
34. Krieg JC, Mohr M, Ellis TJ, Simpson TS, Madey SM, Bottlang M. Emergent stabilization of pelvic ring injuries by controlled circumferential compression: a clinical trial. J Trauma - Inj Infect Crit Care. 2005;59(3):659–64.
35. Schweigkofler U, Wohlrath B, Trentzsch H, Horas K, Hoffmann R, Wincheringer D. Is there any benefit in the pre-hospital application of pelvic binders in patients with suspected pelvic injuries? Eur J Trauma Emerg Surg. 2019;0123456789..
36. Agri F, Bourgeat M, Becce F, Moerenhout K, Pasquier M, Borens O, et al. Association of pelvic fracture patterns, pelvic binder use and arterial angio-embolization with transfusion requirements and mortality rates; a 7-year retrospective cohort study. BMC Surg. 2017;17(1):1–12.
37. Der Hsu S, Chen CJ, Chou YC, Wang SH, Chan DC. Effect of early pelvic binder use in the emergency management of suspected pelvic trauma: a retrospective cohort study. Int J Environ Res Public Health. 2017;14(10):1–9.
38. Fu CY, Wu YT, Liao CH, Kang SC, Wang SY, Hsu YP, et al. Pelvic circumferential compression devices benefit patients with pelvic fractures who need transfers. Am J Emerg Med. 2013;31(10):1432–6.
39. Pizanis A, Pohlemann T, Burkhardt M, Aghayev E, Holstein JH. Emergency stabilization of the pelvic ring: clinical comparison between three different techniques. Injury. 2013;44(12):1760–4.
40. Croce MA, Magnotti LJ, Savage SA, Wood GW, Fabian TC. Emergent pelvic fixation in patients with exsanguinating pelvic fractures. J Am Coll Surg. 2007;204(5):935–9.
41. Ghaemmaghami V, Sperry J, Gunst M, Friese R, Starr A, Frankel H, et al. Effects of early use of external pelvic compression on transfusion requirements and mortality in pelvic fractures. Am J Surg. 2007;194(6):720–3.
42. Guyatt GH, Oxman AD, Vist GE, Kunz R, Falck-Ytter Y, Schünemann HJ. GRADE: what is "quality of evidence" and why is it important to clinicians? BMJ. 2008;336(2):995–8.
43. Gabbe BJ, De Steiger R, Esser M, Bucknill A, Russ MK, Cameron PA. Predictors of mortality following severe pelvic ring fracture: results of a population-based study. Injury. 2011;42(10):985–91.
44. Blackmore CC, Cummings P, Jurkovich GJ, Linnau KF, Hoffer EK, Rivara FP. Predicting major hemorrhage in patients with pelvic fracture. J Trauma - Inj Infect Crit Care. 2006;61(2):346–52.
45. Pohlemann T, Stengel D, Tosounidis G, Reilmann H, Stuby F, Stöckle U, et al. Survival trends and predictors of mortality in severe pelvic trauma: estimates from the German pelvic trauma registry initiative. Injury. 2011;42(10):997–1002.
46. Cryer H, Miller F, Evers B, Rouben L, Seligson D. Pelvic fracture classification: correlation with hemorrhage. J Trauma. 1988;28(7):973–80.
47. Little G, Kelly M, Glucksman E. Critical pitfalls in the immediate assessment of the trauma patient. Trauma. 2001;3(1):43–51.
48. Knops SP, Schep NWL, Spoor CW, Van Riel MPJM, Spanjersberg WR, Kleinrensink GJ, et al. Comparison of three different pelvic circumferential compression devices: a biomechanical cadaver study. J Bone Jt Surg - Ser A. 2011;93(3):230–40.
49. Shahian DM, Normand SLT, Friedberg MW, Hutter MM, Pronovost PJ. Rating the raters: the inconsistent quality of health care performance measurement. Ann Surg. 2016;264(1):36–8.
50. Chin MH, Muramatsu N. What is the quality of quality of medical care measures? Rashomon-like relativism and real-world applications. Perspect Biol Med. 2003;46(1):5–20.
51. Saver BG, Martin SA, Adler RN, Candib LM, Deligiannidis KE, Golding J, et al. Care that matters: quality measurement and health care. PLoS Med. 2015;12(11):1–10.
52. Mainz J. Developing evidence-based clinical indicators: a state of the art methods primer. Int J Qual Heal Care. 2003;15(Supp 1):i5–11.
53. Marshall MN, Shekelle PG, McGlynn EA, Campbell S, Brook RH, Roland MO. Can health care quality indicators be transferred between countries? Qual Saf Health Care. 2003;12(1):8–12.
54. Cassel C, Conway P, Delbanco S, Jha A, Saunders R, Lee T. Getting more performance from performance measurement Christine. N Engl J Med. 2014;371(23):2145–7.
55. Ganann R, Ciliska D, Thomas H. Expediting systematic reviews: methods and implications of rapid reviews; 2010. p. 1–10.
56. Nair R, Aggarwal R, Khanna D. Methods of formal consensus in classification/diagnostic criteria and guideline development. Semin Arthritis Rheum. 2011;41(2):95–105.
57. Tricco A, Langlois E, Straus S. Rapid reviews to strengthen health policy and systems: a practical guide [internet]. Genève: World Health Organisation and Alliance for Health Ploicy and Systems Research; 2017. p. 142. Available from: https://www.who.int/alliance-hpsr/resources/publications/rapid-review-guide/en/.
58. Borah R, Brown AW, Capers PL, Kaiser KA. Analysis of the time and workers needed to conduct systematic reviews of medical interventions using data from the PROSPERO registry. BMJ Open. 2017;7(2):e012545.
59. Sampson M, Barrowman NJ, Moher D, Klassen TP, Pham B, Platt R, et al. Should meta-analysts search Embase in addition to Medline? J Clin Epidemiol. 2003;56(10):943–55.

60. Royle P, Milne R. Literature searching for randomized controlled trials used in Cochrane reviews: rapid versus exhaustive searches. Int J Technol Assess Health Care. 2003;19(4):591–603.
61. Morrison A, Polisena J, Husereau D, Moulton K, Clark M, Fiander M, et al. The effect of english-language restriction on systematic review-based meta-analyses: a systematic review of empirical studies. Int J Technol Assess Health Care. 2012;28(2):138–44.

Publisher's Note

4.3 Manuscript 5

Statement of Authorship

Title of Paper	The development of prehospital care quality indicators for the Australian setting: a modified RAND/UCLA appropriateness method
Publication Status	☑ Published ☐ Accepted for Publication ☐ Submitted for Publication ☐ Unpublished work written in manuscript style
Publication Details	Pap R, Lockwood C, Stephenson M, Simpson P. The development of prehospital care quality indicators for the Australian setting: a modified RAND/UCLA appropriateness method. EMJ. 2021;0:1-6

Principal Author

Name of Principle Author (Candidate)	Robin Pap		
Contribution to Paper	Principle author responsible for the design, conducted the rapid reviews, undertook recruitment of panellists, moderated the consensus process, analysed the data, and wrote the manuscript.		
Overall percentage (%)	85%		
Certification	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature		Date	01 February 2022

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);
ii. permission is granted for the candidate in include the publication in the thesis; and
iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Assoc Prof Craig Lockwood		
Contribution to Paper	Principally supervised development of work and evaluated the manuscript.		
Signature		Date	01 February 2022

Name of Co-Author	Dr Matthew Stephenson		
Contribution to Paper	Co-supervised development of work and evaluated the manuscript.		
Signature		Date	01 February 2022

Name of Co-Author	Assoc Prof Paul Simpson		
Contribution to Paper	Co-supervised development of work, helped with recruitment of panellists, and evaluated the manuscript.		
Signature		Date	01 February 2022

Development of prehospital care quality indicators for the Australian setting: a modified RAND/UCLA appropriateness method

Robin Pap ,[1,2] Craig Lockwood,[2] Matthew Stephenson,[2] Paul Simpson[1]

Handling editor Caroline Leech

► Additional online supplemental material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/emermed-2020-210455).

[1]School of Health Sciences, Western Sydney University, Sydney, New South Wales, Australia
[2]JBI, The University of Adelaide, Adelaide, South Australia, Australia

Correspondence to
Robin Pap, School of Health Sciences, Western Sydney University, Locked Bag 1797, Penrith NSW 2751, Australia; r.pap@westernsydney.edu.au

Received 26 July 2020
Accepted 9 July 2021

To cite: Pap R, Lockwood C, Stephenson M, *et al*. *Emerg Med J* Epub ahead of print: [*please include* Day Month Year]. doi:10.1136/emermed-2020-210455

ABSTRACT

Background Globally, the measurement of quality is an important process that supports the provision of high-quality and safe healthcare services. The requirement for valid quality measurement to gauge improvements and monitor performance is echoed in the Australian prehospital care setting. The aim of this study was to use an evidence-informed expert consensus process to identify valid quality indicators (QIs) for Australian prehospital care provided by ambulance services.

Methods A modified RAND/UCLA appropriateness method was conducted with a panel of Australian prehospital care experts from February to May 2019. The proposed QIs stemmed from a scoping review and were systematically prepared within a clinical and non-clinical classification system, and a structure/process/outcome and access/safety/effectiveness taxonomy. Rapid reviews were performed for each QI to produce evidence summaries for consideration by the panellists. QIs were deemed valid if the median score by the panel was 7–9 without disagreement.

Results Of 117 QIs, the expert panel rated 84 (72%) as valid. This included 26 organisational/system QIs across 7 subdomains and 58 clinical QIs within 10 subdomains. Most QIs were process indicators (n=62; 74%) while QIs describing structural elements and desired outcomes were less common (n=13; 15% and n=9; 11%, respectively). Non-exclusively, 18 (21%) QIs addressed access to healthcare, 21 (25%) described safety aspects and 64 (76%) specified elements contributing to effective services and care. QIs on general time intervals, such as response time, were not considered valid by the panel.

Conclusion This study demonstrates that with consideration of best available evidence a substantial proportion of QIs scoped and synthesised from the international literature are valid for use in the Australian prehospital care context.

Key messages

What is already known on this subject

- There is growing interest in validating existing and developing new clinical and non-clinical quality indicators (QIs) for ambulance service to parallel developments in prehospital care.
- In healthcare disciplines with a limited scientific evidence base, such as paramedicine, systematic QI development needs to combine best available evidence with expert consensus.

What this study adds

- This study used an evidence-informed expert consensus process to identify 84 valid QIs.
- Considerable uncertainty exists about the validity of numerous QIs traditionally utilised for performance measurement in ambulance services.
- This study forms part of a larger research project aimed at developing and testing prehospital care QIs for the Australian setting (https://www.aspireproject.net).

INTRODUCTION

The primary function of ambulance services has traditionally been one of providing essential, stabilising care and rapid transport to an emergency department for patients with critical illness or injury. Correspondingly, ambulance service performance measurement has historically focused on operational aspects and time intervals such as response time.[1] Modern prehospital care that ambulance services provide often involves complex out-of-hospital and mobile healthcare to patients across the lifespan presenting with injury or illness across a spectrum of acuity. For the purpose of this project, the context of prehospital care is limited to that of healthcare provided by ambulance services.

In Australia, prehospital care is delivered predominantly by State/Territory ambulance services or organisations contracted to respective jurisdictional governments as the primary provider of ambulance services. Commensurate with population growth and Australia's ageing population, demand for ambulance services has increased in recent years. In 2018–2019 and across the eight States and Territories, over 21 000 ambulance operatives (15 037 salaried personnel and 6008 volunteers) provided prehospital care to 3.7 million patients; an increase of nearly 16% from the 3.2 million patients treated 5 years earlier in 2013–2014.[2] With Australia's population being projected to increase and the number of high-risk older Australians continuing to grow, this trend is forecast to continue in the next 5 years.[3] Thus, under pressure to function in progressively complex and demanding environments, the success of out-of-hospital care systems is becoming increasingly dependent on effective quality improvement tactics.

Studying data over time is central to quality improvement.[4] Quality measurement is principally based on systematically developed quality

indicators (QIs) that outline specific aspects of the structures that should be in place, the processes that should occur and the desired outcome that should be achieved. A QI is an indicator which is underpinned by evidence supporting its use to assess quality.[5] While this evidence should ideally be of high level, such as that stemming from rigorously conducted clinical trials or robust systematic reviews, in disciplines such as paramedicine, where such high-level evidence may be sparse, it may be necessary to incorporate expert consensus. Still, best available evidence should be integrated by the experts in their evaluation of the validity of QIs. Considering the relatively strong paramedicine research capacity in Australia,[6] it may be well placed for such an evidence-informed consensus process.

While maintaining the primary function of providing access to safe and effective prehospital emergency care, ambulance services worldwide including Australia are expanding their responsibilities to provide out-of-hospital care of equal quality to optimise patient disposition and reduce unnecessary transport to hospital.[7–9] Like any healthcare sector, ambulance services need to do this in accordance with best available evidence. Since meaningful performance measurement not only produces data to ensure the maintenance of quality but also provides information on whether or not change is effective in achieving improvement, there has been growing interest in more sophisticated clinical and non-clinical QIs to parallel ambulance services developments and the progressive prehospital care they provide.[1] As such, the requirement for valid quality measurement to gauge improvements and monitor performance is echoed in the Australian prehospital care setting.

This study forms part of a larger research project aimed at developing and testing prehospital care QIs for the Australian setting (https://www.aspireproject.net). The aim of this study was to use an evidence-informed expert consensus process to identify QIs for Australian prehospital care.

METHODS

The methods applied in this study and other parts of the project were specified in advance in relevant protocols.[10 11]

Study design and setting

This study followed the Research ANd Development/University of California, Los Angeles (RAND/UCLA) Appropriateness Method (RAM) by conducting a two-round, evidence-informed consensus process.[12] The process was run from February to May 2019 and was modified from the conventional RAM as follows:

- Instead of the recommended systematic reviews, rapid reviews were conducted to assist panellists in rating the validity of the QIs. Due to the thorough methods applied when conducting full systematic reviews, they can take an extensive period of time to complete,[13] making them an unrealistic approach in this study.
- For some QIs with time intervals, panellists were able to select a time interval from several options. For example, QI-B.6.4. When attending to a patient suffering neurotrauma or penetrating injury with haemodynamic instability, the ambulance departs the scene within X minutes of arriving on scene, unless unable or impractical to do so for safety or operational reasons (X=10, 15 or 20). Panellists were asked to select that time interval which would facilitate them giving the QI the highest validity rating.
- De novo QI development was considered important and thus panellists were given an opportunity to contribute additional QIs. These additional QIs did not have to align to the proposed subdomains.
- Due to the geographically distant locations of expert panel members across Australia, the process was modified to be entirely online. Rating of the QIs was performed on Qualtrics (Qualtrics, Provo, Utah, USA). The face-to-face meeting was replaced with an asynchronous online forum on the Kialo discussion platform (Kialo, Brooklyn, New York, USA) and moderated by one of the researchers (RP).

Selection of panellists

In line with RAM,[12] an expert panel of 7–15 members was sought. Panellists needed to have expertise in prehospital care, patient perspective, ambulance service management and leadership, quality improvement and performance/quality measurement—all in the Australian context. At the time of recruitment, there were two paramedicine professional associations and 18 universities offering paramedicine programmes. These organisations were contacted and asked to nominate experts for participation in the study. Nominees did not necessarily need to be associated with the contacted professional association or universities. The nomination process required the nominator forwarding a project information sheet and nomination form available to the nominee for perusal and signature. Self-nominations were permitted. The completed form and curriculum vitae (CV) needed to be sent via email to the lead investigator (RP). The research team (RP, CL, MS and PS) selected expert panel members based on information provided in the forms and CVs. This was a confidential process and only the researchers perused the completed forms and CVs. The main selection criteria considered were acknowledged leadership in paramedicine, absence of conflicts of interest and geographic diversity (ideally at least one panellist was sought from each of the Australian states/Territories).

Preliminary work

Preparation of QI

A scoping review was conducted to map the attributes of 'quality' in the context of prehospital care and to establish a list of internationally existing prehospital care QIs.[1] The review employed the JBI methodology for conducting scoping reviews.[14] The review's systematic search confirmed paucity in literature that defines prehospital care quality or that examines what dimensions of generic healthcare quality definitions are important in prehospital care. However, synthesis of included articles suggested that timely access to appropriate, safe and effective care which is responsive to a patient's needs and efficient and equitable to populations is reflective of high-quality prehospital care. The review also indicated that there is growing interest in developing QIs to evaluate prehospital care. In total, the review charted 526 QIs addressing clinical and non-clinical aspects of ambulance services providing prehospital care. The scoping review highlighted the need for validation of existing prehospital care QIs and de novo QI development.

In total, the scoping review identified 17 attributes of prehospital care quality. While each individual attribute on its own describes a component of quality, when considered in combination they can offer a more holistic impression of quality. To aggregate the identified attributes into principle dimensions of quality, the authors adapted a framework previously proposed by Campbell, *et al*[15] and used in the specific context of prehospital care by Owen.[16] Attributes relating to safety, both of the patient and the healthcare provider, were deemed to be of such importance and arguably distinctive to justify subsuming them

Table 1 Dimensions of quality (adapted from Campbell *et al*[15] and Owen[16])

Structure	Process	Outcome	Dimension
Availability Accessibility Equity	Availability Accessibility Continuity/sustainability Equity Timeliness	Health status User evaluation (includes Acceptability)	**Access**
Safety (provider and patient)	Safety (provider and patient)	Absence of Harm Provider Evaluation User Evaluation (includes Acceptability)	**Safety**
Appropriateness Capability Clinical Effectiveness Cost-effectiveness Efficiency Equity	Appropriateness Capability Caring Clinical Effectiveness Continuity/Sustainability Cost-effectiveness Efficiency Equity Interpersonal effectiveness Responsiveness Patient-centredness Well led	Health Status Financial Evaluation User Evaluation (includes Acceptability)	**Effectiveness**

into their own dimension. Table 1 details how the identified attributes were aggregated into the dimensions of access, safety and effectiveness and how they relate to healthcare structures, processes and outcomes.

Many of the 526 QIs identified in the scoping review addressed the same aspects of prehospital care. Therefore, two authors (RP and PS) independently aggregated the QIs as demonstrated in the example provided in table 2. Furthermore, the QIs were classified according to Donabedian type (structure, process or outcome) and quality dimension (access, safety and/or effectiveness). The aggregated QIs were categorised as either organisational/system QIs (appointed domain A) or clinical QIs (domain B). Lastly, within each domain, the QIs were further divided into several subdomains as detailed in table 3. Any disagreement between the two authors during this preparatory process was resolved through discussion and involvement of a third author (CL) when required. This process facilitated the assembly of

Table 2 Example of how indicators identified in the scoping review were aggregated

Identified in scoping review	Aggregated
Correct prehospital diagnosis of ST-elevation myocardial infarction by ambulance practitioner (paramedic/advanced paramedic)	A patient with acute chest pain or other signs/symptoms suggestive of acute coronary syndrome has a 12-lead ECG acquired, interpreted and transmitted to the receiving facility within 10 min of arrival on scene. (Process; effectiveness)
Appropriate 12-lead ECG acquisition rate, as indicated by clinical practice guidelines	
Conduction of 12-lead ECG	
Acquisition of a 12-lead ECG with appropriate, training-based interpretation by a paramedic and/or transmission to a designated emergency physician for interpretation.	
What percentage of patients over the age of 35 with suspected cardiac chest pain received a 12-lead ECG?	
A patient experiencing suspected ischaemic chest pain has a 12-lead ECG performed on them.	
Proportion of patients with chest pain with ECG performed within 10 min of first clinical contact, after arrival of ambulance.	

Table 3 Categorisation of quality indicators into domains and subdomains

Domain A: organisational/system	Domain B: clinical
A.1. General time intervals A.2. Patient safety A.3. Patient experience and satisfaction A.4. Communication and dispatch A.5. Resources and resource management A.6. Paramedic health and safety A.7. Training education and research A.8. Other (organisational/system)	B.1. Airway management, ventilation and oxygen therapy B.2. Out-of-hospital cardiac arrest B.3. Acute coronary syndrome B.4. Stroke B.5. Asthma B.6. Trauma B.7. Seizures B.8. Hypoglycaemia B.9. Pain management B.10. Other (clinical)

111 QIs, 47 in domain A and 64 in domain B. The majority of QIs were process indicators (n=79; 71%). Structural and outcome indicators were less common (n=18; 16% and n=14; 13%, respectively). Non-exclusively, the QIs were classified as addressing aspects access (n=33; 30%), safety (n=31; 28%) and effectiveness (n=74; 67%).

Rapid reviews and evidence summaries

For each subdomain and the proposed QIs, a rapid review was conducted to summarise the best available evidence. The JBI approach to rapid reviews and evidence summaries was applied.[17] The specific methods have been described previously.[11 18] The purpose of the evidence summaries was to provide the expert panel with a synopsis of best available evidence for each QI and thus facilitate evidence-informed rating of their validity. Table 4 details the structure of the evidence summaries supplied to the panel.

Consensus process

In round 1, panellists rated each QI on scales from 1 to 9 for clarity and validity. Panellists were able to add comments to improve the clarity of the QIs and, where applicable, choose a time interval as described above. For the assessment of validity, panellists were asked to consider the summarised evidence as well as their own knowledge and experience to rate each QIs validity in the context of contemporary Australian prehospital care. No QIs were excluded after the first round of rating. Results from the first round were used to make improvements to the clarity of QIs, determine optimal time intervals, and to provide feedback to panellists. Individual and confidential

Table 4 Structure of the evidence summaries

Section	Purpose
Definitions	To provide definitions of terms used in the subdomain and its proposed QIs to ensure standardised interpretation.
Prevalence and/or significance	To place the subdomain in context by providing (where applicable) pertinent Australian statistics and outlining implications for practice.
QIs and Evidence	To list the proposed QIs. Each proposed QI was identified as a structure, process, or outcome indicator and was categorised in one or more dimensions of quality (access, safety, and effectiveness). This was followed by synopses of the identified evidence and their levels according to JBI LoE.
Characteristics of the Evidence	To provide a brief description of the identified studies.
(Supporting Guidelines)	If supporting Australian guidelines were identified during the review process, references were provided in this section.
References	To list the sources.

LoE, level of evidence; QI, quality indicator.

Table 5 Demographics of the expert panel (n=9)

Demographic	N (%)†
Healthcare background*	
Paramedic	8 (89)
Nurse	2 (22)
Place of work*	
University	7 (78)
Ambulance service	5 (56)
Highest academic qualification	
PhD	6 (67)
Masters	3 (33)
Gender	
Male	7 (78)
Female	2 (22)
Location (Australian state/Territory)	
Victoria	4 (44)
Australian Capital Territory	2 (22)
New South Wales	1 (11)
Queensland	1 (11)
Western Australia	1 (11)

*Subcategories are not mutually exclusive.
†Percentages may not total 100 due to rounding.

feedback allowed panellists to see how their ratings compared with the other panellists. To see the distribution of all panellists' first round rating, the median and mean absolute deviation (MAD) around the median were also provided. This feedback provided insight into areas of agreement and, more importantly, disagreement ahead of the discussion forum. During and for a limited time after the discussion forum, panellists were able to participate in round 2 in which they cast their final rating for each QI's validity on the 9-point scale.

Data analysis

Data were analysed using Microsoft Excel 2019 (Microsoft, Richmond, Washington, USA). Criteria constituting validity were based on mathematical rules classically applied in the RAM.[12] QIs were classified as valid if the median score was 7–9 without disagreement, and as invalid if the median score was 1–3 without disagreement. All other outcomes were deemed uncertain. Disagreement was defined as the situation in which at least one-third of the panellists had scored in each of the extreme sections of the 9-point scale (1–3 and 7–9).

Patient and public involvement

No patients were involved in this study.

RESULTS

A panel of nine experts was convened. Table 5 describes the demographics of the panel. None of the recruited panellists declared any conflict of interest. Figure 1 outlines the study process and number of QIs at the various stages. A total of 117 QIs (111 from the preceding preparatory process and six additional ones suggested by the panel) were rated for validity in round 2. Table 6 provides summary statistics for these items and shows that in the organisational/system domain only 26 (51%) of these 51 QIs were considered valid. One QI (QI-A.7.5) had a median score of 7, however, was deemed uncertain (i.e., not valid) due to disagreement among the panel. In contrast, 58 (88%) of the 66 clinical QIs were deemed valid by the consensus process. In total, 84 (72%) of the 117 QIs were rated as valid.

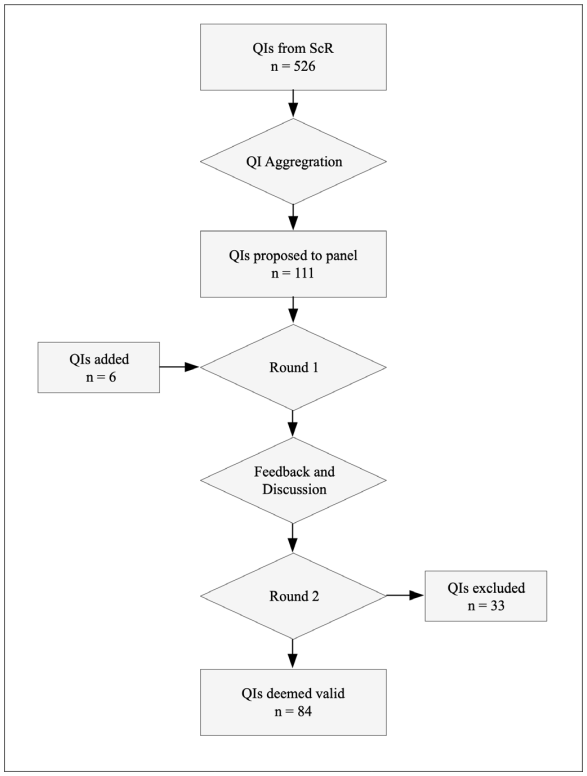


Figure 1 Study process and QI numbers at different stages of the study. QI, quality indicator, ScR, scoping review.

The full list of QIs and detailed results of round 2 can be found in online supplemental appendix.

The table provided in the online supplemental appendix shows all 117 QIs, their Donabedian type and which aspect/s of quality they address. The six additional QIs suggested by the panel are identifiable by a 'addl.' suffix after the QI number, for example, QI-A.4.4.addl. Where re-wording to improve clarity was required, only the revised QI is provided. QIs with time intervals contain only that number selected by the majority of the panel to achieve the highest validity rating. The table also provides the median, MAD around the median, level of consensus and final outcome of the consensus process for each QI. None of the QIs in Sub-domain A.1., which address response times, on-scene time and handover time, were considered valid, making it the only subdomain with no QIs deemed valid in this study. In contrast,

Table 6 Summary of validity ratings from round 2

	Domain A		Domain B		All	
	N	%*	N	%*	N	%*
Quality indicators (n)	51	100	66	100	117	100
Valid	**26**	**51**	**58**	**88**	**84**	**72**
Median 1–3	4	8	1	2	5	4
Median 4–6	20	39	7	11	27	23
Median 7–9	27	53	58	88	85	73
Agreement	13	26	47	71	60	51
Equivocal	34	67	18	27	52	44
Disagreement	4	8	1	2	5	4

*Percentages may not total 100 due to rounding.

all proposed QIs in Sub-domain A.8. addressing systems which enable clinical consultation, procedures for managing patients with mental health disorders or end-of-life care plans, as well as a service-wide quality improvement programme, were considered valid. Furthermore, all clinical QIs in Sub-domains B.1. Airway Management, Ventilation and Oxygen Therapy, B.3. Acute Coronary Syndrome, B.4. Stroke, B.6. Trauma and B.7. Seizures were evaluated to be valid, too.

Of the six additional QIs suggested by panel members, five were process indicators and one was an outcome indicator. Only half of them were considered valid; two process indicators (one each in domains A and B) and one outcome indicator (domain B). The three additionally suggested QIs which were deemed valid addressed effectiveness. Of all 84 QIs considered valid in this study, 13 (15%) were structural indicators, 62 (74%) were process indicators and 9 (11%) were outcome indicators. Non-exclusively, 18 (21%) QIs addressed *access*, 21 (25%) addressed safety, and 64 (76%) did so for effectiveness.

DISCUSSION

While there are substantial benefits in using work from other settings, QIs should not simply be transferred directly between different locations without an intermediate process that facilitates any necessary adjustment to accommodate differences in professional culture and clinical practice.[19] Furthermore, any QI development process should systematically incorporate scientific evidence.[20] This study has shown that with consideration of best available evidence, a substantial proportion of QIs scoped and synthesised from the international literature are valid for use in the Australian prehospital care context. Predictably, the panel agreed on the validity of many of the clinical QIs which are supported by robust, high-level scientific evidence, such as capnography to confirm correct endotracheal tube placement (QI-B.1.8.), withholding oxygen from normoxaemic acute coronary syndrome patients (QI-B.3.3.), or managing trauma patients in accordance with agreed trauma system protocols (QI-B.6.5.). The uneven distribution of valid QIs between the organisational/system and the clinical domains indicates that, at least among the expert panel participating in this study, considerable uncertainty exists about the validity of numerous service-based, non-clinical QIs. Especially the absence of any valid QIs in Sub-domain A.1. may corroborate the shift away from measuring general time intervals to assess the quality of prehospital care services. Nevertheless, many of the QIs with time intervals pertinent to specific, time-critical patients, such as response time to OHCA (QI-B.2.1.) or on-scene time for patients with major trauma (QI-B.6.4), were deemed valid.

The authors considered de novo QI development to be crucial in this study, especially if panellists felt that the proposed QIs from the international literature did not adequately address vital aspects of prehospital care essential for quality measurement in the Australian context. Panellists suggested only six additional QIs, implying that international QIs may sufficiently fill a suite of QIs to measure prehospital care quality in Australia. The few QIs added and considered valid by the expert panel address aspects of a progressive role ambulance services play in holistic healthcare, for example, managing patients in accordance with end-of-care life plans (QI-A.8.5.addl.). Conversely, the limited addition of QIs by the expert panel may also mean that further research is needed to detail this evolving role and elicit more specific areas for QI development.

Most of the QIs that were initially scoped, added by the expert panel and considered valid were process indicators. This is unsurprising because the comparatively short patient contact time common in prehospital care is a barrier to extensive outcome measurement. However, key to development of a good process indicator is that it can be associated with a desirable outcome,[21] a property which can only be ensured by utilising a development process that systematically incorporates scientific evidence. Validity is a central attribute of a QI, but a high-quality QI should possess several other characteristics, too. This study forms part of a three-phased project aimed at developing and testing prehospital care QIs for the Australian setting. QIs assessed to be valid are candidates for acceptability, feasibility and reliability testing in the next phase.

This study adhered principally to a validated and systematic consensus process which incorporates research evidence. RAM is an established method for the development of QIs in healthcare generally and has previously been applied in the paramedicine discipline.[16 22] It was not feasible to conduct systematic reviews for all identified QIs within the time and resources available for this project. The evidence summaries that were compiled instead carry inherent limitations of rapid reviews.[23] It was not possible to establish geographical diversity in the selection process of the expert panel. The panel was overrepresented from the State of Victoria and lacked representation from the Northern Territory, South Australia and Tasmania. As such, the findings of this study may suffer corresponding selection bias. Running online expert panels is a feasible means to facilitate consensus finding among geographically distributed participants.[24] Even when participants are in locations that make face-to-face meetings possible, unforeseen circumstances such as the current COVID-19 pandemic and associated social distancing, border closures or isolation requirements highlight that online discussions may at times be a necessity rather than a choice. Asynchronous discussions may expedite the elicitation process and minimise burden on participants, however, also carry a risk of decreasing engagement especially in small panel sizes such as those conventionally formed in RAM.[25] As such, a face-to-face or synchronous online meeting might have stimulated more discussion. The assessment of a QI's validity is critical, but there are several further steps that need to be taken to make a valid QI useful. This involves testing the QI for further desirable attributes, such as acceptability, feasibility and reliability. Especially feasibility and reliability testing require specifications which, at the most basic level, include the nominator, denominator and exclusion criteria for each QI. Thus, while deemed valid, there may be QIs among the final list produced in this study which are not implementable. The next study of the larger research project aims to test the candidate QIs for acceptability, feasibility, and reliability.

In summary, effective quality improvement starts with relevant and appropriate quality measurement based on valid QIs. Validity refers to the extent to which the indicator statement represents high-quality care and would therefore be an endorsed indicator of quality. Assessing the validity of QIs needs to include careful consideration of the intended context. This study used systematic methods to develop a substantial suite of evidence-informed and expert consensus-based QIs for Australian prehospital care. Before implementation though, these candidate QIs need to be tested.

Twitter Robin Pap @robin_pap

Acknowledgements The authors acknowledge the support provided through an Australian Government Research Training Programme Scholarship and by a research grant from the Australasian College of Paramedicine (ACP). The authors would like to thank all panellists for their time and expertise during the consensus process: A/Prof Malcolm Boyle (Griffith University); Dr Carol Shipp (Australian Capital Territory

Ambulance Service); A/Prof Paul Jennings (Ambulance Victoria); Mr Toby Keene (Australian National University); A/Prof Bill Lord (Monash University); Mr Alan Morrison (New South Wales Ambulance); Prof Peter O'Meara (Monash University); Mr. David Reid (Edith Cowan University); A/Prof Helen Webb (Australian Catholic University).

Contributors RP conceived the project, designed the study and obtained ethics approval and research funding. CL, MS and PS supervised the conduct of the study. RP, PS and CL prepared the quality indicators. RP conducted the rapid reviews. RP and PS undertook recruitment of panellists and all authors were involved in the selection. RP moderated the consensus process, analysed the data and drafted the manuscript. All authors contributed to its revision. RP took responsibility for the paper as a whole.

Funding The project that this study forms part of is supported by an Australian Government Research Training Programme Scholarship and partially by a research grant from the Australasian College of Paramedicine (ACP).

Competing interests None declared.

Patient consent for publication Not required.

Ethics approval Ethical approval was granted by the University of Adelaide Human Research Ethics Committee (approval number H-2017–157).

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as online supplemental information. Evidence summaries are available on reasonable request.

ORCID iD
Robin Pap http://orcid.org/0000-0002-7058-0341

REFERENCES

1 Pap R, Lockwood C, Stephenson M, *et al*. Indicators to measure prehospital care quality: a scoping review. *JBI Database Syst Rev Implement Rep* 2018;16:2192–223.
2 Australian Government Productivity Commission - Steering Committee for the Review of Government Service Provision. Report on Government Services - Chapter 11 (Ambulance Services) [Internet]. Canberra, 2020. Available: https://www.pc.gov.au
3 Harrison L. Ambulance Services in Australia - Healthy growth: Population growth has increased demand for ambulance services [Internet]. Melbourne, 2019. Available: https://www.ibisworld.com
4 Perla RJ, Provost LP, Parry GJ. Seven propositions of the science of improvement: exploring foundations. *Qual Manag Health Care* 2013;22:170–86.
5 Lawrence M, Olesen F. Indicators of quality in health care. *Eur J Gen Pract* 1997;3:103–8.
6 O'Meara P, Maguire B, Jennings P, *et al*. Building an Australasian paramedicine research agenda: a narrative review. *Health Res Policy Syst* 2015;13:79.
7 Lowthian JA, Cameron PA, Stoelwinder JU, *et al*. Increasing utilisation of emergency ambulances. *Aust Health Rev* 2011;35:63–9.
8 Bigham BL, Kennedy SM, Drennan I, *et al*. Expanding paramedic scope of practice in the community: a systematic review of the literature. *Prehosp Emerg Care* 2013;17:361–72.
9 Cooper S, Grant J. New and emerging roles in out of hospital emergency care: a review of the International literature. *Int Emerg Nurs* 2009;17:90–8.
10 Pap R, Lockwood C, Stephenson M, *et al*. Indicators to measure pre-hospital care quality: a scoping review protocol. *JBI Database System Rev Implement Rep* 2017;15:1537–42.
11 Pap R, Lockwood C, Stephenson M, *et al*. Development and testing of Australian prehospital care quality indicators: study protocol. *BMJ Open* 2020;10:e038310.
12 Fitch K, Bernstein SJJ, Aguilar MDD. The RAND/UCLA appropriateness method user's manual [Internet], 2001. Available: http://www.rand.org
13 Borah R, Brown AW, Capers PL, *et al*. Analysis of the time and workers needed to conduct systematic reviews of medical interventions using data from the Prospero registry. *BMJ Open* 2017;7:e012545.
14 Aromataris E, Munn Z, eds. *JBI manual for evidence synthesis [Internet]*. Adelaide: Joanna Briggs Institute, University of Adelaide, 2020. https://wiki.jbi.global/display/MANUAL
15 Campbell SM, Roland MO, Buetow SA. Defining quality of care. *Soc Sci Med* 2000;51:1611–25.
16 Owen RC. *The development and testing of indicators of prehospital care quality [dissertation]*. Manchester: University of Manchester, 2010.
17 Munn Z, Lockwood C, Moola S. The development and use of evidence summaries for point of care information systems: a streamlined rapid review approach. *Worldviews Evid Based Nurs* 2015;12:131–8.
18 Pap R, McKeown R, Lockwood C, *et al*. Pelvic circumferential compression devices for prehospital management of suspected pelvic fractures: a rapid review and evidence summary for quality indicator evaluation. *Scand J Trauma Resusc Emerg Med* 2020;28:65.
19 Marshall MN, Shekelle PG, McGlynn EA, a ME, *et al*. Can health care quality indicators be transferred between countries? *Qual Saf Health Care* 2003;12:8–12.
20 Mainz J. Developing evidence-based clinical indicators: a state of the art methods primer. *Int J Qual Health Care* 2003;15:5i–11.
21 Mainz J. Defining and classifying clinical indicators for quality improvement. *Int J Qual Health Care* 2003;15:523–30.
22 Campbell SM, Braspenning J, Hutchinson A, *et al*. Research methods used in developing and applying quality indicators in primary care. *BMJ* 2003;326:816–9.
23 Haby MM, Chapman E, Clark R, *et al*. What are the best methodologies for rapid reviews of the research evidence for evidence-informed decision making in health policy and practice: a rapid review. *Health Res Policy Syst* 2016;14:1–12.
24 Khodyakov D, Hempel S, Rubenstein L, *et al*. Conducting online expert panels: a feasibility and experimental replicability study. *BMC Med Res Methodol* 2011;11:174–82.
25 Jones Q, Ravid G, Rafaeli S. Information overload and the message dynamics of online interaction spaces: a theoretical model and empirical exploration. *Inf Syst Res* 2004;15:194–210.

Supplementary Appendix: Detailed results of validity ratings from round 2

Quality Indicator	Type	Dimension	Median	MAD	Level of Consensus	Outcome
Sub-domain A.1. General Time Intervals						
QI-A.1.1. In an urban setting, an ambulance arrives on scene of an emergency incident within 4 minutes of the service receiving the call.	Process	Access	5	1.9	Disagreement	Uncertain
QI-A.1.2. In an urban setting, an ambulance arrives on scene of an urgent incident within 20 minutes of the service receiving the call.	Process	Access	4	1.7	Equivocal	Uncertain
QI-A.1.3. In an urban setting, an ambulance arrives on scene of a non-emergency incident within 30 minutes of the service receiving the call.	Process	Access	5	1.8	Equivocal	Uncertain
QI-A.1.4. State//Territory-wide, an ambulance arrives on scene of an emergency incident within 4 minutes of the service receiving the call.	Process	Access	4	1.6	Equivocal	Uncertain
QI-A.1.5. State//Territory-wide, an ambulance arrives on scene of an urgent incident within 20 minutes of the service receiving the call.	Process	Access	4	0.9	Equivocal	Uncertain
QI-A.1.6. State//Territory-wide, an ambulance arrives on scene of a non-emergency incident within 60 minutes of the service receiving the call.	Process	Access	4	1.2	Equivocal	Uncertain
QI-A.1.7. An ambulance departs the scene within 20 minutes of arriving on scene, unless unable or impractical to do so for safety or operational reasons.	Process	Access	3	1.4	Equivocal	Invalid
QI-A.1.8. An ambulance crew hands over the patient to hospital staff and becomes available for the next call within 20 minutes.	Process	Access	3	1.7	Equivocal	Invalid
Sub-domain A.2. Patient Safety						
QI-A.2.1. The ambulance service has a dedicated patient safety incident reporting system.	Structure	Safety	7	1.1	Agreement	Valid
QI-A-2.2. The ambulance service has a guideline that defines the categories of patients that should be left in the care of an appropriate healthcare professional i.e. should not be left unattended.	Structure	Safety	7	0.9	Equivocal	Valid
QI-A.2.3. A patient who is not conveyed to a healthcare facility has been risk-assessed for likelihood of deterioration.	Process	Safety	7	0.7	Agreement	Valid
QI-A.2.4. The ambulance service has policy that describes the treat-and-refer arrangements for patients not conveyed to a health care facility.	Structure	Safety	7	1.0	Equivocal	Valid
QI-A.2.5. For a patient who was treated and discharge on scene, there is no need to call back the ambulance service for the same complaint within a 24-hour period.	Outcome	Safety Effectiveness	4	1.8	Equivocal	Uncertain
QI-A.2.6. For a patient who was treated and discharge on scene, there is no need for hospital admission for the same complaint within a 24-hour period.	Outcome	Safety Effectiveness	5	5.0	Equivocal	Uncertain
Sub-domain A.3. Patient Experience and Satisfaction						
QI-A.3.1. The ambulance service collects and analyses quantitative and qualitative data pertaining to patient experience and satisfaction for the purpose of quality improvement.	Process	Access Safety Effectiveness	8	0.7	Agreement	Valid
QI-A.3.2. In a patient satisfaction survey, a patient reports that they felt that the length of time they waited to be connected to an ambulance service call taker was much quicker or a little quicker than they thought it would be.	Outcome	Access	4	1.3	Equivocal	Uncertain

QI-A.3.3. In a patient satisfaction survey, a patient reports that they felt that the length of time they waited for an ambulance was much quicker or a little quicker than they thought it would be.	Outcome	Access	3	1.2	Equivocal	Invalid
QI-A.3.4. In a patient satisfaction survey, a patient reports that they felt that the level of care provided to them by paramedics was very good or good.	Outcome	Effectiveness	7	1.4	Equivocal	Valid
QI-A.3.5. In a patient satisfaction survey, a patient reports that their level of trust and confidence in paramedics and their ability to provide quality care and treatment was very high or high.	Outcome	Safety Effectiveness	7	1.3	Equivocal	Valid
QI-A.3.6. In a patient satisfaction survey, a patient reports that they were very satisfied or satisfied with the ambulance services they received in the previous 12 months.	Outcome	Access Safety Effectiveness	7	1.8	Equivocal	Valid
QI-A.3.7. In a patient satisfaction survey, a patient reports that the key elements of prehospital care* were delivered. (*Accessibility, response capacity, professionalism, transport conditions, capacity for resolving the situation)	Outcome	Access Safety Effectiveness	4	2.1	Disagreement	Uncertain
QI-A.3.8. The ambulance service collects and analyses quantitative and qualitative data pertaining to complaints for the purpose of quality improvement.	Process	Access Safety Effectiveness	7	0.9	Agreement	Valid
Sub-domain A.4. Communication and Dispatch						
QI-A.4.1. A call is assigned an accurate level of urgency and/or dispatch priority.	Process	Access Effectiveness	8	0.8	Agreement	Valid
QI-A.4.2. A patient is identified to be in OHCA by the ambulance service call-taker before the first resource arrives on scene.	Process	Effectiveness	9	1.0	Agreement	Valid
QI-A.4.3. A caller requesting assistance for suspected/confirmed adult cardiac arrest is offered instructions (audio, or video if possible) in chest-compression-only cardiopulmonary resuscitation (CPR).	Process	Effectiveness	9	0.9	Agreement	Valid
QI-A.4.4.addl. A call with an assigned level or urgency and/or dispatch priority is not downgraded inappropriately.	Process	Access Safety Effectiveness	5	1.3	Equivocal	Uncertain
QI-A.4.5.addl. A call categorized as urgent is not held for longer than 20 minutes before the ambulance is dispatched.	Process	Access Safety Effectiveness	6	1.1	Equivocal	Uncertain
Sub-domain A.5. Resources and Resource Management						
QI-A.5.1. The ambulance service has a policy that defines how many paramedic-staffed ambulances should be in service per 100,000 population.	Structure	Access	5	0.9	Agreement	Uncertain
QI-A.5.2. The ambulance service has an evidence-based policy that defines a minimum equipment list for an ambulance.	Structure	Access	6	1.3	Equivocal	Uncertain
QI-A.5.3. The ambulance service has a policy detailing which resource(s) should respond to each category/type of call.	Structure	Access	7	0.8	Equivocal	Valid
QI-A.5.4. A patient who meets service-defined treat-and-discharge or treat-and-release criteria is not transported.	Process	Access	7	1.3	Equivocal	Valid
Sub-domain A.6. Paramedic Health and Safety						
QI-A.6.1. The ambulance service utilizes a fatigue/sleepiness screening instrument to measure and monitor fatigue in paramedics.	Process	Safety	6	1.1	Equivocal	Uncertain

QI-A.6.2. The ambulance service schedules paramedics to work shifts shorter than 12 hours in duration.	Process	Safety	7	0.7	Equivocal	Valid
QI-A.6.3. The ambulance service provides access for paramedics to caffeine as a fatigue counter measure.	Process	Safety	2	0.8	Agreement	Invalid
QI-A.6.4. The ambulance service provides opportunity for paramedics to rest and recline while on duty to mitigate fatigue.	Structure	Safety	5	1.0	Agreement	Uncertain
QI-A.6.5. The ambulance service provides fatigue training to its paramedics.	Process	Safety	6	0.8	Equivocal	Uncertain
QI-A.6.6. The ambulance service provides mental health programs, including pre-incident preparedness training, to its paramedics.	Process	Safety	7	0.9	Agreement	Valid
QI-A.6.7. The ambulance service utilizes a post-exposure PTSD screening instrument designed for emergency service personnel to identify PTSD in paramedics.	Process	Safety	5	1.3	Equivocal	Uncertain
QI-A.6.8. The ambulance service collects and analysis quantitative and qualitative data pertaining to staff satisfaction.	Process	Effectiveness	7	1.2	Equivocal	Valid
Sub-domain A.7. Training, Education and Research						
QI-A.7.1. The ambulance service has a policy that describes the process for supervision of paramedics in training.	Structure	Safety Effectiveness	7	1.0	Equivocal	Valid
QI-A.7.2. The ambulance service staff have access to electronic/online medical education resources.	Structure	Safety Effectiveness	7	1.1	Equivocal	Valid
QI-A.7.3. The ambulance service has a dedicated training and education unit.	Structure	Access Safety Effectiveness	7	0.9	Agreement	Valid
QI-A.7.4. The ambulance service has a dedicated research unit.	Structure	Access Safety Effectiveness	5	2.0	Disagreement	Uncertain
QI-A.7.5. The ambulance service has a formal collaborative research agreement with a partnering university offering paramedicine programs.	Structure	Access Safety Effectiveness	7	1.8	Disagreement	Uncertain
QI-A.7.6. The ambulance service has a guideline which details the criteria by which it assesses proposals to conduct research by its staff or in collaboration with external parties.	Structure	Safety	7	1.8	Equivocal	Valid
QI-A.7.7.addl. The ambulance service measures and monitors performance against quality indicators related to the effectiveness of paramedicine student field/clinical placements.	Process	Safety Effectiveness	5	1.1	Equivocal	Uncertain
Sub-domain A.8. Other (Organisational/System)						
QI-A.8.1. The ambulance service has arrangements in place enabling paramedics to consult with senior clinical colleagues when treating a patient.	Structure	Safety Effectiveness	7	1.1	Equivocal	Valid
QI-A.8.2. The ambulance service has arrangements in place enabling paramedics to consult with specialist mental health professionals when treating a patient with a mental health disorder.	Structure	Safety Effectiveness	8	1.0	Equivocal	Valid
QI-A.8.3. The ambulance service has a procedure for managing situations in which a patient refuses care or transportation for the physical effects of self-harm.	Structure	Safety Effectiveness	7	0.9	Equivocal	Valid
QI-A.8.4. The ambulance service operates a quality improvement program that includes quality assessment/measurement, control and improvement.	Process	Access Safety Effectiveness	8	1.3	Equivocal	Valid

QI-A.8.5.addl. A patient with accessible end-of-life care plans is managed in accordance with these plans.	Process	Effectiveness	7	1.0	Agreement	Valid
Sub-domain B.1. Airway Management, ventilation and Oxygen Therapy						
QI-B.1.1. A patient with a decreased level of consciousness (Glasgow Coma Score ≤14), has their airway patency assessed.	Process	Effectiveness	8	1.4	Agreement	Valid
QI-B.1.2. A hypoxemic patient (SpO2 <94%) is administered oxygen, unless contraindicated.	Process	Effectiveness	8	1.1	Agreement	Valid
QI-B.1.3. A normoxaemic patient (SpO2 ≥94%) is not administered oxygen, unless specifically indicated.	Process	Effectiveness	7	0.9	Agreement	Valid
QI-B.1.4. A patient who has a supraglottic airway inserted, meets service-defined indications for the airway intervention.	Process	Effectiveness	8	0.8	Agreement	Valid
QI-B.1.5. In a patient who has a supraglottic airway inserted, the correct position of the supraglottic airway is assessed using an exhaled CO2 detector.	Process	Effectiveness	8	1.3	Agreement	Valid
QI-B.1.6. A patient who is endotracheally intubated, meets service-defined indications for the procedure.	Process	Effectiveness	8	0.4	Agreement	Valid
QI-B.1.7. A patient who is intubated, is successfully endotracheally intubated.	Process	Effectiveness	8	0.7	Agreement	Valid
QI-B.1.8. For an endotracheally intubated patient, the correct position of the endotracheal tube is assessed using an exhaled CO2 detector.	Process	Effectiveness	9	0.7	Agreement	Valid
QI-B.1.9. A patient who is endotracheally intubated has their pulse oximetry continuously monitored during the procedure.	Process	Effectiveness	8	0.6	Agreement	Valid
QI-B.1.10. A patient who receives cricothyrotomy, meets service-defined indications for the procedure.	Process	Effectiveness	8	0.8	Agreement	Valid
QI-B.1.11. A patient who receives cricothyrotomy, has the procedure performed successfully.	Process	Effectiveness	8	0.7	Agreement	Valid
Sub-domain B.2. Out-of-Hospital Cardiac Arrest						
QI-B.2.1. An ambulance arrives at an OHCA patient within 4 minutes of the 000-call.	Process	Access	8	1.2	Equivocal	Valid
QI-B.2.2. Paramedics providing CPR utilize an audio-visual feedback and prompt device for real-time optimization of chest compression quality.	Process	Effectiveness	7	1.4	Equivocal	Valid
QI-B.2.3. For an OHCA patient in a shockable rhythm, the first defibrillation attempt is made as soon as possible and within 2 minutes of arrival at the patient.	Process	Effectiveness	8	1.0	Agreement	Valid
QI-B.2.4. For an adult OHCA patient, the airway is secured by a supraglottic airway (SGA) or endotracheal tube (ETT).	Process	Effectiveness	5	1.8	Equivocal	Uncertain
QI-B.2.5. An OHCA patient in refractory ventricular fibrillation/ventricular tachycardia (VF/VT) is administered intravenous/intraosseous amiodarone or lignocaine, unless contraindicated.	Process	Effectiveness	4	1.7	Disagreement	Uncertain
QI-B.2.6. The receiving hospital receives pre-notification of an OHCA/post-OHCA patient.	Process	Access	7	1.3	Agreement	Valid
QI-B.2.7. A patient who was in OHCA has return to spontaneous circulation (ROSC) on arrival at the receiving hospital.	Outcome	Effectiveness	7	0.9	Equivocal	Valid
QI-B.2.8. A patient who was in OHCA survives to discharge from hospital.	Outcome	Effectiveness	7	1.9	Equivocal	Valid
QI-B.2.9. A patient who was in OHCA is discharged from hospital with favourable neurological outcome; CPC ≤2 or mRS ≤3.	Outcome	Effectiveness	8	1.0	Agreement	Valid
QI-B.2.10.addl. A patient who was in OHCA survives to 30 days from the event.	Outcome	Effectiveness	7	1.1	Equivocal	Valid
Sub-domain B.3. Acute Coronary Syndrome						
QI-B.3.1. The ambulance service has a documented clinical care pathway that details the care and transport it provides to patients with signs and/or symptoms suggestive of ACS.	Structure	Access Effectiveness	7	1.2	Agreement	Valid

QI-B.3.2. A patient with signs and/or symptoms suggestive of ACS has a 12-lead electrocardiograph (ECG) acquired and interpreted within 10 minutes of arrival on scene.	Process	Effectiveness	8	1.6	Equivocal	Valid
QI-B.3.3. A patient with signs and/or symptoms suggestive of ACS and normoxaemia (SpO2 ≥94%) is not administered supplementary oxygen.	Process	Effectiveness	8	0.2	Agreement	Valid
QI-B.3.4. A patient with signs and/or symptoms suggestive of ACS is administered aspirin, unless contraindicated.	Process	Effectiveness	8	0.4	Agreement	Valid
QI-B.3.5. A patient with signs and/or symptoms suggestive of ACS has their pain score assessed before and after treatment.	Process	Effectiveness	8	0.8	Agreement	Valid
QI.B.3.6. A patient with signs and/or symptoms suggestive of ACS is administered glyceryl trinitrate, unless contraindicated.	Process	Effectiveness	8	0.9	Agreement	Valid
QI-B.3.7. A patient with acute chest pain suggestive of ACS is administered analgesic agent(s), unless contraindicated.	Process	Effectiveness	7	1.3	Equivocal	Valid
QI-B.3.8. If transport time to a hospital capable of providing primary PCI is ≤30 minutes, a patient with STEMI and within 12 hours of symptom onset is transported directly to that hospital.	Process	Effectiveness	8	1.0	Agreement	Valid
QI-B.3.9.addl. If transport time to a hospital capable of providing primary PCI is >30 minutes, a patient with STEMI and within 12 hours of symptom onset receives prehospital fibrinolysis.	Process	Effectiveness	7	1.6	Equivocal	Valid
Sub-domain B.4. Stroke						
QI-B.4.1. A patient with suspected acute stroke is assessed using a validated stroke identification tool†. ((† Los Angeles prehospital stroke screen (LAPSS score), Cincinnati prehospital stroke scale (CPSS), Face Arm Speech Test (FAST), Melbourne Ambulance Stroke Screen (MASS score), Ontario Prehospital Stroke Screening tool (OPSS) or Recognition Of Stroke In the Emergency Room (ROSIER) scale)	Process	Effectiveness	8	0.4	Agreement	Valid
QI-B.4.2. A patient with suspected acute stroke has their blood glucose level measured.	Process	Effectiveness	8	0.6	Agreement	Valid
QI-B.4.3. In a patient with suspected acute stroke, it is assessed whether or not they are on anticoagulant therapy.	Process	Effectiveness	8	0.7	Agreement	Valid
QI-B.4.4. A patient with suspected acute stroke and normoxaemia (SpO2 ≥94%) is not administered supplementary oxygen.	Process	Effectiveness	8	0.4	Agreement	Valid
QI-B.4.5. In a patient with suspected acute stroke, it is assessed at what time the patient was last known to be without the clinical features of acute stroke.	Process	Effectiveness	8	0.2	Agreement	Valid
QI-B.4.6. A patient presenting with suspected stroke is transported directly to a hospital capable of performing thrombolysis and/or endovascular thrombectomy.	Process	Access	8	0.7	Agreement	Valid
QI-B.4.7. The receiving facility receives notification of a patient experiencing suspected stroke.	Process	Access	8	0.6	Agreement	Valid
Sub-domain B.4. Asthma						
QI-B.5.1. A suspected acute asthma patient has their PEF measured prior to nebulization, unless they are unable to perform the test.	Process	Effectiveness	7	0.8	Agreement	Valid
QI-B.5.2. A patient with acute asthma has their oxygen saturation level continuously monitored.	Process	Safety Effectiveness	8	0.3	Agreement	Valid
QI-B.5.3. A patient with acute asthma is given controlled oxygen titrated to maintain an SpO2 level of 94-98%.	Process	Effectiveness	8	0.7	Agreement	Valid
QI-B.5.4. A patient with acute asthma is administered salbutamol via oxygen-driven nebulizer, unless contraindicated.	Process	Effectiveness	7	0.8	Agreement	Valid

QI-B.5.5. A patient with acute severe asthma or worse is administered salbutamol and ipratropium bromide via oxygen driven nebulizer, unless contraindicated.	Process	Effectiveness	7	0.6	Agreement	Valid
QI-B.5.6. A patient with acute severe asthma or worse is administered intravenous/intramuscular hydrocortisone, unless contraindicated.	Process	Effectiveness	6	1.2	Equivocal	Uncertain
QI-B.5.7. A patient with life-threatening asthma is be administered intramuscular adrenaline, unless contraindicated.	Process	Effectiveness	8	0.6	Agreement	Valid
QI-B.5.8. The receiving facility receives notification of a patient with life-threatening asthma.	Process	Access	8	1.1	Agreement	Valid
QI-B.5.9. A mild acute asthma patient who after treatment is asymptomatic with no dyspnoea and has a PEF higher than the original measurement is prehospitally discharged, unless service-defined risk criteria apply.	Process	Safety Effectiveness	5	1.1	Equivocal	Uncertain
Sub-domain B.6. Trauma						
QI-B.6.1 A patient with active external haemorrhage receives haemorrhage control by application of direct pressure, arterial tourniquet and haemostatic dressing as required.	Process	Effectiveness	8	1.1	Agreement	Valid
QI-B.6.2. A patient with a mechanism of injury and/or other signs/symptoms suggestive of pelvic fracture has a pelvic circumferential compression device (PCCD) applied.	Process	Effectiveness	8	1.0	Agreement	Valid
QI-B.6.3. A patient with recent (≤3 hours) traumatic injury resulting in ongoing haemorrhage and/or ATC (indicated by a validated and prehospitally applicable prediction tool) receives TXA (1g, intravenously).	Process	Effectiveness	7	1.7	Equivocal	Valid
QI-B.6.4. When attending to a patient suffering neurotrauma or penetrating injury with hemodynamic instability, the ambulance departs the scene within 10 minutes of arriving on scene, unless unable or impractical to do so for safety or operational reasons.	Process	Access	7	1.3	Equivocal	Valid
QI-B.6.5. A patient is correctly triaged and transported to an appropriate hospital as per agreed trauma system protocol.	Process	Access	8	0.9	Agreement	Valid
QI-B.6.6. The receiving hospital receives notification of a major trauma patient as per agreed trauma system protocol.	Process	Access	8	0.8	Agreement	Valid
Sub-domain B.7. Seizures						
QI-B.7.1. A patient with a seizure has their blood glucose level measured.	Process	Effectiveness	8	0.1	Agreement	Valid
QI-B.7.2. A patient with an active seizure is administered a benzodiazepine by the best available route.	Process	Effectiveness	8	1.0	Agreement	Valid
Sub-domain B.8. Hypoglycaemia						
QI-B.8.1. A conscious hypoglycaemic patient is administered oral glucose, unless contraindicated.	Process	Effectiveness	8	0.6	Agreement	Valid
QI-B.8.2. An unconscious hypoglycaemic patient is administered intravenous glucose 10% or intramuscular glucagon, unless contraindicated.	Process	Effectiveness	8	1.0	Agreement	Valid
QI-B.8.3. A patient who has been administered glucose (oral or intravenous) or glucagon has their blood glucose level checked following administration.	Process	Effectiveness	8	0.7	Agreement	Valid
QI-B.8.4. A patient who has had a hypoglycaemic episode effectively corrected is prehospitally discharged, unless they are taking oral hypoglycaemic agents (OHA) or other service-defined repeat hypoglycaemic event (RHE) risk criteria apply.	Process	Effectiveness	5	1.4	Equivocal	Uncertain
Sub-domain B.10. Pain Management						
QI-B.9.1. A patient has their pain intensity measured using the 0-10 verbal numerical rating scale (VNRS).	Process	Effectiveness	8	0.9	Agreement	Valid

QI-B.9.2. A patient experiencing mild (2-3/10), moderate (4-6/10) or severe (7-10/10) pain is administered analgesic agent(s), unless contraindicated or refused.	Process	Effectiveness	8	0.4	Agreement	Valid
QI-B.9.3. A patient who is administered analgesic agent(s) reports a reduction in pain to ≤ 3/10 or at least by 3 points.	Outcome	Effectiveness	6	1.1	Equivocal	Uncertain
QI-B.9.4. A responsive patient who is administered analgesic agent(s) remains responsive to verbal stimuli, unless anaesthesia is being induced.	Outcome	Safety	7	1.4	Equivocal	Valid
QI-B.9.5. A responsive patient who is administered analgesic agent(s) does not require airway management or ventilatory support following the administration, unless anaesthesia is being induced.	Outcome	Safety	7	1.2	Agreement	Valid
Sub-domain B.10. Other (Clinical)						
QI-B.10.1. A patient with suspected paracetamol overdose who presents within four hours of ingestion is administered activated charcoal, unless contraindicated.	Process	Effectiveness	3	1.4	Equivocal	Invalid
QI-B.10.2. A patient suspected of opioid overdose who is unconscious or has depressed respiration is administered naloxone (2 mg, intramuscular/intranasal/ intravenous), unless contraindicated.	Process	Effectiveness	6	1.6	Equivocal	Uncertain
QI-B.10.3. The ambulance service has a policy that defines specific categories of patients for which receiving facilities are to be notified of the patient's arrival.	Structure	Access	7	0.8	Agreement	Valid

MAD = mean absolute deviation around the median

4.4 Summary

This chapter detailed the systematic methods and results of study 2 and thus addressed research objective 2 which was to develop a suite of prehospital care QIs for the Australian setting and to assess the QIs for validity. Manuscript 4 is a published exemplar of how a streamlined rapid review approach can provide timely evidence synthesis to inform an expert panel tasked to consider the contextual validly of QIs. Manuscript 5 details the subsequent evidence-informed expert consensus process to develop the suite of prehospital care QIs for the Australian setting. With consideration of best available evidence, a substantial proportion of the QIs proposed to the expert panel was deemed valid for use in the Australian prehospital care context. The panel made minimal additions to the suite implying that QIs scoped and aggregated form the international literature may be sufficient for the Australian context or suggesting that further research is needed to explore areas for QI development. The results also indicated that the expert panel supports a shift away from using QIs relating to general time intervals, such as response time, as a means to evaluate the quality of prehospital care services.

As highlighted in Chapter 1, in addition to validity there are a number of other desirable attributes that high-quality QIs should possess and should be tested for prior to their implementation.[45] One of the most important attributes is acceptability. Testing the QIs deemed valid in study 2 for acceptability is presented in Chapter 5.

Chapter 5: Acceptability of prehospital care quality indicators for the Australian setting

5.1 Overview

Study 2, presented in Chapter 4, employed systematic methods to develop a suite of valid prehospital care QIs for the Australian setting. Besides validity, there are a number of other desirable attributes that QIs should be tested for prior to being implemented, including acceptability. Thus, study 3 presented in this chapter aimed to test the of prehospital care QIs deemed valid in study 2 for acceptability (research objective 3).

In the context of QIs development and application, acceptability refers to the extent to which measurement of performance based on a particular QI is acceptable to both those being assessed and those undertaking the assessment.[34] Acceptability of QIs amongst prehospital care providers and managers is critical because measurement of quality can only be an effective tool for directing improvement efforts when key stakeholders accept them.[39] Neither quantitative nor qualitative data alone could provide sufficient information for meaningful interpretation. Therefore, an explanatory sequential design was adopted, with the qualitative stage forming the core of the mixed methods study. Titled 'Acceptability of Australian prehospital care quality indicators: an explanatory sequential mixed methods study' the manuscript was submitted to a journal shortly before completion of the thesis.

5.2 Manuscript 6

Statement of Authorship

Title of Paper	Acceptability of Australian prehospital care quality indicators: an explanatory sequential mixed methods study
Publication Status	☐ Published ☐ Accepted for Publication ☑ Submitted for Publication ☐ Unpublished work written in manuscript style
Publication Details	Submitted for publication

Principal Author

Name of Principle Author (Candidate)	Robin Pap		
Contribution to Paper	Principle author responsible for the design of the study and writing up of the manuscript.		
Overall percentage (%)	85%		
Certification	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature		Date	01 February 2022

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:
1. the candidate's stated contribution to the publication is accurate (as detailed above);
2. permission is granted for the candidate in include the publication in the thesis; and
3. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Assoc Prof Craig Lockwood		
Contribution to Paper	Principally supervised development of work, helped in defining inclusion and exclusion criteria, and in manuscript evaluation.		
Signature		Date	01 February 2022

Name of Co-Author	Dr Matthew Stephenson		
Contribution to Paper	Co-supervised development of work, helped in defining inclusion and exclusion criteria, and in manuscript evaluation.		
Signature		Date	01 February 2022

Name of Co-Author	Assoc Prof Paul Simpson		
Contribution to Paper	Co-supervised development of work, helped in defining inclusion and exclusion criteria, and in manuscript evaluation.		
Signature		Date	01 February 2022

Acceptability of Australian prehospital care quality indicators: an explanatory sequential mixed methods study

Robin Pap[1,2]*, Matthew Stephenson[2], Paul Simpson[1], Craig Lockwood[2]

1. School of Science and Health, Western Sydney University, Sydney, Australia
2. JBI, University of Adelaide, Adelaide, Australia

* Corresponding author

Email Addresses:	Robin Pap	r.pap@westernsydney.edu.au
	Matthew Stephenson	matthew.stephenson@adelaide.edu.u
	Paul Simpson	p.simpson@westernsydney.edu.au
	Craig Lockwood	craig.lockwood@adelaide.edu.au

Keywords: Quality indicators; Quality improvement; Prehospital care

ABSTRACT

Background: Systematically developed quality indicators (QIs) facilitate the measuring and monitoring of quality of care and ultimately meaningful quality improvement. The aim of this study was to evaluate the acceptability of a predetermined suite of 84 scientifically valid prehospital care QIs from the provider perspective.

Methods: An explanatory sequential mixed methods study design was used. Quantitative data were obtained from 36 participants of an online survey in which they rated the acceptability of the QIs using a 5-point numerical rating scale. Qualitative data were gathered by conducting semi-structured interviews with a purposive sample of nine survey participants. The successional collection of quantitative and qualitative data facilitated integrated interpretations and conclusions about the acceptability of the QIs.

Results: Generally, the acceptability of all QIs in the suite was rated highly. Data suggested a positive association between acceptability and other key characteristics of QIs. QIs which were seen to be clear, supported by scientific evidence, practical, and meaningful tended to be more acceptable than those which were not. The benefits of outcome type QIs was recognised but participants raised concerns about their sensitivity in the measurement of prehospital quality of care. To be acceptable, QIs which included time intervals needed to be specific about time-critical interventions. Further, the high acceptability of the QIs was explained by a connection to participants' professional values and qualities. Assessing the QIs' acceptability from a healthcare provider perspective meant that QIs on patient satisfaction frequently received lower ratings.

Conclusion: The findings of this study provide evidence of the acceptability to prehospital care providers of a proposed suite of QIs. Future research should evaluate the feasibility and reliability of the QIs. There is also a need to investigate how acceptable the proposed QIs are to patients and communities.

BACKGROUND

The measurement of performance is integral to quality management within and across healthcare organisations and systems. Measuring and monitoring the quality of care and services starts with the development of quality indicators (QIs) of desirable performance and outcomes.[1] Quality improvement has experienced extensive growth leading to the emergence of improvement as a science in itself.[2–4] This has advanced the scientific rigour around the approaches and methods used for selecting and developing QIs and QI suites.[5–7] Whilst scientific validity is a minimum prerequisite for any QI, subsequent developmental work should aim to provide empirical evidence, as far as possible, of a number of other key characteristics, including acceptability.[5,6,8,9] Acceptability is a multi-faceted construct,[10] and in the development and application of QIs depends on the extent to which measurement of performance based on a particular QI is acceptable to both those being assessed and those undertaking the assessment.[8] Quality measurement is not synonymous with quality improvement. However, positive change cannot occur without meaningful measurement of performance.[2] For measurement to be effective in facilitating improvement the gathered intelligence needs to be able to influence decision-makers. If decision-makers and key stakeholders do not accept a QI, the results of associated measurement will not be useful for influencing people to make change.[5] Therefore, the potential of a QI to facilitate quality improvement relies on it being acceptable to stakeholders.

An all-inclusive definition of prehospital care comprises all healthcare services prior to referral to a hospital, if needed. However, for the purpose of this project, prehospital care is confined to the care and services provided by ambulance services. In Australia, the provision of prehospital care is performed predominantly by jurisdictional State/Territory ambulance services forming an important part of the national health system. In 2019/20, these ambulance

services had an operational workforce consisting of 16,209 staff (total full time equivalent) and responded to over 3.9 million incidents (154.3 per 1,000 population).[11] Ambulance services in Australia, like most other healthcare services anywhere, are under pressure to maintain contemporary, high-quality patient care in an environment with constantly growing demands and complexity.[12,13] The right measurement of the right data over time, and its use as performance intelligence, plays a pivotal role in guiding any healthcare services' decision-makers with respect to quality of care.[14] This study forms part of a larger research project aimed at developing and testing prehospital care QIs for the Australian setting (www.aspireproject.net).[15] The current study set out with the aim to gain insight into the acceptability of a predetermined suite of 84 scientifically valid prehospital care QIs from the perspective of paramedics and ambulance service managers.

METHODS

The methods applied in this study and other parts of the project were specified in advance in a protocol.[15] Data collection for this study was commenced in February 2021 and completed in August 2021.

Preceding work

The 84 proposed QIs stemmed from previous published studies of the project, namely an initial scoping review,[16] and a subsequent evidence-informed expert consensus process.[17] In preparation for the consensus process, QIs identified in the scoping review were aggregated and systematically prepared within clinical and non-clinical domains, and a structure/process/outcome and access/safety/effectiveness taxonomy as summarised in tables 1 and 2. The combination of best available evidence and expert consensus was used to identify existing QIs and to develop new ones to create a suite deemed valid for the

measurement of Australian prehospital care quality. The 84 valid QIs of the suite are listed in supplementary appendix A.

Table 1 Categorisation of quality indicators into domains and sub-domains

Domain A: Organisational/System	Domain B: Clinical
A.1. General Time Intervals A.2. Patient Safety A.3. Patient Experience and Satisfaction A.4. Communication and Dispatch A.5. Resources and Resource Management A.6. Paramedic Health and Safety A.7. Training Education and Research A.8. Other (Organisational/System)	B.1. Airway Management, Ventilation and Oxygen Therapy B.2. Out-of-Hospital Cardiac Arrest (OHCA) B.3. Acute Coronary Syndrome B.4. Stroke B.5. Asthma B.6. Trauma B.7. Seizures B.8. Hypoglycaemia B.9. Pain Management B.10. Other (Clinical)

Table 2 Dimensions of quality (adapted from Campbell, et al.[18] and Owen[19])

Structure	Process	Outcome	Dimension
Availability Accessibility Equity	Availability Accessibility Continuity/Sustainability Equity Timeliness	Health Status User Evaluation (includes Acceptability)	**Access**
Safety (Provider and Patient)	Safety (Provider and Patient)	Absence of Harm Provider Evaluation User Evaluation (includes Acceptability)	**Safety**
Appropriateness Capability Clinical Effectiveness Cost-effectiveness Efficiency Equity	Appropriateness Capability Caring Clinical Effectiveness Continuity/Sustainability Cost-effectiveness Efficiency Equity Interpersonal effectiveness Responsiveness Patient-centeredness Well-led	Health Status Financial Evaluation User Evaluation (includes Acceptability)	**Effectiveness**

Study design and setting

A two-staged explanatory sequential mixed methods research design was adopted.[20,21] Inquiries within the two stages of the study were guided by appropriate research

paradigms. A postpositivist stance was taken in the initial quantitative stage followed by a constructivist stance in the subsequent qualitative stage.[20] The study used a social science theory lens informed by reviews and frameworks of acceptability as a criterion for evaluating performance measures.[10,22,23] In stage 1, an online survey was conducted to collect quantitative data on the acceptability of the 84 QIs. In stage 2, online one-to-one semi-structured interviews were performed aimed at qualitatively explaining what makes QIs acceptable or unacceptable. Although results of the quantitative and qualitative aspects were integrated, the qualitative stage constituted the core of the research. Integration occurred at the conceptualisation of the study by planning an explanatory sequential design. During the research, integration was achieved through linking data collection and analysis. This was done by connecting through sampling, building by considering results of the survey during the interviews, and merging the two datasets for analysis.[20,24] Integration though narrative was applied using a contiguous approach in reporting the results of the two stages, followed by weaving in the discussion.[24,25] The study was conducted in Australia.

Participants and recruitment

The target population for this study was comprised of paramedics and directors, managers, or supervisors have worked in in quality improvement projects from any Australian ambulance service. Recruitment involved website and email advertisement by the Australasian College of Paramedicine (ACP) followed by social media posts over a four-week period. The sample for stage two was purposively selected aimed at even representation of demographic criteria by inviting survey participants to the subsequent interviews.

Stage 1 data collection

Participants were asked to anonymously complete an online survey (designed on Qualtrics; Qualtrics, Provo, Utah, USA). Since there was no existing survey that met the needs, the survey was purpose-built. The survey collected basic demographic data and then asked participants to answer the following question for each QI using a 5-point numerical rating scale (1 = very unacceptable, 2 = unacceptable, 3 = neutral, 4 = acceptable, 5 = very acceptable): *How acceptable is it to assess the quality of your patient care or the quality of your ambulance service based on data collected using this quality indicator?* Due to the simplicity of the survey, no piloting was done. Survey settings prevented multiple submissions by individuals. Based on the Australian registered paramedic population of approximately 17,000, using a sample size estimation with a confidence level of 95% and, for practical reasons, accepting a margin of error of 8%, an ideal sample size of 149 was pursued.

Stage 1 data analysis

Quantitative data analysis was performed using Microsoft Excel V16 (Microsoft, Richmond, Washington, USA) and IBM SPSS Statistics V27 (IBM, Armonk, New York, USA). Descriptive statistics were completed to summarise all survey items. For each QI, central tendency of acceptability ratings was evaluated using the median. The 5-point rating scale was assumed to represent a continuous variable rather than five discrete categories, and medians were calculated accordingly.[26,27] Diverging stacked bar charts were created to visualise distributions. Explicit acceptability and unacceptability were calculated to be expressed as percentages by combining ratings of 4 (acceptable) and 5 (very acceptable), and 2 (unacceptable) and 1 (very unacceptable), respectively. Kruskal-Wallis tests (KWt) were conducted to examine the differences on medians according to QI types (structure, process, and outcome) and quality dimensions (access, safety, and effectiveness). A p value of <0.05

was considered statistically significant. Finally, and with consideration of the distribution of medians, the median of medians was identified for the entire suite, its two domains, as well as subsets of QIs in accordance with the project's classification system.

Stage 2 data collection

Guided by methods described by DiCicco-Bloom and Crabtree,[28] an interview guide containing *a priori* questions and topics/questions informed by the results of stage 1 was developed. The interview guide facilitated a flexible interview protocol and was supplemented by follow-up questions, probes and comments.[29–31] The open-ended questions aimed at eliciting explanations for what makes QIs acceptable or unacceptable to participants. Participants were asked specifically about QIs which were rated relatively low or high in stage 1. To ensure diversity and to optimise credibility of results, maximum variation sampling was used from the pool of volunteering participants.[32] Interviews, with an intended length of approximately 30 minutes, were conducted in English by the principal investigator (RP) using audio call on Zoom (Zoom Video Communications Inc., San Jose, CA, USA) and recorded for transcription. During the interviews, member checking was performed through the interviewer restating or summarising information and then questioning the participant to determine validity.[29] Field notes were taken during and after each interview. Data was collected until saturation, defined as the point at which no new information was observed,[33,34] was achieved. One additional interview was conducted for assurance.[35] Trustworthiness of the findings was enhanced by data triangulation of recorded interviews, transcripts, and field notes.[20]

176 **Stage 2 data analysis**

177 Using NVivo 12 (QRS International, Doncaster, Australia), the transcripts were analysed by
178 conducting thematic analysis as outlined by Braun and Clarke.[36] An inductive and semantic
179 approach was used. The triangulation which was performed to ensure credibility also enabled
180 content familiarisation (phase 1). Data were disassembled through coding (phase 2) and
181 reassembled by placing it into context with each other to create themes and sub-themes
182 (phase 3). Themes were reviewed (phase 4), defined and named (phase 5), and finally
183 reported upon (phase 6) thereby drawing analytical conclusions.[36]

184

185

186 **RESULTS**

187 **Stage 1**

188 Thirty-six complete responses were received. Participant demographics are detailed Table 3.
189 Participants were predominantly male (61.1%) and relatively young (72.2% aged between 25
190 and 44 years). Half of all participants had a paramedic specialist qualification, and more than
191 half (58.3%) were from New South Wales (NSW). Experience ranged from less than 5 years
192 to more than 24 years. Two-thirds of participants worked primarily as clinicians, whereas the
193 other third chiefly had managerial responsibilities.

194

195 Overall, the acceptability of all QIs in the suite was rated highly. Figure 1 shows the left-
196 skewed distribution of acceptability rating medians for all QIs. Table 4 shows results for
197 those QIs which received significantly low acceptability ratings. The same details for all QIs
198 of the suite can be found in supplementary appendix A. KWts showed that there was a
199 statistically significant difference in medians between the different QI types (structural,
200 process, and outcome) ($KWt(2) = 13.260$; $p = 0.001$), however, no significant difference in

medians between QIs addressing the three quality dimensions (access, safety, and effectiveness) was found (KWt(2) = 0.437; p = 0.8).

The median of medians for all QIs in the suite was 4.60 (IQR 0.32). The medians of medians for QIs within the organisational/system and the clinical domains were identical and equal to that of all QIs (4.60; IQR 0.33). Medians of medians for structural, process and outcome indicators were 4.60 (IQR 0.11), 4.62 (IQR 0.36), and 4.15 (IQR 0.45), respectively. For QIs addressing access, safety, and effectiveness, the medians of medians were 4.58 (IQR 0.38), 4.60 (IQR 0.17) and 4.60 (IQR 0.32), respectively.

Table 3. Participant demographics

	Stage 1		Stage 2	
	n	**%**	**n**	**%**
Total participants	36	100	9	100
Gender				
Male	22	61.1	6	66.7
Female	14	38.9	3	33.3
Age range (years)				
18-24	0	0.0	0	0.0
25-34	15	41.7	2	22.2
35-44	11	30.6	5	55.6
45-54	8	22.2	2	22.2
55-64	2	5.6	0	0.0
>64	0	0.0	0	0.0
Qualification				
Paramedic Trainee	2	5.6	0	0.0
Qualified Paramedic	16	44.4	4	44.4
Paramedic Specialist (ICP, CCP, ECP, etc.)	18	50.0	5	55.6
State/Territory				
Australian Capital Territory	1	2.8	0	0.0
New South Wales	21	58.3	5	55.6
Northern Territory	2	5.6	0	0.0
Queensland	4	11.1	1	11.1
South Australia	3	8.3	1	11.1
Tasmania	0	0.0	0	0.0
Victoria	2	8.3	1	11.1
Western Australia	3	5.6	1	11.1
Experience (years full-time)				
<5 years	6	16.7	0	0.0
5-9 years	9	25.0	5	55.6
10-14 years	8	22.2	0	0.0
15-19 years	3	8.3	1	11.1
20-24 years	5	13.9	3	33.3

>24 years	5	13.9	0	0.0
Primary role				
Clinician	24	66.7	5	55.6
Director, manager, supervisor	12	33.3	4	44.4

CCP Critical Care Paramedic; ECP Extended Care Paramedic; ICP Intensive Care Paramedic

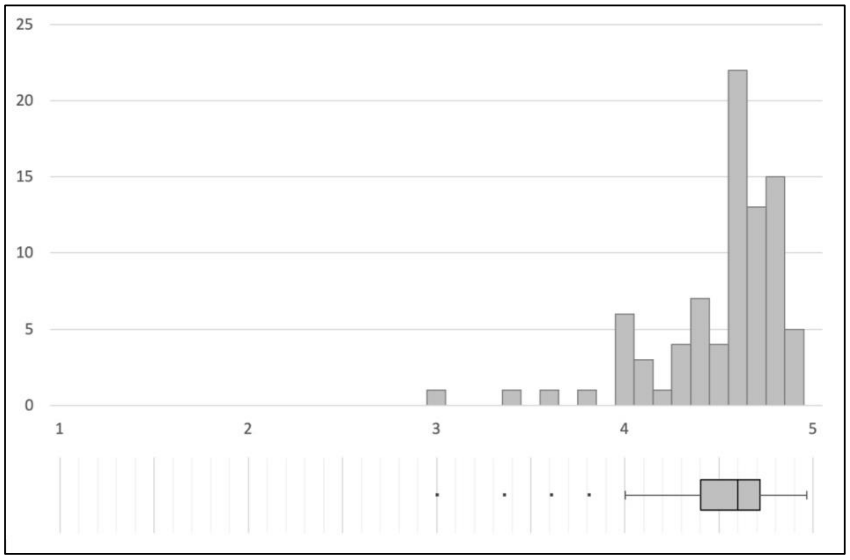


Figure 1. Distribution of median acceptability ratings for all 84 QIs

Table 4. Stage 1 results for quality indicators which were rated significantly low

Quality Indicator *(Type; Quality dimension/s)*	**Explicitly Unacceptable**		**Explicitly Acceptable**	**Median**
QI-A.3.6. In a patient satisfaction survey, a patient reports that they were very satisfied or satisfied with the ambulance services they received in the previous 12 months. *(Outcome; Access, Safety, Effectiveness)*	13.9%		61.1%	3.81
QI-B.2.1. An ambulance arrives at an OHCA patient within 4 minutes of the 000-call. *(Process; Access)*	30.6%		52.8%	3.61
QI-B.5.1. A suspected acute asthma patient has their PEF measured prior to nebulisation unless they are unable to perform the test. *(Process; Effectiveness)*	33.3%		47.2%	3.36
QI-A.6.2. The ambulance service schedules paramedics to work shifts shorter than 12 hours in duration. *(Process; Safety)*	38.9%		38.9%	3.00

very unacceptable; unacceptable; neutral; acceptable; very acceptable

OHCA Out-of-Hospital Cardiac Arrest; PEF Peak Expiratory Flow

221 **Stage 2**

222 Data saturation was achieved after eight interviews. The additional ninth interview yielded no
223 new information. Six of the nine interviewees were clinicians and four were
224 managers/supervisors. Participant demographics are summarised in Table 3 and individual
225 attributes can be found in supplementary appendix B. The mean interview duration was 29
226 minutes, ranging from 15 to 45 minutes. Overall, 5 themes and 6 sub-themes were created
227 (Table 5).

228

229 **Table 5.** Themes and sub-themes

Themes	Sub-themes
1. **Key Characteristics of QIs:** Possessing certain key characteristics makes QIs more acceptable.	a. **Clarity:** Being clear makes QIs more acceptable. b. **Evidence-based:** Being based on best available evidence makes QIs more acceptable. c. **Practicality:** To be acceptable, QIs need to be describe aspects that are realistically achievable. d. **Meaningfulness:** Describing aspects of care that are meaningful makes QIs more acceptable.
2. **Patient Satisfaction:** QIs which describe aspects of patient satisfaction are less acceptable.	a. **Lesser Priority:** Patient satisfaction is of lesser priority, and thus related QIs are less acceptable. b. **Proxy Measures:** Patient satisfaction is a proxy measure of quality, and thus associated QIs are less acceptable.
3. **Outcome Indicators:** QIs which describe desirable patient outcomes are generally better. However, they often are less specific *prehospital care* QIs and thus less acceptable.	NA
4. **Time Intervals:** The acceptability of QIs which include time intervals depends on how specific they are about time-sensitive patients and treatments.	NA
5. **Professional Values and Qualities:** Linking QIs to professional values and qualities is challenging.	NA

230

231

232 Theme 1: Characteristics of QIs

233 To increase the level of acceptability, a QI needed to possess certain characteristics which
234 made it suitable to be implemented for its intended use, i.e., the measurement of quality.

These characteristics included clarity, being evidence-based, practicality, and meaningfulness. The more a QI was perceived to have these desirable characteristics, the more acceptable it was to participants. Vice versa, QIs which lacked these attributes, were less acceptable.

Sub-theme 1a: Clarity

QIs which were ambiguous were less acceptable to participants. QIs needed to be detailed enough so that what would be assessed could be attributed exactly to that QI. Correspondingly, it needed to be clear if there are situations in which the measurement related to the QI should not be performed.

…there may be occasions where oxygen would be appropriate, slash acceptable […]. But I suppose the crunch of that [QI] would be "unless specifically indicated', which is quite generic and probably quite subjective. (Participant #6)

This participating manager explained why they rated the acceptability of QI-B.1.3. relatively low. The phrases "unless specifically indicated" was considered vague and insufficient. For this QI to be more acceptable, it needed to detail certain patient variables to describe the exact clinical scenario when the treatment of interest should be administered.

Sub-theme 1b: Evidence-based

When asked what makes a QI acceptable, a common response from participants was that they should be based on best available evidence. Such QIs were more valid and thus more acceptable to participants. On the other hand, some QIs which were seen as being ill-supported by evidence were considered less acceptable.

[QIs] should be evidence informed. There's no point having quality indicators that say, "do X", if X is way out of date. (Participant #3)

I would say that having an evidence base to support methodologies is pretty important. Because what you want to use is validated approaches that give some credibility to whatever you report. (Participant #8)

Sub-theme 1c: Practicality

Practicality influenced the level of acceptability. Especially participating clinicians considered those QIs which in their eyes described realistically achievable and contextually viable aspects of prehospital care to be more acceptable. Often this was described in terms of the holistic service delivery rather than sub-sets of patient encounters. Thus, there was an element of equity, too.

Quality indicators need to ensure that quality healthcare is delivered, but that it's attainable by all members of the workforce. (Participant #1)

One participant talked about a major trauma patient they recently treated and how QI-B.6.4. would not have been met and how this QI details an unrealistic practice.

But all of this takes way more than 10 minutes. It's totally unrealistic to be suggesting that we're going to be on the road on the way to definitive care in 10 minutes. It's just not happening. You know what I mean? I don't even see how it can. (Participant #4)

Some participants identified a potential risk of 'pleasing the QI' when impractical QIs are implemented, meaning that there is a conflict between what the QI describes and what is in the best interest of the patient. Paramedics may reluctantly provide patient care that is in line with the QI but would see true quality of care being compromised. This made participants comment on flexibility in the interpretation of measurement data and the associated differentiation between warranted and unwarranted variation. Variation from what a QI dictates was considered to be warranted when it is in the best interest of patients' clinical needs or preferences.

I think it also needs to be flexible. So you need to understand why, in some instances, there's deviations from the quality attributes. So if something's happening, sort of investigate why it's happening and then feed that back. (Participant #7)

Sub-theme 1d: Meaningfulness

An acceptable QI described aspects of care that were meaningful to participants. In other words, they needed to describe aspects of prehospital care that conform to the individual participant's ideology of quality in this context. Of the many dimensions of quality, participants placed most emphasis on effectiveness. QIs which focus on the impact of prehospital care provided to patients and communities were considered more acceptable. Safety and patient-centredness also featured as desirable attributes of quality.

It has to be something that's generally involved in patient outcomes as best as possible, and that's multi-faceted. So that's not just response time to getting there, but it's actually what we're able to do for the patient once we are there. (Participant #2)

310 One of the managers commented on the purpose of measurement often being lost in large
311 organisations and questioning the meaningfulness of the collected and analysed data.
312
313 *Sometimes I think when you get into big organizations […] we ask big questions, and we ask*
314 *for big packets of data. But we're not really sure what we're asking, why we're asking*
315 *for it, and what its application is in terms of the strategic information and overview*
316 *and what is it going to drive us to change or verify. (Participant #8)*
317
318 Theme 2: Patient Satisfaction
319 QIs which describe aspects of patient experience and satisfaction were seen by the
320 participants as less important and limited in their validity to be used as measures of quality.
321
322 *Sub-theme 2a: Lesser Priority*
323 The measurement of patient experience and satisfaction was seen as less of a priority
324 compared to other aspects of service and care. This explains the relatively low acceptability
325 rating of QIs describing aspects of patient experience and satisfaction.
326
327 *In our environment, I think to have an expectation that you have this amazing customer*
328 *service experience, amazing clinical care, and amazing outcomes. People are fallible*
329 *and I don't think we can provide that every time. (Participant #1)*
330
331
332 *Sub-theme 2b: Proxy Measures*
333 QIs describing aspects of patient satisfaction were seen as limited in their validity as
334 measures of quality of prehospital care. Patient satisfaction metrics were seen to represent the

patient's subjective contentment with the service, a distinct aspect of care. Patient satisfaction QIs were considered important patient-centred measures, but participants did not think that they should be used as a proxy for overall quality of prehospital care.

Sometimes we're unable to explain our thought processes to our patients, to a level that they understand, […]. I found that quality indicator maybe is very dependent on the patient. I don't know if it would work as well as the others. (Participant #3)

Theme 3: Outcome Indicators

Generally, the importance of patient outcomes and associated measurement was well recognised by participants. Structure and process type QIs were seen as more acceptable when they aligned with outcomes of interest. Nevertheless, some clinicians raised concerns about outcome indicators and their sensitivity to differences in prehospital quality of care. Prehospital care was described as a brief initial part of a much more extensive care pathway, especially in critically ill or injured patients. Outcome measurement at a distant point in that pathway may have limited ability to determine prehospital care quality.

I think, um, as far as determining quality, it's about, you know, a set of outcomes. […] [QIs] have to be tangible and linked to an outcome. (Participant #1)

Well, 30 days after the event, who knows what's happened to them in hospital? I was unsure about how that really linked to pre-hospital quality of care because it was a little bit like, well after 30 days they could have had exceptional ICU care, or they could have been in [hospital name] and it could have been [obscenity]. So their outcome could

be a poor one, but there's no way that that relates to the pre-hospital quality of care that they received. (Participant #4)

Theme 4: Time intervals

When asked about indicators which involve general time intervals, participants considered these to be less acceptable. QIs which were specific about time-sensitive patient cohorts were seen as more acceptable. It was important to participants that any QI which included time-intervals was specific about critical interventions rather than less meaningful aspects, such as arrival on scene or non-specific transport destinations. Any QI with time frames needed to be achievable and contextual, reiterating the importance of practicality.

There's no robust evidence that demonstrates that arriving at a scene within eight minutes of being dispatched improves anything. There's no evidence to support any of that. (Participant #4)

I consider it important for certain things like say for chest pain or stroke symptoms, I consider it important, where time is a factor when it comes to treatment. (Participant #3)

I feel like just saying that we need to get to every job within X time or get to hospital within Y time, is no longer a good indicator of whether we've provided the right care […]. (Participant #8)

Theme 5: Professional values and qualities

As part of the a priori interview questions, participants were asked how the proposed QIs aligned with their professional values and qualities. Participants found it challenging to comment on this. Nevertheless, most participants said that the suite of QIs connected to what they believed to be their professional values and qualities.

'I don't quite know how to answer that, I'll be honest. But I think that I would say that they mostly aligned to most of the stuff that we want to do and that we should be aspiring to do'. (Participant #8)

'Well, it's quite a difficult one to answer. To me, it's about providing good patient care, what's safe and effective and patient focused. And I think anything that aligns with what's best practice definitely then aligns with my own values'. (Participant #9)

DISCUSSION

Overall, participants found almost all QIs in the proposed suite to be acceptable. If a cut-off median score of 3.5 or greater in the ratings was applied, the initial list of 84 QIs would be reduced by only two. Nevertheless, besides commenting on desirable factors, participants also described aspects of the QIs which negatively affected the level of acceptability.

For participants in this study, the acceptability of the proposed QIs was dependent on the perceived presence of other key characteristics. When participants thought that a QI lacked clarity or when they believed a QI was poorly supported by evidence, they rated this QI less acceptable. The need for a QI to possess clarity (a proxy for content validity) and be

409 supported by evidence suggests a positive association between how acceptable QIs are to
410 healthcare providers and *scientific* acceptability. Scientific acceptability addresses, at least in
411 part, the basic measurement principle of validity.[37] Whilst the concept of validity is often
412 applied to the results of measurement, it must also be considered in the elements of QIs and
413 hence their development. In QI development, validity refers to the correctness of the QI as
414 compared to scientifically credible sources.[5,37] Unsurprisingly, the findings of this study
415 suggest that QIs which are developed systematically on the premise of being based on high-
416 quality evidence, or a combination of best-available evidence and expert opinion when high-
417 quality evidence is scarce or absent, are more likely to be accepted by healthcare providers.
418 The link between undisputable evidence and acceptability provides plausible explanation for
419 some of the highest ratings, e.g. QI-A.4.3. or QI-B.1.8. Since all QIs in this study were
420 previously validated, this notion may also explain the high acceptability ratings in general.
421
422 Considerable commentary emerged about the practicality of what QIs describe. The
423 acceptability of some QIs was rated relatively low by some participants because they felt that
424 the described aspects were unrealistic, e.g., QI-A.6.2. and QI-B.6.4. Undoubtedly, this is one
425 of the most important findings. Involving those who will be assessed and those who will
426 conduct the measurement, analysis, and resultant decision-making can provide a useful
427 reality check for whether the QI is practical and sensible. Primarily this enables refinement of
428 QIs. Further though, stakeholder consultation may serve as a catalyst for their effective
429 application. In other words, assessing the acceptability of QIs may increase their acceptability
430 and hence successful use.[38]
431 Linked to practicality of what QIs describe, participants also highlighted the importance of
432 flexibility in QI application. The concept of variation may be considered in somewhat
433 different ways. In performance measurement, variation often refers to changes in the data

434 over time, its interpretation being one of the cornerstones of improvement science.[39]
435 However, the variation that interview participants referred to is best described as a difference
436 in healthcare processes, compared to peers or to a gold standard such as an evidence-based
437 guideline recommendation,[40] or a QI. Variation is not automatically an indicator of poor
438 quality. In fact, to some degree, variation should always exist because patients are unique and
439 care should be responsive to differences between patients.[41,42] Participants raised concerns
440 about inflexibility of QI application, and sensitivity to patient characteristics or situational
441 demands not being recognised as warranted variation. Many participants highlighted that this
442 may lead to 'pleasing the QI'. In other words, paramedics providing prehospital care that
443 aligns with applicable QIs even when this compromises patient-centredness or other genuine
444 aspects of quality.
445
446 Lastly within the 'Key Characteristics of QIs' theme, meaningfulness featured strongly in the
447 interviews. For any indicator to be meaningful, it must have a relationship to the underlying
448 phenomenon it is intending to signal.[43] Therefore, a prehospital care *quality* indicator must
449 describe aspects of good patient care delivered by ambulance services. When theory or
450 scientific evidence is robust, this link is clear.[44] However, in developing healthcare
451 disciplines with a limited evidence base such as paramedicine, there may be dispute over the
452 strength of a relationship between the proposed indicator and the underlying phenomenon to
453 be measured. In the absence of an agreed definition of prehospital care quality, the
454 acceptability of associated indicators will inevitably vary. This provides explanation of the
455 wide range in ratings for some of the QIs, e.g. QI-A.6.2. or QI-B.2.7. More importantly, it
456 highlights the need for consensus on a definition of prehospital care quality as it would
457 contribute to more consistent acceptance of aligned QIs and ultimately their strength in
458 affecting meaningful improvement.

Different perspectives on health care quality often result in different expectations and thus different indicators of quality. As illustrated in sub-theme 1d, healthcare providers frequently view quality through clinical effectiveness and associated outcomes. Whilst outcomes are important to patients too, they frequently place extensive value on the emotional or interpersonal aspects of care. This might be especially true in settings like prehospital care where noticeable outcomes are seldomly reached due to short patient contact times. As a result, participants considered QIs which described aspects of patient satisfaction to be of lesser priority and less valid as prehospital care QIs. This does not mean that participants disregarded patient values or that QIs describing aspects of patient experience and satisfaction were unacceptable. It means that perspective matters and that the development of a symmetrical suite of QIs will need to involve patients.[45]

In the evaluation of quality of health care, structural, process and outcome indicators all have advantages and disadvantages.[46] The perceived level of acceptability of outcome QIs was somewhat conflicted by the advantages and disadvantages of this type of indicator. Participants realised that outcome QIs are beneficial since they facilitate measurement of something that is important in its own right. However, since most outcome measurement will occur sometime after the brief prehospital care phase, it is reflective of all aspects of healthcare, not only that provided by paramedics. Outcome measurement is also influenced by variables other than healthcare processes, e.g., patient characteristics. Therefore, although generally recognised as important types of QIs, participants expressed concern about the sensitivity of outcome indicators in evaluating prehospital care quality. This explains the somewhat wider distribution in the acceptability ratings of QIs-B.2.8 to 10 and the statistically significant difference in medians between the different QI types.

Timeliness was considered to be an important attribute of prehospital care quality. Participants agreed that in time-sensitive patients, such as cardiac arrest, stroke, or major trauma, timely access to healthcare contributes to desirable health outcomes, e.g., QI-B.2.3., QI-B.3.8., and QI-B.3.9.addl. However, participants reiterated what has been debated within the paramedicine discipline for some time. That is, there is little evidence to support the generic measurement of response times as an indicator of prehospital care quality.[47] It is worth noting at this point that in this project indicators detailing general time intervals such as response time, time on scene, or turnaround time, were all deemed not valid in the preceding study.[17] Advances in ambulance deployment modelling and call triaging, and a systematically developed suite of QIs, should contributed to more sustainable performance and meaningful measurement of timely access to health care.

Participants found it difficult to comment on how the proposed QIs connected with their professional values and qualities. Similar to other registered healthcare professions, paramedicine in Australia is regulated by its own regulatory authority, the Paramedicine Board of Australia (PBA). The code of conduct for registered health practitioners was developed by most of the 15 National Boards. It states that "while individual practitioners have their own personal beliefs and values, there are certain professional values on which all practitioners are expected to base their practice".[48(p. 6)] The code describes a framework for the provision of appropriate, effective, and ethical health care. Thus, there should be a fundamental link between guidance on how to provide high-quality patient care and indicators thereof. Although hesitant, participants seemed to consider their professional values and qualities by reflecting on what is meaningful prehospital care and considered the suit of QIs to be in line.

Limitations

The recruitment strategy includes a risk of volunteer bias. A range of strategies were considered and despite this limitation, it still represented the best approach. The formally calculated sample size (n = 149) for the survey was not reached. Therefore, stage 1 is underpowered and at risk of type 2 error. Maintaining a confidence level of 95%, the sample size of 36 leads to a 16% margin of error signalling low confidence in the results of this study being representative of the Australian paramedic population. The results remain of value but should be considered as hypothesis generating rather than definitive. Limitations inherent to Likert-type questions may be present, namely central tendency bias, acquiescence bias, and social desirability bias; the latter two being more likely in light of the results. Participants from NSW were overrepresented in stage 1 of the study. Despite maximum variation sampling in stage 2, the overrepresentation remained. Although semi-structured interview guides were used, the principal investigator's understanding and interpretation of the data may have potentially introduced confirmation bias. Furthermore, since the principal investigator conducted the interviews he was not blinded to the study objectives, thereby potentially introducing bias. Whilst multiple best practices for rigor in qualitative research were followed, transcripts were not returned to participants for checking of themes and sub-themes. Further research is needed, which was beyond the scope of this study, to investigate how acceptable the proposed QIs are to patients and communities.

Conclusion

In conclusion, the findings of this study provide insight into how acceptable the proposed suite of QIs is to paramedics. More specifically, the results suggest that 82 of the 84 QIs may be acceptable to prehospital care providers. Increasingly QIs are described in terms of being fit-for-purpose and fit-for-use, together contributing to their actionability. The findings of this

study echo those of a recent multiphase qualitative analysis exploring the concept of actionability of QIs. Barbazza, Klazinga, and Kringos describe three clusters within which a QI's fitness for use can be appraised: methodological, contextual and managerial.[49] In particular, the methodological considerations resonate with the findings of this study supporting the idea that a QI which is systematically developed with careful considerations of key characteristics will be more acceptable to prehospital care clinicians and managers and ultimately possess more potential to facilitate improvement. Future research should evaluate the QIs feasibility and reliability.

List of Abbreviations:

ACP Australasian College of Paramedicine

KWt Kruskal-Wallis test

NSW New South Wales

QI Quality indicator

DECLARATIONS

Ethics approval and consent to participate: Ethical approval was granted by the University of Adelaide Human Research Ethics Committee (H-2017-157). All methods were carried out in accordance with the Australian Code for the Responsible Conduct of Research. Informed consent was obtained from all participants.

Consent for publication: Not applicable

Availability of data and materials: The complete data that support the findings of this study are available from the corresponding author, but restrictions apply to the availability of these data and so are not publicly available. Data are however available from the corresponding author upon reasonable request and with permission of participants.

Competing interests: The authors have no conflict of interest to declare.

Funding: This study was supported by a research grant from the Australasian College of Paramedicine (ACP)

Authors' contributions: RP conceived the project, designed the study, and obtained ethics approval and research funding. MS, PS and CL supervised the conduct of the study. RP build the survey, undertook recruitment, conducted the interviews, and performed data analyses. RP wrote the manuscript. All authors contributed intellectually and reviewed it. RP takes responsibility for the paper as a whole.

Acknowledgments: This study, and the research project it forms part of, receives support through the provision of an Australian Government Research Training Program Scholarship

573 **REFERENCES**

574 1. Mainz J. Defining and classifying clinical indicators for quality improvement. Int J
575 Qual Heal Care. 2003;15(156):523–30.
576 2. Perla RJ, Provost LP, Parry GJ. Seven propositions of the science of improvement:
577 exploring foundations. Qual Manag Health Care. 2013;22(3):170–86.
578 3. Marshall M, Pronovost P, Dixon-Woods M. Promotion of improvement as a science.
579 Lancet [Internet]. 2013;381:419–21. Available from: http://dx.doi.org/10.1016/S0140-
580 6736(12)61850-9
581 4. Kringos D, Groene O, Johnsen S. Training the First Generation of Health Care
582 Performance Intelligence Professionals in Europe and Canada. Acad Med.
583 2019;94(6):747–8.
584 5. Mainz J. Developing evidence-based clinical indicators: a state of the art methods
585 primer. Int J Qual Heal Care. 2003;15(Supp 1):i5–11.
586 6. Campbell S, Kontopantelis E, Hannon K, Burke M, Barber A, Lester H. Framework
587 and indicator testing protocol for developing and piloting quality indicators for the UK
588 quality and outcomes framework. BMC Fam Pract. 2011;12(1):85.
589 7. Schang L, Blotenberg I, Boywitt D. What makes a good quality indicator set? A
590 systematic review of criteria. Int J Qual Heal care J Int Soc Qual Heal Care.
591 2021;33(3):1–10.
592 8. Campbell SM, Braspenning J, Hutchingson A, Marshall MN. Research Methods Used
593 in Developing and Applying Quality Indicators in Primary Care. Qual Saf Heal Care.
594 2002;11:358–64.
595 9. Jones P, Shepherd M, Wells S, Le Fevre J, Ameratunga S. Review article: what makes
596 a good healthcare quality indicator? A systematic review and validation study. Emerg
597 Med Australas. 2014;26(2):113–24.

598 10. Sekhon M, Cartwright M, Francis JJ. Acceptability of healthcare interventions: An
599 overview of reviews and development of a theoretical framework. BMC Health Serv
600 Res. 2017;17(1):1–13.
601 11. Australian Government Productivity Commission - Steering Committee for the
602 Review of Government Service Provision. Report on Government Services 2022,
603 Ambulance Services [Internet]. Canberra; 2022. Available from:
604 https://www.pc.gov.au/research/ongoing/report-on-government-services
605 12. Harrison L. Ambulance Services in Australia - Healthy growth: Population growth has
606 increased demand for ambulance services [Internet]. Melbourne; 2019. Available
607 from: https://www.ibisworld.com
608 13. Braithwaite J, Churruca K, Ellis LA, Long J, Clay-Williams R, Damen N, et al.
609 Complexity Science in Healthcare. Sydney: Macquarie University; 2017. 118 p.
610 14. Provost L, Murray S. The health care data guide: learning from data for improvement.
611 1st ed. Hoboken, NJ: Wiley; 2011.
612 15. Pap R, Lockwood C, Stephenson M, Simpson P. Development and testing of
613 Australian prehospital care quality indicators: study protocol. BMJ Open.
614 2020;10:e038310.
615 16. Pap R, Lockwood C, Stephenson M, Simpson P. Indicators to measure prehospital care
616 quality: a scoping review. JBI Database Syst Rev Implement Reports.
617 2018;16(11):2192–223.
618 17. Pap R, Lockwood C, Stephenson M, Simpson P. Development of prehospital care
619 quality indicators for the Australian setting : a modified RAND / UCLA
620 appropriateness method. Emerg Med J. 2021;0:1–6.
621 18. Campbell S., Roland M., Buetow S. Defining quality of care. Soc Sci Med.
622 2000;51:1611–25.

623 19. Owen RC. The development and testing of indicators of prehospital care quality
624 [dissertation]. [Manchester]. University of Manchester; 2010.
625 20. Creswell J, Plano Clark V. Designing and conducting mixed methods research. 2nd ed.
626 Los Angeles: Sage Publications Inc.; 2011. 457 p.
627 21. Ivankova N V., Creswell JW, Stick SL. Using Mixed-Methods Sequential Explanatory
628 Design: From Theory to Practice. Field methods. 2006;18(1):3–20.
629 22. Levy PE, Williams JR. The social context of performance appraisal: A review and
630 framework for the future. J Manage. 2004;30(6):881–905.
631 23. Hedge JW, Teachout MS. Exploring the Concept of Acceptability as a Criterion for
632 Evaluating Performance Measures. Gr Organ Manag. 2000;25(1):22–44.
633 24. Fetters MD, Curry LA, Creswell JW. Achieving integration in mixed methods designs
634 - Principles and practices. Health Serv Res. 2013;48(6 PART2):2134–56.
635 25. Creswell JW, Tashakkori A. Editorial: Developing Publishable Mixed Methods
636 Manuscripts. J Mix Methods Res. 2007;1(2):107–11.
637 26. Harpe SE. How to analyze Likert and other rating scale data. Curr Pharm Teach Learn.
638 2015;7(6):836–50.
639 27. Sullivan GM, Artino AR. Analyzing and Interpreting Data From Likert-Type Scales. J
640 Grad Med Educ. 2013;5(4):541–2.
641 28. DiCicco-Bloom B, Crabtree BF. The qualitative research interview. Med Educ.
642 2006;40(4):314–21.
643 29. DeJonckheere M, Vaughn LM. Semistructured interviewing in primary care research:
644 A balance of relationship and rigour. Fam Med Community Heal. 2019;7(2):1–8.
645 30. Kallio H, Pietilä AM, Johnson M, Kangasniemi M. Systematic methodological review:
646 developing a framework for a qualitative semi-structured interview guide. J Adv Nurs.
647 2016;72(12):2954–65.

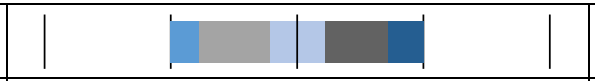
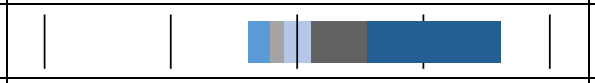
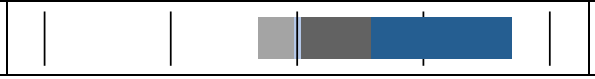
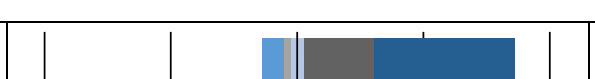
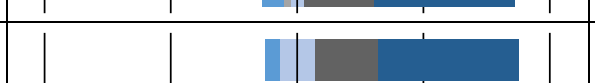
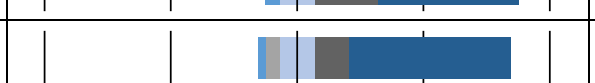
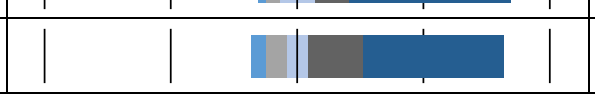
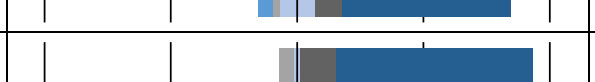
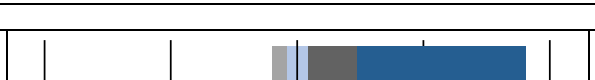
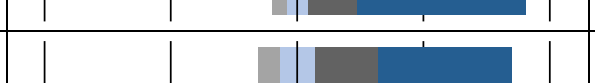
31. Britten N. Qualitative Interviews. In: Pope C, Mays N, editors. Qualitative Research in Health Care. 3rd ed. John Wiley & Sons, Incorporated; 2006.
32. Teddlie C, yu F. Mixed Methods Sampling: A Typology With Examples. J Mix Methods Res. 2007;1(1):77–100.
33. Guest G, Bunce A, Johnson L. How Many Interviews Are Enough?: An Experiment with Data Saturation and Variability. Field methods. 2006;18(1):59–82.
34. Fusch PI, Ness LR. Are we there yet? Data saturation in qualitative research. Qual Rep. 2015;20(9):1408–16.
35. Guest G, Namey E, Chen M. A simple method to assess and report thematic saturation in qualitative research. PLoS One [Internet]. 2020;15(5):1–17. Available from: http://dx.doi.org/10.1371/journal.pone.0232076
36. Braun V, Clarke V. Using thematic analysis in psychology. Qual Res Psychol. 2006;3(2):77–101.
37. Ferris T, Amster A, Dunton N, Findlay S, Hopkins D, Kmetik K, et al. Guidance for Measure Testing and Evaluating Scientific Acceptability of Measure Properties [Internet]. 2011. Available from: http://www.qualityforum.org/publications/2011/01/measure_testing_task_force.aspx
38. Jones B, Kwong E, Warburton W. Quality improvement made simple: what everyone should know about health care quality improvement. [Internet]. 3rd ed. London: The Health Foundation; 2021. 67 p. Available from: http://www.health.org.uk/publications/quality-improvement-made-simple
39. Neuhauser D, Provost L, Bergman B, Blanchard CE. The meaning of variation to healthcare managers, clinical and health-services researchers, and individual patients. BMJ Qual Saf. 2011;20(SUPPL. 1).
40. Australian Commission on Safety and Quality in Healthcare. Australian Atlas of

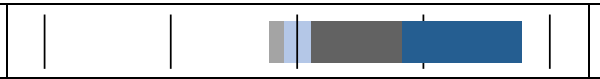
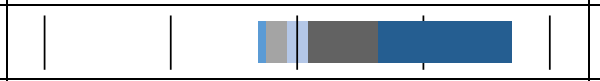
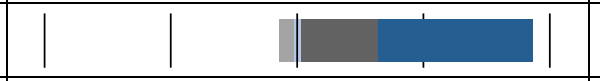
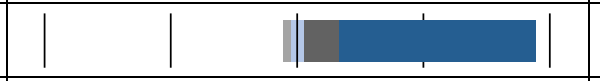
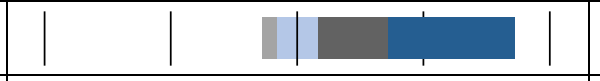
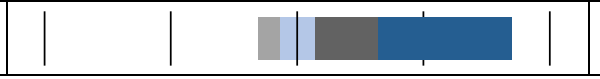
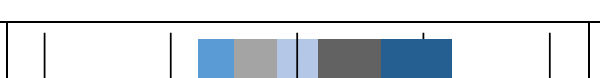
673 Healthcare Variation [Internet]. Sydney; 2021. Available from:
674 https://www.safetyandquality.gov.au/our-work/healthcare-variation/fourth-atlas-2021
675 41. Atsma F, Elwyn G, Westert G. Understanding unwarranted variation in clinical
676 practice: A focus on network effects, reflective medicine and learning health systems.
677 Int J Qual Heal Care. 2020;32(4):271–4.
678 42. Wennberg JE. Unwarranted variations in healthcare delivery: Implications for
679 academic medical centres. Br Med J. 2002;325(7370):961–4.
680 43. Donabedian A. The Quality of Care: How Can It Be Assessed? J Am Med A.
681 1988;260(12):1743–8.
682 44. Goldenberg MJ. Defining "quality of care" persuasively. Theor Med Bioeth.
683 2012;33(4):243–61.
684 45. Berland A. Using the Johari Window to explore patient and provider perspectives. Int J
685 Heal Gov. 2017;22(1):47–51.
686 46. Mant J. Process versus outcome indicators in the assessment of quality of health care.
687 Int J Qual Heal Care. 2001;13(6):475–80.
688 47. Al-Shaqsi SZK. Response time as a sole performance indicator in EMS: Pitfalls and
689 solutions. Open Access Emerg Med. 2010;2:1–6.
690 48. The Australian Health Practitioner Regulation Agency. Paramedicine Board of
691 Australia - Code of conduct (interim) [Internet]. Paramedicine Board of Australia.
692 2018. Available from: https://www.paramedicineboard.gov.au/Professional-
693 standards/Codes-guidelines-and-policies.aspx
694 49. Barbazza E, Klazinga NS, Kringos DS. Exploring the actionability of healthcare
695 performance indicators for quality of care: A qualitative analysis of the literature,
696 expert opinion and user experience. BMJ Qual Saf. 2021;1–11.
697

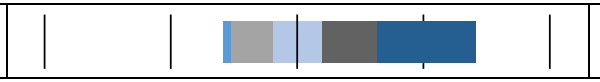
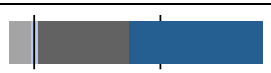
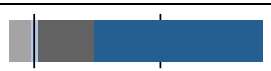
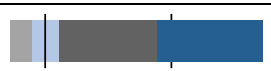
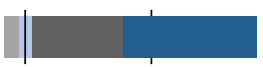
Supplemental appendix A: Results from stage 1

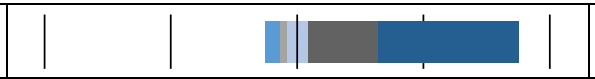
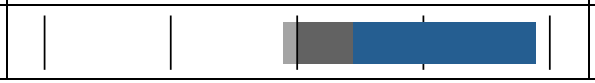
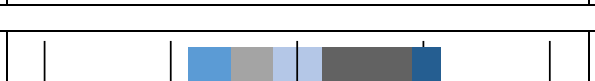
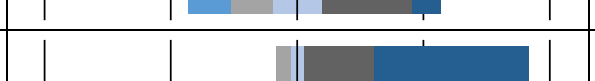
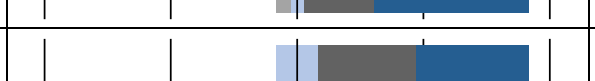
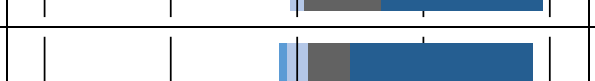
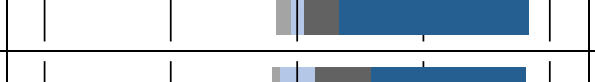
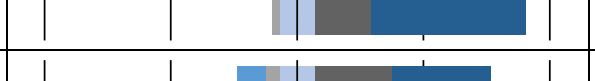
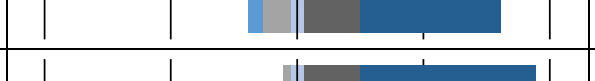
Quality Indicator* *(Type; Quality dimension/s)*	Explicitly Unacceptable	Explicitly Acceptable	Median
Domain A: Organisational/System QIs			
Sub-domain A.2. Patient Safety			
QI-A.2.1. The ambulance service has a dedicated patient safety reporting system. *(Structure; Safety)*	8.3%	86.1%	4.64
QI-A.2.2. The ambulance service has a guideline that defines the categories of patients that should be left in the care of an appropriate healthcare professional, i.e., should not be left unattended. *(Structure; Safety)*	11.1%	75.0%	4.60
QI-A.2.3. A patient who is not conveyed to a healthcare facility has been risk-assessed for likelihood of deterioration. *(Process, Safety)*	5.6%	91.7%	4.72
QI-A.2.4. The ambulance service has policy that describes the treat-and-refer arrangements for patients not conveyed to a health care facility. *(Structure; Safety)*	2.8%	91.7%	4.64
Sub-domain A.3. Patient Experience and Satisfaction			
QI-A.3.1. The ambulance service collects and analyses quantitative and qualitative data pertaining to patient experience and satisfaction for the purpose of quality improvement. *(Process; Access, Safety, Effectiveness)*	13.9%	77.8%	4.55
QI-A.3.4. In a patient satisfaction survey, a patient reports that they felt that the level of care provided to them by paramedics was very good or good. *(Outcome; Effectiveness)*	11.1%	75.0%	3.97
QI-A.3.5. In a patient satisfaction survey, a patient reports that their level of trust and confidence in paramedics and their ability to provide quality care and treatment was very high or high. *(Outcome; Safety, Effectiveness)*	5.6%	86.1%	4.15
QI-A.3.6. In a patient satisfaction survey, a patient reports that they were very satisfied or satisfied with the ambulance services they received in the previous 12 months. *(Outcome; Access, Safety, Effectiveness)*	13.9%	61.1%	3.81
QI-A.3.8. The ambulance service collects and analyses quantitative and qualitative data pertaining to complaints for the purpose of quality improvement. *(Process; Access, Safety, Effectiveness)*	13.9%	83.3%	4.36
Sub-domain A.4. Communication			
QI-A.4.1. A call is assigned an accurate level of urgency and/or dispatch priority. *(Process; Access, Effectiveness)*	13.9%	83.3%	4.42
QI-A.4.2. A patient is identified to be in OHCA by the ambulance service call-taker before the first resource arrives on scene. *(Process: Effectiveness)*	11.1%	80.6%	4.81
QI-A.4.3. A caller requesting assistance for suspected/confirmed adult cardiac arrest is offered instructions (audio, or video if possible) in chest-compression-only cardiopulmonary resuscitation (CPR). *(Process: Effectiveness)*	0.0%	94.5%	4.86
Sub-domain A.5. Resources and Resource Management			
QI-A.5.3. The ambulance service has a policy detailing which resource(s) should respond to each category/type of call. *(Structure; Access)*	11.1%	75.0%	4.25
QI-A.5.4. A patient who meets service-defined treat-and-discharge or treat-and-release criteria is not transported. *(Process; Access)*	16.7%	72.2%	4.03
Sub-domain A.6. Paramedic Health and Safety			

Supplemental appendix A: Results from stage 1

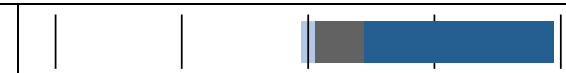
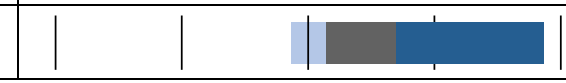
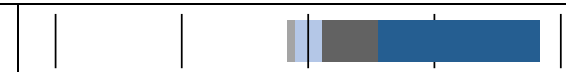
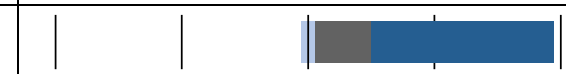
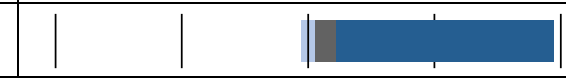
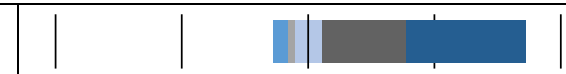
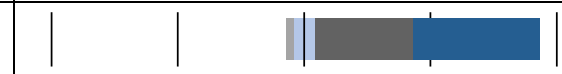
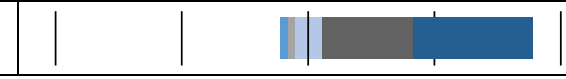
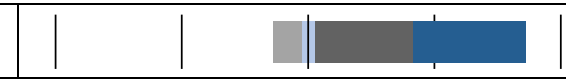
QI-A.6.2. The ambulance service schedules paramedics to work shifts shorter than 12 hours in duration. *(Process; Safety)*	38.9%		38.9%	3.00
QI-A.6.6. The ambulance service provides mental health programs, including pre-incident preparedness training, to its paramedics. *(Process; Safety)*	13.9%		75.0%	4.55
QI-A.6.8. The ambulance service collects and analysis quantitative and qualitative data pertaining to staff satisfaction. *(Process; Effectiveness)*	13.9%		83.3%	4.60
Sub-domain A.7. Training, Education, and Research				
QI-A.7.1. The ambulance service has a policy that describes the process for supervision of paramedics in training. *(Structure; Safety, Effectiveness)*	11.1%		83.3%	4.60
QI-A.7.2. The ambulance service staff have access to electronic/online medical education resources. *(Structure; Safety, Effectiveness)*	5.6%		80.6%	4.60
QI-A.7.3. The ambulance service has a dedicated training and education unit. *(Structure; Access, Safety, Effectiveness)*	8.3%		77.8%	4.72
QI-A.7.6. The ambulance service has a guideline which details the criteria by which it assesses proposals to conduct research by its staff or in collaboration with external parties. *(Structure; Safety)*	13.9%		77.8%	4.60
Sub-domain A.8. Other (Organisational/System)				
QI-A.8.1. The ambulance service has arrangements in place enabling paramedics to consult with senior clinical colleagues when treating a patient. *(Structure; Safety, Effectiveness)*	13.9%		86.1%	4.72
QI-A.8.2. The ambulance service has arrangements in place enabling paramedics to consult with specialist mental health professionals when treating a patient with a mental health disorder. *(Structure; Safety, Effectiveness)*	11.1%		83.3%	4.68
QI-A.8.3. The ambulance service has a procedure for managing situations in which a patient refuses care or transportation for the physical effects of self-harm. *(Structure; Safety, Effectiveness)*	5.6%		86.1%	4.55
QI-A.8.4. The ambulance service operates a quality improvement program that includes quality assessment/measurement, control, and improvement. *(Structure; Access, Safety, Effectiveness)*	8.3%		77.8%	4.75
QI-A.8.5.addl. A patient with accessible end-of-life care plans is managed in accordance with these plans. *(Process; Effectiveness)*	5.6%		91.7%	4.86
Clinical Domain				
Sub-domain B.1. Airway Management, Ventilation, and Oxygen Therapy				
QI-B.1.1. A patient with a decreased level of consciousness (GCS ≤14), has their airway patency assessed. *(Process; Effectiveness)*	5.6%		86.1%	4.75
QI-B.1.2. A hypoxemic patient (SpO_2 <94%) is administered oxygen, unless contraindicated. *(Process; Effectiveness)*	8.3%		77.8%	4.55

QI-B.1.3. A normoxaemic patient ($SpO_2 \geq 94\%$) is not administered oxygen, unless specifically indicated. *(Process; Effectiveness)*	5.6%		83.3%	4.42
QI-B.1.4. A patient who has a supraglottic airway inserted, meets service-defined indications for the airway intervention. *(Process; Effectiveness)*	2.8%		86.1%	4.55
QI-B.1.5. In a patient who has a supraglottic airway inserted, the correct position of the supraglottic airway is assessed using an exhaled CO_2 detector. *(Process; Effectiveness)*	11.1%		80.6%	4.55
QI-B.1.6. A patient who is endotracheally intubated, meets service-defined indications for the procedure. *(Process; Effectiveness)*	5.6%		83.3%	4.68
QI-B.1.7. A patient who is intubated, is successfully endotracheally intubated. *(Process; Effectiveness)*	5.6%		91.7%	4.68
QI-B.1.8. For an endotracheally intubated patient, the correct position of the endotracheal tube is assessed using an exhaled CO_2 detector. *(Process; Effectiveness)*	2.8%		91.7%	4.86
QI-B.1.9. A patient who is endotracheally intubated has their pulse oximetry continuously monitored during the procedure. *(Process; Effectiveness)*	5.6%		88.9%	4.81
QI-B.1.10. A patient who receives cricothyrotomy, meets service-defined indications for the procedure. *(Process; Effectiveness)*	5.6%		77.8%	4.50
QI-B.1.11. A patient who receives cricothyrotomy, has the procedure performed successfully. *(Process; Effectiveness)*	8.3%		77.8%	4.55
Sub-domain B.2. Out-of-Hospital Cardiac Arrest				
QI-B.2.1. An ambulance arrives at an OHCA patient within 4 minutes of the 000-call. *(Process; Access)*	30.6%		52.8%	3.61
QI-B.2.2. Paramedics providing CPR utilize an audio-visual feedback and prompt device for real-time optimization of chest compression quality. *(Process; Effectiveness)*	13.9%		72.2%	4.12
QI-B.2.3. For an OHCA patient in a shockable rhythm, the first defibrillation attempt is made as soon as possible and within 2 minutes of arrival at the patient. *(Process; Effectiveness)*	5.6%		91.7%	4.68
QI-B.2.6. The receiving hospital receives pre-notification of an OHCA/post-OHCA patient. *(Process; Access)*	5.6%		91.7%	4.72
QI-B.2.7. A patient who was in OHCA has ROSC on arrival at the receiving hospital. *(Outcome; Effectiveness)*	13.9%		63.9%	3.95
QI-B.2.8. A patient who was in OHCA survives to discharge from hospital. *(Outcome; Effectiveness)*	8.3%		75.0%	4.32
QI-B.2.9. A patient who was in OHCA is discharged from hospital with favourable neurological outcome; CPC ≤2 or mRS ≤3. *(Outcome; Effectiveness)*	22.2%		63.9%	4.50

QI-B.2.10. A patient who was in OHCA survives to 30 days from the event. *(Outcome; Effectiveness)*	19.5%		61.1%	4.00
Sub-domain B.3. Acute Coronary Syndrome				
QI-B.3.1. The ambulance service has a documented clinical care pathway that details the care and transport it provides to patients with signs and/or symptoms suggestive of ACS. *(Structure; Access, Effectiveness)*	8.3%		88.9%	4.55
QI-B.3.2. A patient with signs and/or symptoms suggestive of ACS has a 12-lead ECG acquired and interpreted within 10 minutes of arrival on scene. *(Process; Effectiveness)*	8.3%		88.9%	4.75
QI-B.3.3. A patient with signs and/or symptoms suggestive of ACS and normoxaemia (SpO_2 ≥94%) is not administered supplementary oxygen. *(Process; Effectiveness)*	8.3%		80.6%	4.29
QI-B.3.4. A patient with signs and/or symptoms suggestive of ACS is administered aspirin, unless contraindicated. *(Process; Effectiveness)*	2.8%		91.7%	4.78
QI-B.3.5. A patient with signs and/or symptoms suggestive of ACS has their pain score assessed before and after treatment. *(Process; Effectiveness)*	5.6%		88.9%	4.55
QI.B.3.6. A patient with signs and/or symptoms suggestive of ACS is administered glyceryl trinitrate, unless contraindicated. *(Process; Effectiveness)*	5.6%		77.8%	4.27
QI-B.3.7. A patient with acute chest pain suggestive of ACS is administered analgesic agent(s), unless contraindicated. *(Process; Effectiveness)*	13.9%		72.2%	4.03
QI-B.3.8. If transport time to a hospital capable of providing primary PCI is ≤30 minutes, a patient with STEMI and within 12 hours of symptom onset is transported directly to that hospital. *(Process; Effectiveness)*	5.6%		86.1%	4.72
QI-B.3.9.addl. If transport time to a hospital capable of providing primary PCI is >30 minutes, a patient with STEMI and within 12 hours of symptom onset receives prehospital fibrinolysis. *(Process; Effectiveness)*	11.1%		80.6%	4.60
Sub-domain B.4. Stroke				
QI-B.4.1. A patient with suspected acute stroke is assessed using a validated stroke identification tool†. *(Process; Effectiveness)*	8.3%		91.7%	4.81
QI-B.4.2. A patient with suspected acute stroke has their blood glucose level measured. *(Process; Effectiveness)*	5.6%		91.7%	4.78
QI-B.4.3. In a patient with suspected acute stroke, it is assessed whether or not they are on anticoagulant therapy. *(Process; Effectiveness)*	11.1%		83.3%	4.60
QI-B.4.4. A patient with suspected acute stroke and normoxaemia (SpO_2 ≥94%) is not administered supplementary oxygen. *(Process; Effectiveness)*	11.1%		69.4%	4.04
QI-B.4.5. In a patient with suspected acute stroke, it is assessed at what time the patient was last known to be without the clinical features of acute stroke. *(Process; Effectiveness)*	5.6%		91.7%	4.75

QI-B.4.6. A patient presenting with suspected stroke is transported directly to a hospital capable of performing thrombolysis and/or endovascular thrombectomy. *(Process; Access)*	8.3%		83.3%	4.60
QI-B.4.7. The receiving facility receives notification of a patient experiencing suspected stroke. *(Process; Access)*	5.6%		94.4%	4.81
Sub-domain B.5. Asthma				
QI-B.5.1. A suspected acute asthma patient has their PEF measured prior to nebulization unless they are unable to perform the test. *(Process; Effectiveness)*	33.3%		47.2%	3.36
QI-B.5.2. A patient with acute asthma has their oxygen saturation level continuously monitored. *(Process; Safety, Effectiveness)*	5.6%		88.9%	4.68
QI-B.5.3. A patient with acute asthma is given controlled oxygen titrated to maintain an SpO_2 level of 94-98%. *(Process; Effectiveness)*	0.0%		83.3%	4.36
QI-B.5.4. A patient with acute asthma is administered salbutamol via oxygen-driven nebulizer, unless contraindicated. *(Process; Effectiveness)*	16.7%		61.1%	4.07
QI-B.5.5. A patient with acute severe asthma or worse is administered salbutamol and ipratropium bromide via oxygen driven nebulizer, unless contraindicated. *(Process; Effectiveness)*	8.3%		75.0%	4.50
QI-B.5.7. A patient with life-threatening asthma is be administered intramuscular adrenaline, unless contraindicated. *(Process; Effectiveness)*	0.0%		94.5%	4.72
QI-B.5.8. The receiving facility receives notification of a patient with life-threatening asthma. *(Process; Access)*	2.8%		88.9%	4.81
Sub-domain B.6. Trauma				
QI-B.6.1 A patient with active external haemorrhage receives haemorrhage control by application of direct pressure, arterial tourniquet and haemostatic dressing as required. *(Process; Effectiveness)*	5.6%		88.9%	4.83
QI-B.6.2. A patient with a mechanism of injury and/or other signs/symptoms suggestive of PCCD applied. *(Process; Effectiveness)*	2.8%		83.3%	4.68
QI-B.6.3. A patient with recent (≤3 hours) traumatic injury resulting in ongoing haemorrhage and/or ATC (indicated by a validated and prehospitally applicable prediction tool) receives TXA (1g, intravenously). *(Process; Effectiveness)*	16.7%		69.5%	4.14
QI-B.6.4. When attending to a patient suffering neurotrauma or penetrating injury with hemodynamic instability, the ambulance departs the scene within 10 min. of arriving on scene, unless unable or impractical to do so for safety or operational reasons. *(Process; Access)*	16.7%		77.8%	4.60
QI-B.6.5. A patient is correctly triaged and transported to an appropriate hospital as per agreed trauma system protocol. *(Process; Access)*	2.8%		91.7%	4.78
QI-B.6.6. The receiving hospital receives notification of a major trauma patient as per agreed trauma system protocol. *(Process; Access)*	0.0%		97.2	4.86
Sub-domain B.7. Seizures				

Supplemental appendix A: Results from stage 1

QI-B.7.1. A patient with a seizure has their blood glucose level measured. *(Process; Effectiveness)*	0.0%		94.4%	4.83
QI-B.7.2. A patient with an active seizure is administered a benzodiazepine by the best available route. *(Process; Effectiveness)*	0.0%		86.1%	4.64
Sub-domain B.8. Hypoglycaemia				
QI-B.8.1. A conscious hypoglycaemic patient is administered oral glucose, unless contraindicated. *(Process; Effectiveness)*	2.8%		86.1%	4.72
QI-B.8.2. An unconscious hypoglycaemic patient is administered intravenous glucose 10% or intramuscular glucagon, unless contraindicated. *(Process; Effectiveness)*	0.0%		94.4%	4.81
QI-B.8.3. A patient who has been administered glucose (oral or intravenous) or glucagon has their blood glucose level checked following administration. *(Process; Effectiveness)*	0.0%		94.4%	4.92
Sub-domain B.9. Pain Management				
QI-B.9.1. A patient has their pain intensity measured using the 0-10 VNRS. *(Process; Effectiveness)*	8.3%		80.6%	4.42
QI-B.9.2. A patient experiencing mild (2-3/10), moderate (4-6/10) or severe (7-10/10) pain is administered analgesic agent(s), unless contraindicated or refused. *(Process; Effectiveness)*	0.0%		86.1%	4.55
QI-B.9.4. A responsive patient who is administered analgesic agent(s) remains responsive to verbal stimuli unless anaesthesia is being induced. *(Outcome, Safety)*	2.8%		88.9%	4.50
QI-B.9.5. A responsive patient who is administered analgesic agent(s) does not require airway management or ventilatory support following the administration unless anaesthesia is being induced. *(Outcome, Safety)*	5.6%		83.3%	4.42
Sub-domain B.10. Other (Clinical)				
QI-B.10.3. The ambulance service has a policy that defines specific categories of patients for which receiving facilities are to be notified of the patient's arrival. *(Structure; Access)*	11.1%		83.3%	4.36

very unacceptable; unacceptable; neutral; acceptable; very acceptable

ACS Acute Coronary Syndrome; ATC Acute Traumatic Coagulopathy; CPC Cerebral Performance Category; CPR Cardiopulmonary Resuscitation; ECG Electrocardiogram; GCS Glasgow Coma Score; mRS modified Rankin Scale; OHCA Out-of-Hospital Cardiac Arrest; PCCD Pelvic Circumferential Compression Device; PCI Percutaneous Coronary Intervention; PEF Peak Expiratory Flow; ROSC Return Of Spontaneous Circulation; TXA Tranexamic Acid; VNRS Visual Numerical Rating Scale

*Numbering of the QIs has been maintained throughout the project. Therefore, QIs which were not deemed valid in the preceding study of the project were not included in this study and hence numbering may appear incomplete.

† Los Angeles prehospital stroke screen (LAPSS score), Cincinnati prehospital stroke scale (CPSS), Face Arm Speech Test (FAST), Melbourne Ambulance Stroke Screen (MASS score), Ontario Prehospital Stroke Screening tool (OPSS) or Recognition Of Stroke In the Emergency Room (ROSIER) scale

Supplementary appendix B: Participant attributes

Participant #	Gender	Age range	Qualification	State/Territory	Experience	Primary role
1	Male	35-44 years	ICP/MICA/CCP/ECP	VIC	20-24 years	Clinician
2	Male	25-34 years	ICP/MICA/CCP/ECP	NSW	5-9 years	Clinician
3	Male	35-44 years	Qualified Paramedic	SA	5-9 years	Clinician
4	Female	45-54 years	Qualified Paramedic	NSW	5-9 years	Clinician
5	Male	35-44 years	ICP/MICA/CCP/ECP	NSW	20-24 years	Director, manager, or supervisor
6	Female	25-34 years	Qualified Paramedic	NSW	5-9 years	Director, manager, or supervisor
7	Male	35-44 years	ICP/MICA/CCP/ECP	QLD	15-19 years	Director, manager, or supervisor
8	Male	45-54 years	ICP/MICA/CCP/ECP	WA	20-24 years	Director, manager, or supervisor
9	Female	35-44 years	Qualified Paramedic	NSW	5-9 years	Clinician

5.3 Summary

The study presented in this chapter tested the prehospital care QIs deemed valid in study 2 for acceptability and in doing so addressed research objective 3. In the initial quantitative stage of the two-staged explanatory sequential mixed methods study, the acceptability of the QIs was generally rated highly. For participants of stage 2 (qualitative) there was a link between how acceptable a QI is and the presence of other key characteristics, namely clarity, validity, practicality, and meaningfulness. Since outcome-type QIs often refer to aspects distant to the short initial prehospital phase, participants expressed concern about their sensitivity in the measurement of prehospital quality of care. Participants also made it clear that any QI referring to time intervals needed to be clinically justified. Participant felt a connection between the QIs and their professional values and qualities, in part explaining the overall high acceptability ratings. The study tested the QIs acceptability from the healthcare provider perspective which meant that the acceptability of QIs describing aspects of patient satisfaction were often rated lower. In the next chapter the findings of this study and preceding ones are summarised, overall strengths and limitations are examined, and recommendations are discussed.

Chapter 6: Discussion and conclusion

6.1 Overview

This final chapter presents an integrated discussion and conclusion of the thesis. Its purpose is to summarise the key findings and weave the discussion points from the individual manuscripts comprising the thesis, elaborate on the logic and linkages between them, and highlight how their findings address the overall aim of the research.[69] Overarching strengths and limitations of the research are discussed and, in light of the main results, several recommendations and suggestions for future research are made before the chapter ends with concluding remarks.

6.2 Summary of key findings

The overall aim of this research was to develop and test prehospital care QIs for the Australian setting. Healthcare providers and patients have a common interest in ensuring that healthcare systems and services provide the best and safest possible care and improve where there are deficiencies.[70,71] Central to quality assurance and quality improvement is the measurement of performance within and across healthcare organisations.[20,21,72] Measuring quality is achieved by assessing and monitoring whether a service's operations and patient care are consistent with QIs.[25,39,65] It follows that the systematic development and testing of high-quality QIs is an essential first step towards trustworthy quality assurance and meaningful quality improvement, a step that historically in prehospital care did not carefully considered evidence or did not include evidence at all.

To achieve the intended aim of the research, three specific objectives were addressed using multiple methods. First, a scoping review was conducted to locate, examine, and describe the

international literature on indicators used to measure prehospital care quality (research objective 1).[29,73] Informed by the results of the scoping review, an evidence informed expert consensus process in the form of a modified RAM including extensive preparatory work was conducted to develop a suite of valid prehospital care QIs for the Australian setting (research objective 2).[50–52] Finally, an explanatory sequential mixed methods study, with the qualitative stage constituting its core, was conducted to test the acceptability of prehospital care QIs deemed valid in the preceding study (research objective 3).[50]

Research objective 1: To locate, examine, and describe the international literature on indicators used to measure prehospital care quality.

A scoping review protocol (manuscript 1) was developed which set out the methods to be used for addressing research objective 1.[49] The scoping review (manuscript 2) comprised two systematic literature searches which 1) identified a relatively small body of literature that defines or describes prehospital care quality and 2) a rise in publications on prehospital care QIs indicating growing interest in the measurement in this context.[29] This increasing interest seemed to be led by the research community; Government agencies, professional associations, and accrediting bodies made comparatively scarce contributions.[29] The attributes of prehospital care quality identified by the scoping review are not unique to this specific healthcare setting. However, similar to other areas or disciplines of healthcare, prehospital care appears to demand more emphasis on certain attributes. Thus, the findings suggested that attributes of prehospital care quality may be characterised as timely access to appropriate, safe, and effective care that is responsive to a patient's needs and efficient and equitable to populations.[29] The identification of these key attributes of prehospital care quality was important because they contributed to a conceptual framework in the preparatory work of the study 2. This framework was used to articulate important areas of measurement

thus providing a valuable guide for the development of a balanced suite of QIs and a linkage to the underlying concept of prehospital care quality.[27,74]

Examination of the QIs charted in the scoping review showed that within the clinical category, QIs which describe the management and desirable outcomes of out-of-hospital cardiac arrest (OHCA) and acute coronary syndrome (ACS) had the highest frequency of representation.[29] Within the system/organisational category, QIs relating to time intervals and resources and deployment appeared most frequently in the literature.[29] Although undeniably important for patients with time-sensitive conditions such as OHCA or ACS, these findings confirms that surrogate QIs such as response time targets and QIs focusing on select high-acuity presentations continue to have significant influence on the measurement of quality in prehospital care. The review also identified less commonly reported prehospital care QIs thus establishing an extensive list spanning across several areas within the clinical and organisational/system categories.[29] Given the short patient contact time in prehospital care and the challenges associated with the measurement of meaningful outcomes during this brief initial phase of patient care,[75,76] process QIs were the most common type identified in the scoping review.[29] Valid process (or structural) QIs are ones which demonstrate a link to desirable outcomes or to prevention of adverse events.[65,77,78] Therefore, it was necessary to establish such linkages before any particular aspects of structure or process is used to assess quality.[65] Considering the historical perspectives of quality measurement in prehospital care as well as the need for intermediate processes when transferring QIs between countries or systems to review their supporting evidence and the quality thereof, there was a need for research to develop the QIs and appraise their validity. This led to the development of the study protocol (manuscript 3) and to addressing research objective 2.

Research objective 2: To develop a suite of Australian prehospital care quality indicators and to assess them for validity.

The initial list of QIs to be proposed to the expert panel was established through a scoping review of the international literature.[29] Forming an initial list of potential QIs based on a review of the literature is a common method used to prepare Delphi questionnaires aimed at QI development.[79] Further preparatory work of this study included 1) aggregating the prehospital care quality attributes and combining these with Donabedian's structure-process-outcome model to form a guiding taxonomy, 2) aggregating the QIs charted in the scoping review, sorting them within clinical and non-clinical categories and designating appropriate descriptors based on the access-safety-effectiveness/structure-process-outcome taxonomy, and 3) summarising the best available evidence for the proposed QIs by means of streamlined rapid reviews (Appendix B).[50,52]

For the purpose of this thesis, a rapid review for one, randomly selected QI was expanded to a publishable exemplar (manuscript 4).[51] Similar to the more condensed evidence summaries provided to the expert panel, this review demonstrated how a weak evidence base necessitates its combination with expert opinion to evaluate the validity of a QI.[34]

Systematic development of QIs by means of expert interpretation of best available evidence requires rigorous and reproducible methods to assess the level of agreement on the validity of the QIs.[37,80] Therefore, central to study 2 was a modified RAM aimed at combining expert opinion with best available evidence using validated consensus techniques (manuscript 5).[52] The nine-member expert panel rated 117 QIs (111 stemming from the preceding scoping review and preparatory process and six additional ones suggested by the panel) for validity in the Australian prehospital care context.[52] Overall, validity ratings were weighted towards the

clinical domain which was generally supported by more robust scientific evidence.[52] The panel considered 58 (88%) of the 66 proposed clinical QIs to be valid.[52] In the organisational/system domain only 26 (51%) of the 51 QIs were deemed valid suggesting substantial uncertainty about numerous service-based, non-clinical QIs.[52] Whilst cognisant of the health care needs of specific patients with time-sensitive conditions, a significant finding of this study was that the best available evidence in support of indicators describing general time interval targets was insufficient for the panel to consider these to be valid QIs.[52] Whilst such indicators are easy to implement and understand, this finding supports a shift away from oversimplifying prehospital care quality by gauging it based on general time intervals such as response times. The limited number of additional QIs suggested by the panel indicated that existing QIs scoped from the international literature may adequately fill a suite to validly measure prehospital care quality in Australia. Alternatively, and in light of those QIs that were added by the panel which addressed aspects of the progressive role that ambulance services play, for example, managing patients in accordance with end-of-life care plans, it may highlight a need for further research.[52] This study utilised systematic methods to develop a list of 84 valid QIs for the evaluation of prehospital care quality in Australia. These QIs became candidates for testing therein addressing research objective 3.

Research objective 3: To test the acceptability of prehospital care quality indicators deemed valid in study 2.

Validity is a minimum requirement for any QI. Prior to implementation, QIs should be tested for a number of other key characteristics, including acceptability.[34,39,46,47] The final study (manuscript 6) of this research thus sought to test the acceptability of prehospital care QIs previously deemed valid. An explanatory sequential mixed methods study design was used to

successively collect quantitative and qualitative data pertaining to the acceptability of the QIs. Data collected in the two stages were integrated but emphasis was placed on the qualitative aspect. Eighty-two of the 84 QIs had a median score greater than 3.5 on a 5-point Likert-type numerical rating scale and thus participants generally found almost all of the QIs to be explicitly acceptable.

Generally, QIs which participants considered to be clear, supported by scientific evidence, practical, and meaningful tended to be more acceptable than those which were not. This suggests an association between acceptability and other key characteristics of high-quality QIs which is an important finding of this study. If high acceptability of QIs facilitates their successful implementation and the degree of acceptability depends on the presence of key characteristics, then this finding supports the theory of a link between systematic QI development and effective quality improvement. Indeed lack of front-line engagement and poorly planned measurement have previously been identified as reasons for failure of quality improvement initiatives.[81,82]

Whilst participants acknowledged the benefits of outcome QIs, they raised concerns about their sensitivity in the measurement of prehospital quality of care. The strengths and weaknesses of different types of indicators are well established.[83–85] Outcome indicators are goal-orientated and meaningful to patients and policy-makers, however, can suffer from attribution and ambiguity in that they may be influenced by factors outside the control of the healthcare organisation, and poor outcomes may be attained despite high-quality processes of care (and vice versa).[83–85] Similarly, participants recognised benefits and pitfalls of using time interval targets as QIs of prehospital care. To be acceptable to the participants, QIs which included time interval targets needed to be specific about time-sensitive

interventions. As such, participants demonstrated clear understanding of the association between timely interventions and clinical outcomes in specific, time-sensitive patient cohorts, such as those presenting with penetrating trauma or ACS.[86–89] However, participants were equally aware of the lack of evidence in support of using response time or other time interval targets as generic prehospital care QIs.[90–92] This finding echoed the outcome of the preceding study excluding indicators describing general time interval targets from the list of valid prehospital care QIs.[52] The importance and hence acceptability of evaluating timeliness as indicators of prehospital care quality in specific time-sensitive patients thus remains self-evident but fixating on broad response time indicators cannot evaluate modern prehospital care quality holistically. Therefore, any QI detailing response time or other time interval targets should be specific about patients and interventions. The appropriate use of such QIs also relies on the accurate identification of patients with a need for time-sensitive interventions during the emergency call taking and ambulance dispatch processes.[93,94]

Whilst generally still rated as acceptable, QIs on patient experience and satisfaction frequently received comparatively lower ratings. Despite evidence suggesting a positive association between patient experience and clinical effectiveness and patient safety,[95] scepticism by healthcare providers about the meaningfulness of evaluating quality from a patient perspective is not uncommon.[96,97] Participants of the semi-structured interviews in study 3 did not disregarded patient values or QIs describing aspects of patient experience and satisfaction but the commentary suggested some uncertainty about the validity and hence acceptability of such QIs. This finding supports the need for patient and public involvement in future QI development and testing. Finally, the study found that, although hesitant, participants seemed to consider their own professional values and qualities by reflecting on what is meaningful prehospital care to them and generally deemed the proposed suite of QIs

to be in line with these. A connection between healthcare providers' professional values and qualities and the QIs implemented to evaluate the services and care they provide is important. Factors related to the intrinsic motivation of healthcare professionals and managers for improvement and possibilities to improve care are important facilitators of successful QI implementation.[98,99] Table 6.1 summarises the key findings and Table 6.2 provides a complete list of developed Australian prehospital care QIs.

Table 6.1 Summary of key findings

- There is growing interest and understanding about the importance of the measurement of prehospital care quality.
- Prehospital care quality may be described as timely access to appropriate, safe, and effective care that is responsive to a patient's needs and efficient and equitable to populations.
- Surrogate QIs (e.g. response time targets) and QIs focusing on select high-acuity presentations (e.g. OHCA) continue to have significant influence on the measurement of quality in prehospital care.
- A suite of 84 valid Australian prehospital care QIs was developed.
- With consideration of best available evidence, the expert panel did not deem indicators describing general time intervals to be valid.
- Eighty-two of the 84 valid Australian prehospital care QIs are likely to be acceptable to paramedics and ambulance service managers.
- There is a positive association between acceptability and other key characteristics of high-quality QIs.
- To be acceptable prehospital care QIs, outcome indicators need to be clearly attributable to prehospital care.
- The importance and hence acceptability of evaluating timeliness as indicators of prehospital care quality in specific time-sensitive patients remains self-evident but fixating on general response time indicators cannot evaluate modern prehospital care quality holistically.
- There may be some scepticism amongst prehospital care providers about the meaningfulness of evaluating quality from a patient perspective.
- The suite of valid Australian prehospital care QIs generally aligned to participants' professional values and standards.

OHCA Out-of-hospital cardiac arrest; QI Quality indicator

Table 6.2 Complete list of developed Australian prehospital care QIs

Quality Indicator* ***(Type; Quality dimension/s)***
Domain A: Organisational/System QIs
Sub-domain A.2. Patient Safety
QI-A.2.1. The ambulance service has a dedicated patient safety reporting system. *(Structure; Safety)*
QI-A.2.2. The ambulance service has a guideline that defines the categories of patients that should be left in the care of an appropriate healthcare professional, i.e., should not be left unattended. *(Structure; Safety)*
QI-A.2.3. A patient who is not conveyed to a healthcare facility has been risk-assessed for likelihood of deterioration. *(Process, Safety)*
QI-A.2.4. The ambulance service has policy that describes the treat-and-refer arrangements for patients not conveyed to a health care facility. *(Structure; Safety)*
Sub-domain A.3. Patient Experience and Satisfaction
QI-A.3.1. The ambulance service collects and analyses quantitative and qualitative data pertaining to patient experience and satisfaction for the purpose of quality improvement. *(Process; Access, Safety, Effectiveness)*
QI-A.3.4. In a patient satisfaction survey, a patient reports that they felt that the level of care provided to them by paramedics was very good or good. *(Outcome; Effectiveness)*
QI-A.3.5. In a patient satisfaction survey, a patient reports that their level of trust and confidence in paramedics and their ability to provide quality care and treatment was very high or high. *(Outcome; Safety, Effectiveness)*
QI-A.3.6. In a patient satisfaction survey, a patient reports that they were very satisfied or satisfied with the ambulance services they received in the previous 12 months. *(Outcome; Access, Safety, Effectiveness)*
QI-A.3.8. The ambulance service collects and analyses quantitative and qualitative data pertaining to complaints for the purpose of quality improvement. *(Process; Access, Safety, Effectiveness)*
Sub-domain A.4. Communication
QI-A.4.1. A call is assigned an accurate level of urgency and/or dispatch priority. *(Process; Access, Effectiveness)*
QI-A.4.2. A patient is identified to be in OHCA by the ambulance service call-taker before the first resource arrives on scene. *(Process: Effectiveness)*
QI-A.4.3. A caller requesting assistance for suspected/confirmed adult cardiac arrest is offered instructions (audio, or video if possible) in chest-compression-only cardiopulmonary resuscitation (CPR). *(Process: Effectiveness)*
Sub-domain A.5. Resources and Resource Management
QI-A.5.3. The ambulance service has a policy detailing which resource(s) should respond to each category/type of call. *(Structure; Access)*
QI-A.5.4. A patient who meets service-defined treat-and-discharge or treat-and-release criteria is not transported. *(Process; Access)*
Sub-domain A.6. Paramedic Health and Safety
QI-A.6.6. The ambulance service provides mental health programs, including pre-incident preparedness training, to its paramedics. *(Process; Safety)*
QI-A.6.8. The ambulance service collects and analysis quantitative and qualitative data pertaining to staff satisfaction. *(Process; Effectiveness)*
Sub-domain A.7. Training, Education, and Research
QI-A.7.1. The ambulance service has a policy that describes the process for supervision of paramedics in training. *(Structure; Safety, Effectiveness)*
QI-A.7.2. The ambulance service staff have access to electronic/online medical education resources. *(Structure; Safety, Effectiveness)*
QI-A.7.3. The ambulance service has a dedicated training and education unit. *(Structure; Access, Safety, Effectiveness)*
QI-A.7.6. The ambulance service has a guideline which details the criteria by which it assesses proposals to conduct research by its staff or in collaboration with external parties. *(Structure; Safety)*
Sub-domain A.8. Other (Organisational/System)
QI-A.8.1. The ambulance service has arrangements in place enabling paramedics to consult with senior clinical colleagues when treating a patient. *(Structure; Safety, Effectiveness)*

QI-A.8.2. The ambulance service has arrangements in place enabling paramedics to consult with specialist mental health professionals when treating a patient with a mental health disorder. *(Structure; Safety, Effectiveness)*
QI-A.8.3. The ambulance service has a procedure for managing situations in which a patient refuses care or transportation for the physical effects of self-harm. *(Structure; Safety, Effectiveness)*
QI-A.8.4. The ambulance service operates a quality improvement program that includes quality assessment/measurement, control, and improvement. *(Structure; Access, Safety, Effectiveness)*
QI-A.8.5.addl. A patient with accessible end-of-life care plans is managed in accordance with these plans. *(Process; Effectiveness)*
Clinical Domain
Sub-domain B.1. Airway Management, Ventilation, and Oxygen Therapy
QI-B.1.1. A patient with a decreased level of consciousness (GCS ≤14), has their airway patency assessed. *(Process; Effectiveness)*
QI-B.1.2. A hypoxemic patient (SpO_2 <94%) is administered oxygen, unless contraindicated. *(Process; Effectiveness)*
QI-B.1.3. A normoxaemic patient (SpO_2 ≥94%) is not administered oxygen, unless specifically indicated. *(Process; Effectiveness)*
QI-B.1.4. A patient who has a supraglottic airway inserted, meets service-defined indications for the airway intervention. *(Process; Effectiveness)*
QI-B.1.5. In a patient who has a supraglottic airway inserted, the correct position of the supraglottic airway is assessed using an exhaled CO_2 detector. *(Process; Effectiveness)*
QI-B.1.6. A patient who is endotracheally intubated, meets service-defined indications for the procedure. *(Process; Effectiveness)*
QI-B.1.7. A patient who is intubated, is successfully endotracheally intubated. *(Process; Effectiveness)*
QI-B.1.8. For an endotracheally intubated patient, the correct position of the endotracheal tube is assessed using an exhaled CO_2 detector. *(Process; Effectiveness)*
QI-B.1.9. A patient who is endotracheally intubated has their pulse oximetry continuously monitored during the procedure. *(Process; Effectiveness)*
QI-B.1.10. A patient who receives cricothyrotomy, meets service-defined indications for the procedure. *(Process; Effectiveness)*
QI-B.1.11. A patient who receives cricothyrotomy, has the procedure performed successfully. *(Process; Effectiveness)*
Sub-domain B.2. Out-of-Hospital Cardiac Arrest
QI-B.2.1. An ambulance arrives at an OHCA patient within 4 minutes of the 000-call. *(Process; Access)*
QI-B.2.2. Paramedics providing CPR utilize an audio-visual feedback and prompt device for real-time optimization of chest compression quality. *(Process; Effectiveness)*
QI-B.2.3. For an OHCA patient in a shockable rhythm, the first defibrillation attempt is made as soon as possible and within 2 minutes of arrival at the patient. *(Process; Effectiveness)*
QI-B.2.6. The receiving hospital receives pre-notification of an OHCA/post-OHCA patient. *(Process; Access)*
QI-B.2.7. A patient who was in OHCA has ROSC on arrival at the receiving hospital. *(Outcome; Effectiveness)*
QI-B.2.8. A patient who was in OHCA survives to discharge from hospital. *(Outcome; Effectiveness)*
QI-B.2.9. A patient who was in OHCA is discharged from hospital with favourable neurological outcome; CPC ≤2 or mRS ≤3. *(Outcome; Effectiveness)*

QI-B.2.10. A patient who was in OHCA survives to 30 days from the event. *(Outcome; Effectiveness)*
Sub-domain B.3. Acute Coronary Syndrome
QI-B.3.1. The ambulance service has a documented clinical care pathway that details the care and transport it provides to patients with signs and/or symptoms suggestive of ACS. *(Structure; Access, Effectiveness)*
QI-B.3.2. A patient with signs and/or symptoms suggestive of ACS has a 12-lead ECG acquired and interpreted within 10 minutes of arrival on scene. *(Process; Effectiveness)*
QI-B.3.3. A patient with signs and/or symptoms suggestive of ACS and normoxaemia (SpO_2 ≥94%) is not administered supplementary oxygen. *(Process; Effectiveness)*
QI-B.3.4. A patient with signs and/or symptoms suggestive of ACS is administered aspirin, unless contraindicated. *(Process; Effectiveness)*
QI-B.3.5. A patient with signs and/or symptoms suggestive of ACS has their pain score assessed before and after treatment. *(Process; Effectiveness)*
QI.B.3.6. A patient with signs and/or symptoms suggestive of ACS is administered glyceryl trinitrate, unless contraindicated. *(Process; Effectiveness)*
QI-B.3.7. A patient with acute chest pain suggestive of ACS is administered analgesic agent(s), unless contraindicated. *(Process; Effectiveness)*
QI-B.3.8. If transport time to a hospital capable of providing primary PCI is ≤30 minutes, a patient with STEMI and within 12 hours of symptom onset is transported directly to that hospital. *(Process; Effectiveness)*
QI-B.3.9.addl. If transport time to a hospital capable of providing primary PCI is >30 minutes, a patient with STEMI and within 12 hours of symptom onset receives prehospital fibrinolysis. *(Process; Effectiveness)*
Sub-domain B.4. Stroke
QI-B.4.1. A patient with suspected acute stroke is assessed using a validated stroke identification tool†. *(Process; Effectiveness)*
QI-B.4.2. A patient with suspected acute stroke has their blood glucose level measured. *(Process; Effectiveness)*
QI-B.4.3. In a patient with suspected acute stroke, it is assessed whether or not they are on anticoagulant therapy. *(Process; Effectiveness)*
QI-B.4.4. A patient with suspected acute stroke and normoxaemia (SpO_2 ≥94%) is not administered supplementary oxygen. *(Process; Effectiveness)*
QI-B.4.5. In a patient with suspected acute stroke, it is assessed at what time the patient was last known to be without the clinical features of acute stroke. *(Process; Effectiveness)*
QI-B.4.6. A patient presenting with suspected stroke is transported directly to a hospital capable of performing thrombolysis and/or endovascular thrombectomy. *(Process; Access)*
QI-B.4.7. The receiving facility receives notification of a patient experiencing suspected stroke. *(Process; Access)*
Sub-domain B.5. Asthma
QI-B.5.2. A patient with acute asthma has their oxygen saturation level continuously monitored. *(Process; Safety, Effectiveness)*
QI-B.5.3. A patient with acute asthma is given controlled oxygen titrated to maintain an SpO_2 level of 94-98%. *(Process; Effectiveness)*
QI-B.5.4. A patient with acute asthma is administered salbutamol via oxygen-driven nebulizer, unless contraindicated. *(Process; Effectiveness)*
QI-B.5.5. A patient with acute severe asthma or worse is administered salbutamol and ipratropium bromide via oxygen driven nebulizer, unless contraindicated. *(Process; Effectiveness)*
QI-B.5.7. A patient with life-threatening asthma is be administered intramuscular adrenaline, unless contraindicated. *(Process; Effectiveness)*
QI-B.5.8. The receiving facility receives notification of a patient with life-threatening asthma. *(Process; Access)*

Sub-domain B.6. Trauma
QI-B.6.1 A patient with active external haemorrhage receives haemorrhage control by application of direct pressure, arterial tourniquet and haemostatic dressing as required. *(Process; Effectiveness)*
QI-B.6.2. A patient with a mechanism of injury and/or other signs/symptoms suggestive of PCCD applied. *(Process; Effectiveness)*
QI-B.6.3. A patient with recent (≤3 hours) traumatic injury resulting in ongoing haemorrhage and/or ATC (indicated by a validated and prehospitally applicable prediction tool) receives TXA (1g, intravenously). *(Process; Effectiveness)*
QI-B.6.4. When attending to a patient suffering neurotrauma or penetrating injury with hemodynamic instability, the ambulance departs the scene within 10 min. of arriving on scene, unless unable or impractical to do so for safety or operational reasons. *(Process; Access)*
QI-B.6.5. A patient is correctly triaged and transported to an appropriate hospital as per agreed trauma system protocol. *(Process; Access)*
QI-B.6.6. The receiving hospital receives notification of a major trauma patient as per agreed trauma system protocol. *(Process; Access)*
Sub-domain B.7. Seizures
QI-B.7.1. A patient with a seizure has their blood glucose level measured. *(Process; Effectiveness)*
QI-B.7.2. A patient with an active seizure is administered a benzodiazepine by the best available route. *(Process; Effectiveness)*
Sub-domain B.8. Hypoglycaemia
QI-B.8.1. A conscious hypoglycaemic patient is administered oral glucose, unless contraindicated. *(Process; Effectiveness)*
QI-B.8.2. An unconscious hypoglycaemic patient is administered intravenous glucose 10% or intramuscular glucagon, unless contraindicated. *(Process; Effectiveness)*
QI-B.8.3. A patient who has been administered glucose (oral or intravenous) or glucagon has their blood glucose level checked following administration. *(Process; Effectiveness)*
Sub-domain B.9. Pain Management
QI-B.9.1. A patient has their pain intensity measured using the 0-10 VNRS. *(Process; Effectiveness)*
QI-B.9.2. A patient experiencing mild (2-3/10), moderate (4-6/10) or severe (7-10/10) pain is administered analgesic agent(s), unless contraindicated or refused. *(Process; Effectiveness)*
QI-B.9.4. A responsive patient who is administered analgesic agent(s) remains responsive to verbal stimuli unless anaesthesia is being induced. *(Outcome, Safety)*
QI-B.9.5. A responsive patient who is administered analgesic agent(s) does not require airway management or ventilatory support following the administration unless anaesthesia is being induced. *(Outcome, Safety)*
Sub-domain B.10. Other (Clinical)
QI-B.10.3. The ambulance service has a policy that defines specific categories of patients for which receiving facilities are to be notified of the patient's arrival. *(Structure; Access)*

ACS Acute Coronary Syndrome; ATC Acute Traumatic Coagulopathy; CPC Cerebral Performance Category; CPR Cardiopulmonary Resuscitation; ECG Electrocardiogram; GCS Glasgow Coma Score; mRS modified Rankin Scale; OHCA Out-of-Hospital Cardiac Arrest; PCCD Pelvic Circumferential Compression Device; PCI Percutaneous Coronary Intervention; ROSC Return Of Spontaneous Circulation; TXA Tranexamic Acid; VNRS Visual Numerical Rating Scale

*Numbering of the QIs has been maintained throughout the project. Therefore, QIs which were not deemed valid in study 2 of the project are not included and hence numbering may appear incomplete.

† Los Angeles prehospital stroke screen (LAPSS score), Cincinnati prehospital stroke scale (CPSS), Face Arm Speech Test (FAST), Melbourne Ambulance Stroke Screen (MASS score), Ontario Prehospital Stroke Screening tool (OPSS) or Recognition Of Stroke In the Emergency Room (ROSIER) scale

6.3 Strengths and limitations

This section discusses the broad strengths and limitations of the research overall. Strengths and limitations of individual studies are discussed in the relevant manuscripts.

To the knowledge of the investigators, this work presents the first published systematic development of a suite of prehospital care QIs for the Australian setting. QIs are often chosen arbitrarily which may result in unintended consequences.[47] A such, the rigorous and structured methods applied in this research are one of its key strengths. The initial scoping review and preparatory work of study 2 ensured that the QIs have a clear connection to the concept of prehospital care quality, an essential step towards the development of meaningful QIs. Central to systematic development, the rapid reviews and evidence summaries prepared for the expert consensus process ensured that the assessment of validity of the QIs was informed by best available evidence. The expert consensus process itself utilised rigorous and reproducible methods to assess the level of agreement. Finally, purposeful mixing of methods in data collection, analysis, and interpretation was applied as an appropriate systematic approach to testing the QIs for acceptability. From a methodological perspective, the rapid review approach, the modified RAM, and the explanatory sequential mixed methods study epitomised the philosophical underpinnings of this research demonstrating a pragmatic approach with a focus on the research questions thereby embracing plurality of methods in an effort to achieve the overall research aim.

There are several limitations which need to be considered. In principle, quality measurement serves two distinct purposes. Quality measurement is used for quality assurance as a summative assessment for external accountability and verification, and as a formative mechanism for quality improvement.[21,39] Although the line between quality assurance and

quality improvement often blurs it can be useful to focus on one specific purpose at the outset of QI development which was not done in this research.

As acknowledged in the Covid-19 impact statement, the original intent to test QIs for various key characteristics had to be amended by concentrating on testing their acceptability. The final list of QIs thus need to be considered in the context of being subjected to a limited testing protocol. Testing the QIs for other desirable characteristics forms part of future research opportunities.

Especially in research that aims to address what constitutes quality, the involvement of patients and public is as important as the participation of healthcare providers.[100] The development and testing of the QIs in this research was performed primarily from the perspective of the clinician/provider.

Lastly, this research developed a general suite of prehospital care QIs. Considering its evolution and growth it can be argued that the field of prehospital care has become too broad for a single suite of QIs to cover it adequately. A focus on specific areas within prehospital care such as those detailed in the sub-domains, or further ones such as mental health or prehospital obstetric care, may enhance the quality of the QIs.

6.4 Recommendations arising from this research

This research represents the first published systematic development of prehospital care QIs for the Australian setting. A number of recommendations arose from the key findings of the research.

6.4.1 Developed Australian prehospital care QIs

The overarching aim of this research was to develop and test prehospital care QIs for the Australian setting. Whilst recognising the limitations of the research, this aim was achieved in that a suite of valid Australian prehospital care QIs was developed and tested for acceptability. Australian ambulance services and other organisations involved in the measurement of prehospital care quality for assurance or improvement purposes should consider this suite. Many of the QIs developed in this thesis validate QIs currently being used by Australian ambulance services or governing bodies. Others may be new providing an opportunity to expand the range of clinical and non-clinical areas of measurement through the implementation of validated QIs.

6.4.2 Collaboration between academia and industry

The development of QIs forms only the initial step towards monitoring and assuring improvements. Implementing QIs, analysing and interpreting the data obtained from measurement, and making effective use of the gained intelligence to improve quality form the next critical steps in this process. Closer collaboration between academic institutions and ambulance services, governing bodies, and professional associations would bring significant benefits for research in this area and should be considered as essential to ensure that prehospital care QIs serve their ultimate purpose.

6.4.3 Systematic development of meaningful QIs

For measurement of quality in any field to be meaningful it must be linked to a contextual definition of quality. This research utilised systematic methods to elicit attributes of prehospital care quality and drew on previous research to aggregate these attributes into a framework to guide measurement. Prehospital care quality measurement should include

structure, process, and outcome QIs that address access to services and care, safety for providers and patients, and effectiveness of services and care. Access as a dimension of prehospital care quality is complex and involves more than prompt arrival of an ambulance at the scene of an incident. Access includes an ambulance service's ability to assign an accurate level of dispatch priority to a call, the availability of appropriate resources, timely access to meaningful prehospital assessment and care, facilitation of access to more definitive diagnostics and interventions, or the availability and accessibility of options for onward referral when required. Concerted efforts are needed to move away from using response time targets and other general time intervals as chief indicators of prehospital care quality. Whilst the appropriate and specific use of such QIs will continue to play an important role in evaluating care for time-critical patients, there is a need for a strong drive towards the use of other valid QIs to evaluate the quality of modern prehospital care for all patients. Given the need of QIs to be of high quality in order to be acceptable to prehospital care providers, and acceptability being an important requisite for successful implementation, any development of prehospital care QIs should deploy systematic methods. Thus, if ambulance services and other organisations are serious about trustworthy quality assurance and effective quality improvement, they should utilise rigorous and transparent processes when developing QIs.

6.5 Recommendations for future research

The findings of the research presented in this thesis have made contribution to the existing body of knowledge related to indicators of Australian prehospital care quality. They have also highlighted several areas that call for further exploration and thus revealed possible new research directions.

6.5.1 Development of QIs based on current best available evidence

First and foremost the impermanent nature of QIs must be recognised as a need for ongoing research. Just like evidence-based healthcare is perpetually evolving, so too are indicators of healthcare quality. As such QIs which are based on best available evidence today may be out of date tomorrow and a need for development based on *current* best available evidence arises.

6.5.2 Integrated guidelines and QI development

Guidelines and QIs differ somewhat in their purpose; guidelines assist health care providers and patients in decision-making about appropriate health care for specific clinical circumstances whereas QIs serve to evaluate that care. However, guidelines and QIs have a common aim in that both intend to assure and improve the quality of healthcare delivery and health outcomes. As such, there may be advantages in aligning methods and activities resulting in an integrated guidelines and QI development approach. Future research could thus amalgamate the development of prehospital care guidelines and associated QIs, possibly at a national level and perhaps within more intricate prehospital care specialities.

6.5.3 Further testing of the QIs

As previously noted, further testing of the QIs for other desirable characteristics may be beneficial prior to implementation. Desirable characteristics include feasibility and reliability, as was originally planned in this research, but also sensitivity to change, actionability, and patient and community acceptability.

6.5.4 Patient and public involvement

Given the differences between how providers and patients may perceive quality, patients or patient representatives should be involved in future development processes to capture patient views on quality of prehospital care.

6.5.5 Paramedic perceptions on of patient experience and satisfaction

Considering some of the commentary that emerged from study 3 of this research project, there is a need to investigate paramedic perception of patient experience and satisfaction and their validity as indicators of prehospital care quality.

6.6 Concluding remarks

This thesis presents an investigation that developed and tested prehospital care QIs for the Australian setting. QIs are the tools for measurement and thus central to trustworthy quality assurance and effective quality improvement. As the prehospital care landscape in Australia continues to evolve, efforts to validly measure, compare, monitor, and improve the quality of patient care are becoming increasingly important. This research has demonstrated a rigorous and transparent process of moving from a definition of prehospital care quality and best available evidence to meaningful, valid, and acceptable QIs for evaluating a broad array of clinical and non-clinical aspects of prehospital care in Australia.

References

1. Dick WF. Anglo-American vs. Franco-German emergency medical services system. Prehosp Disaster Med. 2003;18(1):29–35.
2. Wankhade P, Mackway-Jones K, editors. Ambulance Services: Leadership and Management Perspectives. Cham: Springer; 2015.
3. Von Vopelius-Feldt J, Benger J. Who does what in prehospital critical care? An analysis of competencies of paramedics, critical care paramedics and prehospital physicians. Emerg Med J. 2014;31(12):1009–13.
4. Paramedics Australasia. Paramedicine Role Descriptions [Internet]. Melbourne: Paramedics Australasia; 2012. p. 1–23. Available from: https://www.paramedics.org
5. Owen RC. The development and testing of indicators of prehospital care quality [dissertation]. [Manchester]. University of Manchester; 2010.
6. Middleton P. International Perspectives: Australian Ambulance Services in 2020. In: Wankhade P, Mackway-Jones K, editors. Ambulance Services. Cham: Springer; 2015.
7. Australian Government Productivity Commission - Steering Committee for the Review of Government Service Provision. Report on Government Services 2022, Ambulance Services [Internet]. Canberra; 2022. Available from: https://www.pc.gov.au/research/ongoing/report-on-government-services
8. Williams B, Beovich B, Olaussen A. The Definition of Paramedicine: An International Delphi Study. J Multidiscip Healthc. 2021;14:3561–70.
9. Australian Health Practitioner Regulation Agency (AHPRA). Australian Health Practitioner Regulation Agency Board of Paramedicine [Internet]. 2022. Available from: https://www.paramedicineboard.gov.au/registration.aspx
10. Braithwaite J, Churruca K, Ellis LA, Long J, Clay-Williams R, Damen N, et al. Complexity Science in Healthcare. Sydney: Macquarie University; 2017. 118 p.

11. Australian Bureau of Statistics. Population [Internet]. 2022. Available from: https://www.abs.gov.au/statistics/people/population
12. Richardson. A. Ambulance Services in Australia [Internet]. AU INDUSTRY (ANZSIC) REPORT Q8591. 2021. Available from: https://www.ibisworld.com
13. World Health Organization (WHO). WHO Global Health Observatory [Internet]. 2022. Available from: https://www.who.int/data/gho
14. Lawry T. Rise of the Intelligent Health Consumer. In: Lawry T, editor. AI in Health: A Leader's Guide to Winning in the New Age of Intelligent Health Systems. HIMSS Publishing; 2021. p. 222.
15. Atsma F, Elwyn G, Westert G. Understanding unwarranted variation in clinical practice: A focus on network effects, reflective medicine and learning health systems. Int J Qual Heal Care. 2020;32(4):271–4.
16. Australian Commission on Safety and Quality in Healthcare. Australian Atlas of Healthcare Variation [Internet]. Sydney; 2021. Available from: https://www.safetyandquality.gov.au/our-work/healthcare-variation/fourth-atlas-2021
17. NSW Ambulance. Redefining our Future: NSW Ambulance Vision and Strategic Plan 2021-206. Sydney; 2021.
18. Ambulance Victoria. Ambulance Victoria Strategic Plan 2017-2022. Melbourne; 2017.
19. Queensland Ambulance Service. Queensland Ambulance Service Strategy 2016-2021. Brisbane; 2016.
20. Mainz J. Quality indicators: Essential for quality improvement. Int J Qual Heal Care. 2004;16(Suppl. 1):10–1.
21. Quentin W, Partanen V, Brownwood I, Klazinga N. Measuring healthcare quality. In: Busse R, Klazinga N, Panteli D, Quentin W, editors. Improving healthcare quality in Europe Characteristics, effectiveness and implementation of different strategies

[Internet]. Copenhagen (Denmark): European Observatory on Health Systems and Policies; 2019. p. 420. Available from: https://www.ncbi.nlm.nih.gov/books/NBK549260/

22. Langley G, Moen R, Nolan K, Nolan T, Norman C. The Improvement Guide: A Practical Approach to Enhancing Organizational Performance. 2nd ed. Hoboken, NJ: John Wiley & Sons Inc; 2009.

23. Goldenberg MJ. Defining "quality of care" persuasively. Theor Med Bioeth. 2012;33(4):243–61.

24. DeCarlo M. Scientific Inquiry in Social Work [Internet]. Montreal: Open Social Work Education; 2018. Available from: https://scientificinquiryinsocialwork.pressbooks.com

25. Donabedian A. The Quality of Care: How Can It Be Assessed? J Am Med A. 1988;260(12):1743–8.

26. Maxwell RJ. Dimensions of quality revisited: from thought to action. Qual Saf Heal Care. 1992;1(3):171–7.

27. Campbell S., Roland M., Buetow S. Defining quality of care. Soc Sci Med. 2000;51:1611–25.

28. Cooperberg MR, Birkmeyer JD, Litwin MS. Defining high quality health care. Urol Oncol Semin Orig Investig. 2009;27:411–6.

29. Pap R, Lockwood C, Stephenson M, Simpson P. Indicators to measure prehospital care quality: a scoping review. JBI Database Syst Rev Implement Reports. 2018;16(11):2192–223.

30. Steffen G. Quality Medical Care. A Definition. JAMA - J Am Med Assoc. 1988;260(1):56–61.

31. Donabedian A. Evaluating the Quality of Medical Care. Milbank Mem Fund Q. 1966;44(3):166–206.

32. Donabedian A. The Definition of Quality and Approaches to Its Assessment. Vol 1. Explorations in Quality Assessment and Monitoring. Ann Arbor, Michigan: Health Administration Press; 1980.

33. Canadian Council on Health Services Accreditation. A guide to the development and use of performance indicators. Ottawa, Ontario: Canadian Council on Health Services Accreditation; 1996. 98 p.

34. Campbell SM, Braspenning J, Hutchingson A, Marshall MN. Research Methods Used in Developing and Applying Quality Indicators in Primary Care. Qual Saf Heal Care. 2002;11:358–64.

35. Coster JE, Irving AD, Turner JK, Phung V-H, Siriwardena AN. Prioritizing novel and existing ambulance performance measures through expert and lay consensus: A three-stage multimethod consensus study. Heal Expect. 2017;21(1):249–60.

36. Institut für Qualitätssicherung und Transparenz im Gesundheitswesen (IQTIG). Methodische Grundlagen V1.1.s. Entwurf für das Stellungnahmeverfahren [Internet]. 2018. Available from: https://iqtig.org/das-iqtig/grundlagen/methodische-grundlagen/

37. Lawrence M, Olesen F. Indicators of Quality in Health Care. Eur J Gen Pract. 1997;3(9):103–8.

38. Donabedian A. An introduction to quality assurance in healthcare. Oxford: Oxford University Press; 2003.

39. Mainz J. Developing evidence-based clinical indicators: a state of the art methods primer. Int J Qual Heal Care. 2003;15(Supp 1):i5–11.

40. Langendam MW, Piggott T, Nothacker M, Agarwal A, Armstrong D, Baldeh T, et al. Approaches of integrating the development of guidelines and quality indicators: a systematic review. BMC Health Serv Res. 2020;20(1):1–11.

41. Kötter T, Blozik E, Scherer M. Methods for the guideline-based development of

quality indicators - a systematic review. Implement Sci. 2012;7(1):21.

42. Marshall MN, Shekelle PG, McGlynn E a, Campbell S, Brook RH, Roland MO. Can health care quality indicators be transferred between countries? Qual Saf Health Care. 2003;12(1):8–12.

43. Delnoij DMJ, Westert GP. Assessing the validity of quality indicators: Keep the context in mind! Eur J Public Health. 2012;22(4):452–3.

44. Frongillo EA, Baranowski T, Subar AF, Tooze JA, Kirkpatrick SI. Establishing Validity and Cross-Context Equivalence of Measures and Indicators. J Acad Nutr Diet. 2019;119(11):1817–30.

45. Krabbe PFM. The Measurement of Health and Health Status: Concepts, Methods and Applications from a Multidisciplinary Perspective. San Diego: Elsevier Science & Technology; 2016. 380 p.

46. Campbell S, Kontopantelis E, Hannon K, Burke M, Barber A, Lester H. Framework and indicator testing protocol for developing and piloting quality indicators for the UK quality and outcomes framework. BMC Fam Pract. 2011;12(1):85.

47. Jones P, Shepherd M, Wells S, Le Fevre J, Ameratunga S. Review article: what makes a good healthcare quality indicator? A systematic review and validation study. Emerg Med Australas. 2014;26(2):113–24.

48. Barbazza E, Klazinga NS, Kringos DS. Exploring the actionability of healthcare performance indicators for quality of care: A qualitative analysis of the literature, expert opinion and user experience. BMJ Qual Saf. 2021;1–11.

49. Pap R, Lockwood C, Stephenson M, Simpson P. Indicators to measure pre-hospital care quality: a scoping review protocol. JBI Database Syst Rev Implement Reports. 2017;15(6).

50. Pap R, Lockwood C, Stephenson M, Simpson P. Development and testing of

Australian prehospital care quality indicators: study protocol. BMJ Open. 2020;10:e038310.

51. Pap R, McKeown R, Lockwood C, Stephenson M, Simpson P. Pelvic circumferential compression devices for prehospital management of suspected pelvic fractures: a rapid review and evidence summary for quality indicator evaluation. Scand J Trauma Resusc Emerg Med. 2020;28:65.

52. Pap R, Lockwood C, Stephenson M, Simpson P. Development of prehospital care quality indicators for the Australian setting : a modified RAND / UCLA appropriateness method. Emerg Med J. 2021;0:1–6.

53. Teddlie C, Tashakkori A. Foundations of mixed methods research : integrating quantitative and qualitative techniques in the social and behavioral sciences. Thousand Oaks, CA: SAGE Publications; 2009.

54. Maxcy S. Pragmatic threads in mixed methods research in the social sciences: The search for multiple modes of inquiry and the end of the philosophy of formalism. In: Tashakkori A, Teddlie C, editors. Handbook of Mixed Methods in Social and Behavioral Research. Thousand Oaks, CA: SAGE Publications; 2003. p. 51–89.

55. Biesta G. Pragmatism and the Philosophical Foundations of Mixed Methods Research. In: Tashakkori A, Teddlie C, editors. SAGE Handbook of Mixed Methods in Social and Behavioral Research. 2nd ed. Thousand Oaks, CA: SAGE Publications, Inc.; 2010.

56. Creswell J, Plano Clark V. Designing and conducting mixed methods research. 2nd ed. Los Angeles: Sage Publications Inc.; 2011. 457 p.

57. Nair R, Aggarwal R, Khanna D. Methods of Formal Consensus in Classification/Diagnostic Criteria and Guideline Development. Semin Arthritis Rheum. 2011;41(2):95–105.

58. Dalkey N, Brown B, Cochran S. The Delphi method: an experimental study of group opinion. Santa Monica, CA: Rand Corp.; 1969.

59. Turoff M. The design of a policy Delphi. Technol Forcasting Soc Chang. 1970;2(2):149–71.

60. Dalkey N, Helmer O. An Experimental Application of the Delphi Method to the Use of Experts. Manage Sci. 1963;9(3):458–67.

61. Kaushik V, Walsh CA. Pragmatism as a research paradigm and its implications for social work research. Soc Sci. 2019;8(9):1–17.

62. Ivankova N V., Creswell JW, Stick SL. Using Mixed-Methods Sequential Explanatory Design: From Theory to Practice. Field methods. 2006;18(1):3–20.

63. Feilzer MY. Doing mixed methods research pragmatically: Implications for the rediscovery of pragmatism as a research paradigm. J Mix Methods Res. 2010;4(1):6–16.

64. Berwick D, Fox D. "Evaluating the Quality ofMedical Care": Donabedian's Classic Article 50 Years Later. Millbank Q. 2016;94(2):237–41.

65. Mainz J. Defining and classifying clinical indicators for quality improvement. Int J Qual Heal Care. 2003;15(156):523–30.

66. Snooks H, Evans A, Wells B, Peconi J, Thomas M. What are the highest priorities for research in pre-hospital care? Results of a review and Delphi consultation exercise. J Emerg Prim Heal Care. 2008 Dec;6(4):20p-20p.

67. O'Meara P, Maguire B, Jennings P, Simpson P. Building an Australasian paramedicine research agenda: a narrative review. Health Res Policy Syst. 2015;13(1):79.

68. Jensen JL, Bigham BL, Blanchard IE, Dainty KN, Socha D, Carter A, et al. The Canadian National EMS research agenda: A mixed methods consensus study. Can J Emerg Med. 2013;15(2):73–82.

69. Lewis KB, Graham ID, Boland L, Stacey D. Writing a compelling integrated discussion: A guide for integrated discussions in article-based theses and dissertations. Int J Nurs Educ Scholarsh. 2021;18(1):1–9.

70. Australian Commission for Safety and Quality in Health Care (ACSQHC). National Model Clinical Governance Framework [Internet]. Sydney; 2017 [cited 2022 Mar 28]. Available from: https://www.safetyandquality.gov.au

71. Australian Institute of Health and Welfare. Safety and quality of health care [Internet]. 2020 [cited 2022 Mar 31]. Available from: https://www.aihw.gov.au/reports/australias-health/safety-and-quality-of-health-care

72. Perla RJ, Provost LP, Parry GJ. Seven propositions of the science of improvement: exploring foundations. Qual Manag Health Care. 2013;22(3):170–86.

73. Pap R, Lockwood C, Stephenson M, Simpson P. Indicators to measure pre-hospital care quality: a scoping review protocol. JBI Database Syst Rev Implement Reports. 2017;15(6):1537–42.

74. Klassen A, Miller A, Anderson N, Shen J, Schiariti V, O'Donnell M. Performance measurement and improvement frameworks in health, education and social services systems: A systematic review. Int J Qual Heal Care. 2009;22(1):44–69.

75. Phung V-H, Booth A, Coster J, Turner J, Wilson R, Siriwardena N. Prehospital outcomes for ambulance service care: systemactic review. Emerg Med J. 2015;32(5):e10.

76. Turner J, Siriwardena AN, Coster J, Jacques R, Irving A, Crum A, et al. Developing new ways of measuring the quality and impact of ambulance service care: the PhOEBE mixed-methods research programme [Internet]. School of Health and Related Research, University of Sheffield, Sheffield, UK: NIHR Journals Library, Southampton (UK); 2019. (Programme Grants for Applied Research). Available from:

http://europepmc.org/abstract/MED/31034193

77. Fujita K, Moles RJ, Chen TF. Quality indicators for responsible use of medicines: A systematic review. BMJ Open. 2018;8(7).

78. Cheng EM, Sanders AE, Cohen AB, Bever CT. Quality measurement: It's here to stay. Neurol Clin Pract. 2014;4(5):441–6.

79. Boulkedid R, Abdoul H, Loustau M, Sibony O, Alberti C. Using and reporting the Delphi method for selecting healthcare quality indicators: A systematic review. PLoS One. 2011;6(6).

80. Campbell SM, Cantrill JA. Consensus methods in prescribing research. J Clin Pharm Ther. 2001;26:5–14.

81. Vaz N, Araujo C. Failure factors in healthcare quality improvement programmes: reviewing two decades of the scientific field. Int J Qual Serv Sci. 2022;

82. Donnelly LF. Avoiding failure: tools for successful and sustainable quality-improvement projects. Pediatr Radiol. 2017;47(7):793–7.

83. Davies H. Measuring and reporting the quality of health care: issues and evidence from the international research literature. 2005.

84. Freeman T. Using performance indicators to improve health care quality in the public sector: A review of the literature. Heal Serv Manag Res. 2002;15(2):126–37.

85. Mant J. Process versus outcome indicators in the assessment of quality of health care. Int J Qual Heal Care. 2001;13(6):475–80.

86. Byrne JP, Mann NC, Dai M, Mason SA, Karanicolas P, Rizoli S, et al. Association Between Emergency Medical Service Response Time and Motor Vehicle Crash Mortality in the United States. JAMA Surg. 2019;154(4):286–93.

87. Nasser AAH, Nederpelt C, El Hechi M, Mendoza A, Saillant N, Fagenholz P, et al. Every minute counts: The impact of pre-hospital response time and scene time on

mortality of penetrating trauma patients. Am J Surg. 2020;220(1):240–4.

88. Scholz KH, Maier SKG, Maier LS, Lengenfelder B, Jacobshagen C, Jung J, et al. Impact of treatment delay on mortality in ST-segment elevation myocardial infarction (STEMI) patients presenting with and without haemodynamic instability: Results from the German prospective, multicentre FITT-STEMI trial. Eur Heart J. 2018;39(13):1065–74.

89. Lambert L, Brown K, Segal E, Brophy J, Rodes-Cabau J, Bogaty P. Association between timeliness of reperfusion therapy and clinical outcomes in ST-elevation myocardial infarction. JAMA. 2010;303(21):2148–55.

90. Blanchard IE, Doig CJ, Hagel BE, Anton AR, Zygun DA, Kortbeek JB, et al. Emergency medical services response time and mortality in an urban setting. Prehospital Emerg Care. 2012;16(1):142–51.

91. Blackwell TH, Kline JA, Willis JJ, Hicks GM. Lack of association between prehospital response times and patient outcomes. Prehospital Emerg Care. 2009;13(4):444–50.

92. Price L. Treating the clock and not the patient: ambulance response times and risk. Qual Saf Health Care. 2006;15:127–30.

93. Ball SJ, Williams TA, Smith K, Cameron P, Fatovich D, O'Halloran KL, et al. Association between ambulance dispatch priority and patient condition. EMA - Emerg Med Australas. 2016;28(6):716–24.

94. Andrew E, Jones C, Stephenson M, Walker T, Bernard S, Cameron P, et al. Aligning ambulance dispatch priority to patient acuity: A methodology. EMA - Emerg Med Australas. 2019;31(3):405–10.

95. Doyle C, Lennox L, Bell D. A systematic review of evidence on the links between patient experience and clinical safety and effectiveness. BMJ Open. 2013;3(1).

96. Zakkar MA, Janes C, Meyer S. Barriers and reliability of patient experience evaluation in Ontario: perspectives of healthcare providers, managers, and policymakers. Int J Heal Gov. 2022;(in print).

97. Geissler KH, Friedberg MW, Steelfisher GK, Schneider EC. Motivators and barriers to using patient experience reports for performance improvement. Med Care Res Rev. 2013;70(6):621–35.

98. de Vos MLG, van der Veer SN, Graafmans WC, de Keizer NF, Jager KJ, Westert GP, et al. Implementing quality indicators in intensive care units: Exploring barriers to and facilitators of behaviour change. Implement Sci. 2010;5(1):1–8.

99. Addington D, Kyle T, Desai S, Wang JL. Facilitators and barriers to implementing quality measurement in primary mental health care: Systematic review. Can Fam Physician. 2010;56(12):1322–31.

100. Kötter T, Schaefer FA, Scherer M, Blozik E. Involving patients in quality indicator development - A systematic review. Patient Prefer Adherence. 2013;7:259–68.

Appendices

THE UNIVERSITY of ADELAIDE

RESEARCH SERVICES
OFFICE OF RESEARCH ETHICS, COMPLIANCE AND INTEGRITY
THE UNIVERSITY OF ADELAIDE

LEVEL 4, RUNDLE MALL PLAZA
50 RUNDLE MALL
ADELAIDE SA 5000 AUSTRALIA

TELEPHONE +61 8 8313 5137
FACSIMILE +61 8 8313 3700
EMAIL hrec@adelaide.edu.au

CRICOS Provider Number 00123M

25 August 2017

Associate Professor C Lockwood
Joanna Briggs Institute

Dear Associate Professor Lockwood

ETHICS APPROVAL No: **H-2017-157**

PROJECT TITLE: **The development and testing of Australian prehospital care quality indicators**

The ethics application for the above project has been reviewed by the Low Risk Human Research Ethics Review Group (Faculty of Health and Medical Sciences) and is deemed to meet the requirements of the *National Statement on Ethical Conduct in Human Research (2007)* involving no more than low risk for research participants. You are authorised to commence your research on **25 Aug 2017**.

Ethics approval is granted for three years and is subject to satisfactory annual reporting. The form titled *Annual Report on Project Status* is to be used when reporting annual progress and project completion and can be downloaded at http://www.adelaide.edu.au/research-services/oreci/human/reporting/. Prior to expiry, ethics approval may be extended for a further period.

Participants in the study are to be given a copy of the Information Sheet and the signed Consent Form to retain. It is also a condition of approval that you immediately report anything which might warrant review of ethical approval including:

- serious or unexpected adverse effects on participants,
- previously unforeseen events which might affect continued ethical acceptability of the project,
- proposed changes to the protocol; and
- the project is discontinued before the expected date of completion.

Please refer to the following ethics approval document for any additional conditions that may apply to this project.

Yours sincerely,

Amy Lehmann
Human Research Ethics Officer
Office of Research Ethics, Compliance and Integrity

THE UNIVERSITY of ADELAIDE

RESEARCH SERVICES
OFFICE OF RESEARCH ETHICS, COMPLIANCE AND INTEGRITY
THE UNIVERSITY OF ADELAIDE

LEVEL 4, RUNDLE MALL PLAZA
50 RUNDLE MALL
ADELAIDE SA 5000 AUSTRALIA

TELEPHONE +61 8 8313 5137
FACSIMILE +61 8 8313 3700
EMAIL hrec@adelaide.edu.au

CRICOS Provider Number 00123M

Applicant:	**Associate Professor C Lockwood**
School:	**Joanna Briggs Institute**
Project Title:	**The development and testing of Australian prehospital care quality indicators**

The University of Adelaide Human Research Ethics Committee
Low Risk Human Research Ethics Review Group (Faculty of Health and Medical Sciences)

ETHICS APPROVAL No: **H-2017-157** **App. No.: 0000022407**

APPROVED for the period: **25 Aug 2017 to 31 Aug 2020**

Thank you for your response dated 23.08.2017 to the matters raised.

It is a condition of approval that the research receives the approval(s) required by the State/Territory Ambulance Services involved in the project.

It is noted this study includes Robin Pap, PhD candidate.

Amy Lehmann
Human Research Ethics Officer
Office of Research Ethics, Compliance and Integrity

RESEARCH SERVICES
OFFICE OF RESEARCH ETHICS, COMPLIANCE AND INTEGRITY
THE UNIVERSITY OF ADELAIDE

LEVEL 4, RUNDLE MALL PLAZA
50 RUNDLE MALL
ADELAIDE SA 5000 AUSTRALIA

TELEPHONE +61 8 8313 5137
FACSIMILE +61 8 8313 3700
EMAIL hrec@adelaide.edu.au

CRICOS Provider Number 00123M

Our reference 0000022407

19 March 2020

Associate Professor Craig Lockwood
Joanna Briggs Institute

Dear Associate Professor Lockwood

ETHICS APPROVAL No: H-2017-157
PROJECT TITLE: The development and testing of Australian prehospital care quality indicators

Thank your for the amended ethics application provided by Robin Pap on the 19th of March 2020, requesting an amendment to the research methodology, recruitment, and time-extension. Your amendment request,as well a the request for a time-extension has been approved.

The ethics amendment for the above project has been reviewed by the Low Risk Human Research Ethics Review Group (Faculty of Health and Medical Sciences) and is deemed to meet the requirements of the *National Statement on Ethical Conduct in Human Research 2007 (Updated 2018)* involving no more than low risk for research participants.

You are authorised to commence your research on: 25/08/2017
The ethics expiry date for this project is: 31/08/2023

NAMED INVESTIGATORS:

Chief Investigator:	Associate Professor Craig Lockwood
Student - Postgraduate Doctorate by Research (PhD):	Mr Robin Pap
Associate Investigator:	Dr Matthew David Stephenson
Associate Investigator:	Dr Paul Simpson

CONDITIONS OF APPROVAL: It is a condition of approval that the research receives the approval(s) required by the State/Territory Ambulance Services involved in the project.

Ethics approval is granted for three years and is subject to satisfactory annual reporting. The form titled Annual Report on Project Status is to be used when reporting annual progress and project completion and can be downloaded at http://www.adelaide.edu.au/research-services/oreci/human/reporting/. Prior to expiry, ethics approval may be extended for a further period.

Participants in the study are to be given a copy of the information sheet and the signed consent form to retain. It is also a condition of approval that you immediately report anything which might warrant review of ethical approval including:

- serious or unexpected adverse effects on participants,
- previously unforeseen events which might affect continued ethical acceptability of the project,
- proposed changes to the protocol or project investigators; and
- the project is discontinued before the expected date of completion.

Yours sincerely,

Ms Samara Jane Mitchell
Secretary

The University of Adelaide

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	23
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	23
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	24-5
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	24-5
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	25
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	25
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	25-6
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	41-4
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	26
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	26
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	26
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	NA
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	26

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	26-30
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	27-31
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	NA
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	49-54
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	28-36
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	36-7
Limitations	20	Discuss the limitations of the scoping review process.	37
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	37
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	37

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.
* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.
† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).
‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.
§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	74 (identified as RR)
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	74
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	75
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	75-6
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	76
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	76
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	76 and Appendix S1
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	76
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	76
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	76
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	76
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	76
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Not specified in this RR
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Not described in this RR
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Not described in this RR
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Not described in this RR
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	76 No MA performed
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	NA

Section and Topic	Item #	Checklist item	Location where item is reported
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	NA
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	76
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	76
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	76-7
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	77
Study characteristics	17	Cite each included study and present its characteristics.	77
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	77
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	78-82
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	77-83
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	NA
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	NA
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	NA
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	NA
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	78-82
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	83
	23b	Discuss any limitations of the evidence included in the review.	83
	23c	Discuss any limitations of the review processes used.	83-4
	23d	Discuss implications of the results for practice, policy, and future research.	83-4
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Not registered
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Protocol not prepared
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	NA
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	84
Competing	26	Declare any competing interests of review authors.	84

Section and Topic	Item #	Checklist item	Location where item is reported
interests			
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	84

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

For more information, visit: http://www.prisma-statement.org/

Summarising the evidence for the AuStralian Prehospital care quality IndicatoR projEct (ASPIRE)

A review of best available evidence for perusal by the ASPIRE Expert Panel

Pap R[1,2], Lockwood C[1], Stephenson M[1], Simpson P[2]

1. Joanna Briggs Institute, University of Adelaide, Adelaide, Australia
2. School of Science and Health, Western Sydney University, Sydney, Australia

20 February 2019

Dear Expert Panel Member,

We would like to express our appreciation in advance for your participation in the AuStralian Prehospital care quality IndicatoR projEct (ASPIRE) expert panel consensus process. As you know, this study forms part of a larger research project aiming to develop and test prehospital care quality indicators for the Australian setting. Intelligent measurement of performance relies on the selection of meaningful quality indicators. Together with the available evidence, your expert evaluation is important to assess how clear and valid the proposed quality indicators are. This is only possible through your commitment of time and effort, which is especially notable given your normal responsibilities.

This document contains important information about the research project as a whole and information which you will need to participate effectively in this particular study. Please read the 'Introduction and Explanatory Notes' and 'The Consensus Process' first. These sections provide pertinent background and will guide you through the consensus process. As the document includes hyperlinks, we suggest reading it in electronic format.

If you have any questions or concerns, please don't hesitate to contact me via email (robin.pap@adelaide.edu.au) or phone (0475 915 573).

Thank you once again.

Sincerely,

Robin Pap

CONTENT

1. INTRODUCTION AND EXPLANATORY NOTES

1.1. Background and Project Information

The quality and safety of health care is on the agenda in any modern healthcare organisation, including ambulance services. Strategies to continuously improve the quality of service should primarily be based on information about the level of quality produced by the health care organisation.[1] Indicators for structure, process and outcome measurement allow the quality of care and services to be measured. This assessment can be done by systematically developing quality indicators that describe the performance that should occur, and then evaluating whether a service's operations and patient care are consistent with these indicators.[2]

Similar to many other countries, Australia has a limited number of measures in its national performance indicator framework for ambulance services,[3] which tracks the quality of care delivered to its residents across the various jurisdictions. There is increasing research activity within the field of paramedicine which means that its evidence base is growing. National registration of paramedics in Australia has recently commenced. Both, an expanding evidence-base and regulations which primarily ensure patient and community safety, ultimately aim to protect and continuously improve the quality of prehospital care. Therefore, there is a timely need to expand the nationally utilised indicators of prehospital care quality. The aim of the research project is to develop and test prehospital care quality indicators (QIs) for the Australian setting. This is being accomplished in three phases (Figure 1):

Phase 1: This phase has been completed. A scoping review was conducted to map the attributes of 'quality' in the context of prehospital care and to chart existing international prehospital care QIs. If you are interested in reading the scoping review, you can find it here or in Appendix A. However, expert panel members are not required to read the scoping review in order to participate.

Phase 2: The expert panel consensus process which you are participating in forms part of phase 2. The QIs charted in phase 1 were aggregated and examined for applicability to the Australian context. Rapid reviews were conducted to compile evidence summaries which provide information about best available evidence for each QI. During this review process, QIs were also developed *de novo*. Newly developed QIs were considered important to capture recent advances in the evidence base. The proposed QIs are now being assessed for clarity and validity in this study. Clear and valid QIs are candidates for the third and final phase.

Phase 3: This phase will see the candidate QIs being tested for acceptability, technical feasibility and reliability. This will be done using mixed methods.

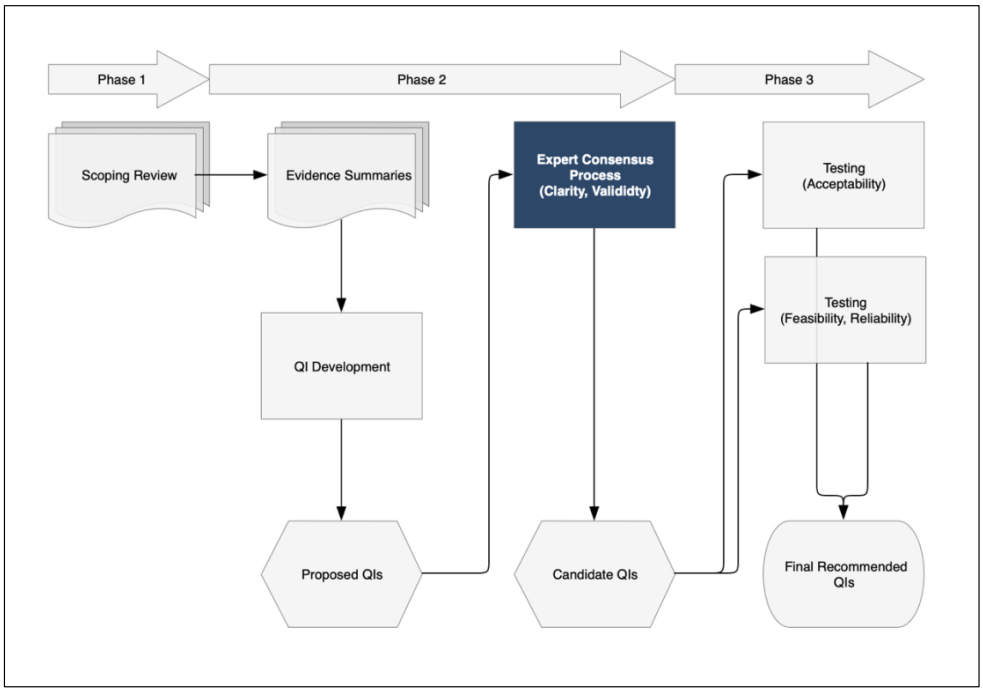


Figure 1 Phases of the project. The expert consensus process forms part of phase 2.

This research project is being conducted by Mr Robin Pap (Student ID a1701299) and will form the basis for the degree of Doctor of Philosophy (Ph.D.) at the University of Adelaide under the supervision of Assoc Prof Craig Lockwood, Dr Matthew Stephenson and Dr Paul Simpson. The project has been approved by the University of Adelaide Human Research Ethics Committee (Approval Number H-2017-157 – Appendix B). It is supported through an Australian Government Research Training Program Scholarship and in part by a research grant from the Australian and New Zealand College of Paramedicine (ANZCP).

If you have questions or problems associated with the practical aspects of your participation in the project or wish to raise a concern or complaint about the project, then you should consult the principle investigator. If you wish to speak with an independent person regarding a concern or complaint, the University's policy on research involving human participants, or your rights as a participant, please contact the Human Research Ethics Committee's Secretariat (telephone 08 8313 6028; email hrec@adelaide.edu.au; mail Level 4, Rundle Mall Plaza, 50 Rundle Mall, Adelaide SA 5000).

Any complaint or concern will be treated in confidence and fully investigated. You will be informed of the outcome.

1.2. About the Quality Indicators and their Development

There are a number of terms related to the measurement of quality and considerable confusion between them exists. Understanding what an indicator is and how it differs to other related terms is essential for this study. An indicator is an explicitly defined and measurable aspect of health care services.[4] Indicators may stem from guidelines and can be operationalised in the form of a measures, review criteria and standards, but these are not the same.[5] Table 1 distinguishes an indicator from a guideline, measure, review criterion and a standard.

Table 1 Definitions and examples of a guideline, indicator, measure, review criterion, and a standard (target and achieved):

Term	Definition	Example
Guideline	A statement that includes recommendations intended to optimise patient care that is informed by a systematic review of evidence and an assessment of the benefits and harms of alternative care options.[6]	If a patient presents with signs and symptoms suggestive of acute coronary syndrome, 300mg aspirin should be administered orally, unless contraindicated.
Indicator	**An explicitly defined and measurable aspect of health care services.[4] A quality indicator is a measurable element of health care services for which there is evidence or consensus that it can be used to assess the quality, and hence change in quality.[7]**	**A patient who presents with signs and/or symptoms of acute coronary syndrome is administered 300mg aspirin orally, unless contraindicated.**
Measure	An expression of an indicator as a proportion, rate, ratio or mean value for a sample population. Measures are different to indicators. Indicators are by their very nature indicative of performance or quality, but are not direct measures of it.[8]	The proportion of patient who present with signs and symptoms suggestive of acute coronary syndrome who are administered 300mg aspirin orally, unless contraindicated.
Review Criterion	Systematically developed statement or question relating to a single act of medical care that is so clearly defined that it is possible to determine retrospectively whether the element of care occurred or not.	If a patient presented with signs and symptoms suggestive of acute coronary syndrome, was 300mg aspirin administered orally, unless contraindicated?
Standard	The level of compliance with a criterion or indicators.[1,7] A target standard is set prospectively and stipulates the level that an organisation must strive to meet.[4] An achieved is measured retrospectively and shows an organisation's achievement.[4]	Target standard: 95% of patients with signs and symptoms suggestive of acute coronary syndrome should be administered 300mg aspirin orally, unless contraindicated. Achieved standard: 90% of patients with signs and symptoms suggestive of acute coronary syndrome were administered 300mg aspirin orally, unless contraindicated.

Indicators may be characterised in many ways. The following paragraphs differentiate a QI from an *activity* indicator, a *performance* indicator and a *sentinel* indicator, and provide details about how the proposed QIs in this document have been categorised.

- *Activity, Performance, Quality and Sentinel Indicators*

  Activity indicators facilitate the measurement of frequency with which an event occurs. For example, the number of patients with a hypoglycaemic episode attended to by an ambulance service within a one-month period. Performance indicators add a value component and can be used to monitor the degree to which an endeavour is optimised, however, they do not necessarily make inference about quality. For example, the average total ambulance service cost per hypoglycaemia incident is less than $550. There is a subtle yet distinct difference between a performance indicator and a QI in that a QI can be used to make a judgement about quality, i.e. there is evidence and/or consensus that the indicator can be operationalised to assess the quality of health care services. For example, a patient who has had a hypoglycaemic episode effectively corrected is prehospitally discharged, unless risk criteria apply. All indicators in this document are proposed QIs. A sentinel indicator, also referred to as a trigger, identifies real or potential adverse events requiring investigation or phenomena that are intrinsically undesirable.[2] For example, a patient is administered fentanyl and naloxone during the same encounter.

- *Domains and Sub-Domains*

  For the purpose of this study, the proposed QIs are divided into two domains, namely *Domain A: Organisational/System* and *Domain B: Clinical*. Each domain has several sub-domains, e.g. *Sub-Domain A.2. Patient Safety* and *B.9. Pain Management*. QIs within Domain A describe operational and other non-clinical features of ambulance services whereas QIs within Domain B facilitate the measurement of patient care aspects.

- *Structure, Process and Outcome*

  Indictors can be related to the structures, processes or outcomes of health care. Table 2 describes these three types and shows the icons that are used in the evidence summaries to indicate the type of each QI. The majority of proposed QIs are process indicators. This is because the relatively short patient-contact time in prehospital care and the complexities of relating hospital-based outcome measures to preceding prehospital care.

- *Dimensions of Quality*

  QIs can also be related to specific attributes of quality. The scoping review in phase 1 of the project mapped attributes of 'quality' in the context of prehospital care. It has been argued that these attributes can be aggregated into two principle dimensions of quality of care for individual patients: access and effectiveness.[9,10] Whilst safety may be considered to reside within effectiveness,[11] it is of such critical importance to both the patient and the health care provider that it is identified as a separate dimension of

quality in this project. Health care for populations introduces the additional attributes of equity and efficiency.[9,10] These may be encapsulated within access and effectiveness. Table 3 shows how these dimensions of quality can be related to health care structures, processes and outcomes to produce a taxonomy of quality of care for individual patients.

Table 2 Types of indicators

Dimension	Icon	Description
Structure		Structure indicators describe the characteristics of the setting in which care is provided.[2,12] This comprises material resources (e.g. medical equipment), human resources (e.g. the qualifications of staff) and organisational attributes (e.g. the presence of policies and guidelines).
Process		Process indicators detail what is being done in providing service and patient care, i.e. the organisation's or individual health care provider's activities in assessing the patient, giving specific treatment and other appropriate practice in managing the patient.[2,12]
Outcome		Outcome indicators describe the effects of care on health status of individuals or populations, such as return of spontaneous circulation (ROSC) or patient satisfaction.[2,12]

Table 3 Dimensions of quality (adapted from Campbell, et al.[9] and Owen[10])

Dimension	Icon	Structure	Process	Outcome
Access		Availability Accessibility Equity (populations)	Availability Accessibility (first contact and referral access) Timeliness Equity (populations)	Heath status User evaluation
Safety		Patient safety Provider safety	Patient safety Provider safety	Heath status Absence of harm User evaluation Provider evaluation
Effectiveness			Appropriateness Clinical effectiveness Interpersonal effectiveness Equity (populations) Efficiency (populations)	Heath status User evaluation

Quality indicators can be developed using non-systematic and systematic methods.[4] Non-systematic methods are relatively quick and useful; however, they do not incorporate evidence during the QI development. Systematically developed QIs are ideally based purely on high-level scientific evidence or they are derived from evidence-informed guidelines. In

areas or disciplines with limited scientific evidence, such as paramedicine, it may be necessary to combining the available evidence with expert consensus.[13]

There are several consensus processes that have been used for the development of QIs. The RAND/UCLA Appropriateness Method (RAM) is a formal panel judgement process which systematically and quantitatively combines available scientific evidence with expert opinion by asking panel members to rate, discuss and then re-rate the items of interest.[14] The original RAM was developed in the mid-1980s by the RAND Corporation in collaboration with the University of California Los Angeles (UCLA) as an instrument to facilitate the measurement of medical and surgical intervention appropriateness.[15] RAM has been used extensively as a method of QI development,[4,5,16,17] including QIs to evaluate prehospital care.[10] The expert panel consensus process you are participating in is a modified RAM. This is explained further in 'Section 2: The Consensus Process'.

1.3. About the Evidence Summaries

Fundamental to the systematic development of quality indicators is the systematic review of the underpinning evidence. Due to the rigorous methods applied when conducing a full systematic review, they can take an extensive amount of time to complete.[18] Clearly, it was not feasible to conduct systematic reviews for the 18 sub-domains within the time and resources available for this project. Instead, to assist you in rating the validity of the QIs, evidence summaries have been compiled for those QIs where published research evidence has been identified. The development of these summaries was guided by the Joanna Briggs Institute (JBI) approach for rapid reviews and evidence summaries.[19] They are succinct synopses of existing international evidence to which you are asked to relate your own experience and expertise when rating the QIs. In line with JBI's approach to evidence summaries,[19,20] the best available evidence was incorporated in each summary. This means that lower-level evidence was included only when no systematic reviews were located. Appendix C provides an outline of the methods used.

The evidence summaries were intentionally written to only summarise findings, not to provide conclusions or recommendations. For a number of the proposed QIs, high-level evidence has been identified. Your rating of the validity is likely to be correspondingly high. However, keep in mind that the evidence stems from the international literature and your expert consideration of validity in the Australian context is required. For other proposed QIs, no significant evidence was identified. For these QIs, you are asked to base your ratings solely on your experience and expertise. However, when the evidence supporting particular QIs is non-existent, you should not automatically rate its validity low. The lack of evidence may be due to

no research having been conducted, or technical or ethical difficulties with conducting research in the particular area. It is especially here that your expertise will be relied upon to rate the QIs.

Along with those QIs for which an evidence summary has been compiled, a level of evidence (LOE) has been assigned to each piece of supporting evidence. Many organisations have developed their own unique ranking or grading systems and there are now a number of different hierarchies to rank research evidence.[21] The evidence in this document has been categorized using the JBI approach.[20] Tables 4, 5 and 6 provide details of the JBI levels of evidence for effectiveness (therapy/interventions), diagnosis and meaningfulness (qualitative research) respectively. Importantly though, the LOE does not preclude the need for careful consideration of the summarised evidence and informed reasoning when making an expert judgement about validity.

Table 4 JBI Levels of Evidence - Effectiveness[20]

Level	Abbreviation	Study Designs
Level 1	(LOE1)	Experimental Designs including: a. Systematic review of Randomized Controlled Trials (RCTs) b. Systematic review of RCTs and other study designs c. RCTs d. Pseudo-RCTs
Level 2	(LOE2)	Quasi-Experimental Designs including: a. Systematic review of quasi-experimental studies b. Systematic review of quasi-experimental and other lower study designs c. Quasi-experimental prospectively controlled study d. Pre-test post-test or historic/retrospective control group study
Level 3	(LOE3)	Observational – Analytic Designs including: a. Systematic review of comparable cohort studies b. Systematic review of comparable cohort and other lower study designs c. Cohort study with control group d. Case-controlled study e. Observational study without a control group
Level 4	(LOE4)	Observational – Descriptive Designs including: a. Systematic review of descriptive studies b. Cross-sectional study c. Case series d. Case study
Level 5	(LOE5)	Expert Opinion and Bench Research including: a. Systematic review of expert opinion b. Expert consensus c. Bench research/single expert opinion

Table 5 JBI Levels of Evidence - Diagnosis[20]

Level	Abbreviation	Study Designs
Level 1	(LOE1)	Studies of test accuracy among consecutive patients: a. Systematic review of studies of test accuracy among consecutive patients b. Study of test accuracy among consecutive patients
Level 2	(LOE2)	Studies of Test Accuracy among non-consecutive patients: a. Systematic review of studies of test accuracy among non-consecutive patients b. Study of test accuracy among non-consecutive patients
Level 3	(LOE3)	Diagnostic Case control studies: a. Systematic review of diagnostic case control studies b. Diagnostic case-control study
Level 4	(LOE4)	Diagnostic yield studies: a. Systematic review of diagnostic yield studies b. Individual diagnostic yield study
Level 5	(LOE5)	Expert Opinion and Bench Research: a. Systematic review of expert opinion b. Expert consensus c. Bench research/ single expert opinion

Table 6 JBI Levels of Evidence - Meaningfulness[20]

Level	Abbreviation	Study Designs
Level 1	(LOE1)	Qualitative or mixed-methods systematic review
Level 2	(LOE2)	Qualitative or mixed-methods synthesis
Level 3	(LOE3)	Single qualitative study
Level 4	(LOE4)	Systematic review of expert opinion
Level 5	(LOE5)	Expert opinion

Some of the proposed QIs refer to time intervals. Instead of being set to a specific time interval, these will refer to several options. During the rating process, you will be asked to select the time interval (X) which will result in your highest possible validity rating for that QI. An example of a proposed QI with a time interval is provided in Box 1.

Some of the proposed QIs, especially within the clinical domain, are supported by systematically developed and prehospitally applicable Australian guidelines, e.g. guidelines by the Australian and New Zealand Council On Resuscitation (ANZCOR). Whilst guideline-derived QI development may be considered a systematic method, this study aimed at developing and testing QIs based on research evidence and expert consensus. Therefore, guidelines were excluded from the evidence summaries. However, for QIs which are supported by systematically developed and nationally applicable Australian guidelines

(identifiable by a 'Guidelines' icon), a reference is provided. Similarly, if the proposed QI is supported by a clinical care standard (CCS) developed by the Australian Commission for Safety and Quality in Health Care (identifiable by a 'ACSQHC-CCS' icon),[22] the reference is provided. An example of a proposed QI supported by Australian guidelines and an ACSQHC CCS is provided in Box 2.

QI-A.2.6: **For a patient who was treated and discharge on-scene, there is no need for hospital admission within a X-hour period (X = 12, 24, 48, or 72).**

Safety | Effectiveness

Box 1 Example of a proposed QI with a time interval

QI-B.3.2. **A patient with acute chest pain or other signs and/or symptoms suggestive of ACS has a 12-lead electrocardiograph (ECG) acquired, interpreted and transmitted to the receiving facility within 10 minutes of arrival on scene.**

Effectiveness | ⇨ Guidelines[A,B] | ⇨ ACSQHC-CCS*

Box 2 Example of a proposed QI supported by Australian guidelines and an ACQSHC Clinical Care Standard (CCS)

1.4. About Clarity and Validity

As far as possible, QIs should adhere to some fundamental a priori characteristics.[4] In this study, the clarity and validity of the proposed QIs will be assessed. The studies planned for the third and final phase of the project will evaluate the acceptability, feasibility and reliability of the candidate QIs.

A good quality indicator has clear meaning which enables what is being assessed to be precisely attributable to that indicator.[5,17] In other words, a clear QI is one which is free of ambiguity, inaccuracy or imprecision.

Validity is arguably the most important property of a quality indicator. In science, validity refers to the degree to which evidence and theory support the interpretation of the scores entailed by proposed uses of the instrument.[23] Thus, in the quality measurement context, validity refers to the degree to which evidence and theory support the expected interpretation of measured elements of practice performance related to the proposed quality indicators. In more simple terms, validity refers to the extent to which the given statement represents high-quality care and would therefore be an indorsed indicator of quality.

When assessing the validity of QIs, careful consideration of the intended context is important.[24–26] Whilst there are considerable benefits in using work from other locations, QIs cannot simply be transferred directly between different settings without an intermediate process to allow for variation in professional culture and clinical practice.[27] Rating the validity of the proposed QIs, therefore, entails as much assessment of how much they represent high-quality care as it does of how contextually applicable they are. Rating the proposed QIs is explained further in the following section.

References

1. Donabedian A. An introduction to quality assurance in healthcare. Oxford: Oxford University Press; 2003.
2. Mainz J. Defining and classifying clinical indicators for quality improvement. Int J Qual Heal Care. 2003;15(156):523–30.
3. Australian Government Productivity Commission - Steering Committee for the Review of Government Service Provision. Report on Government Services - Chapter 11 (Ambulance Services) [Internet]. Canberra; 2019. Available from: https://www.pc.gov.au/research/ongoing/report-on-government-services/2019/health/ambulance-services
4. Campbell SM, Braspenning J, Hutchingson A, Marshall MN. Research Methods Used in Developing and Applying Quality Indicators in Primary Care. Qual Saf Heal Care. 2002;11:358–64.
5. Campbell SM, Braspenning J, Hutchinson A, Marshall M. Research methods used in developing and applying quality indicators in primary care. Br Med J. 2003;326:816–9.
6. Committee on Standards for Develping Trustorthy Clinical Practice Guidelines. Clinical Practice Guidelines We Can Trust. Graham R, Mancher M, Miller Wolman D, Greenfield S, Steinberg E, editors. Washington (DC): The National Academies Press; 2011.
7. Lawrence M, Olesen F. Indicators of Quality in Health Care. Eur J Gen Pract. 1997;3(9):103–8.
8. Coster JE, Irving AD, Turner JK, Phung V-H, Siriwardena AN. Prioritizing novel and existing ambulance performance measures through expert and lay consensus: A three-stage multimethod consensus study. Vol. 21, Health Expectations. 2017.
9. Campbell S., Roland M., Buetow S. Defining quality of care. Soc Sci Med. 2000;51:1611–25.
10. Owen RC. The development and testing of indicators of prehospital care quality. University of Manchester; 2010.
11. Erickson S, Wolcott J, Corrigan J, Aspden P, editors. Patient Safety: Achieving a New Standard for Care. National Academies Press; 2004.
12. Donabedian A. The Quality of Care: How Can It Be Assessed? J Am Med A. 1988;260(12):1743–8.
13. Mainz J. Developing evidence-based clinical indicators: a state of the art methods primer. Int J Qual Heal Care. 2003;15(Supp 1):i5–11.
14. Nair R, Aggarwal R, Khanna D. Methods of Formal Consensus in Classification/Diagnostic Criteria and Guideline Development. Semin Arthritis Rheum. 2011;41(2):95–105.
15. Fitch K, Bernstein SJJ, Aguilar MDD, Burnand B, LaCalle JRR, Lazaro P, et al. The RAND / UCLA Appropriateness Method User ' s Manual [Internet]. Transformation. 2001. 109 p. Available from: http://www.rand.org
16. Campbell SM, Cantrill JA. Consensus methods in prescribing research. J Clin Pharm Ther. 2001;26:5–14.
17. Campbell S, Kontopantelis E, Hannon K, Burke M, Barber A, Lester H. Framework and indicator testing protocol for developing and piloting quality indicators for the UK quality and outcomes framework. BMC Fam Pract. 2011;12(1):85.
18. Borah R, Brown AW, Capers PL, Kaiser KA. Analysis of the time and workers needed to conduct systematic reviews of medical interventions using data from the PROSPERO registry. BMJ Open. 2017;7(2):e012545.
19. Munn Z, Lockwood C, Moola S. The Development and Use of Evidence Summaries for Point of Care Information Systems: A Streamlined Rapid Review Approach. Worldviews Evidence-Based Nurs. 2015;12(3):131–8.
20. Joanna Briggs Institute. The JBI Approach [Internet]. 2017 [cited 2018 May 1]. Available from: http://joannabriggs.org/jbi-approach.html
21. The Joanna Briggs Institute Levels of Evidence and Grades of Recommendation Working Party. Supporting Document for the Joanna Briggs Institute Levels of Evidence and Grades of Recommendation [Internet]. The Joanna Briggs Institute. 2014. Available from: http://joannabriggs.org/assets/docs/approach/Levels-of-Evidence-SupportingDocuments-v2.pdf
22. Australian Commission on Safety and Quality in Health Care (ACSQHC). Clinical Care Standards [Internet].

2019 [cited 2019 Jan 19]. Available from: https://www.safetyandquality.gov.au/our-work/clinical-care-standards/

23. Krabbe PFM. The Measurement of Health and Health Status: Concepts, Methods and Applications from a Multidisciplinary Perspective. San Diego: Elsevier Science & Technology; 2016.
24. Delnoij DMJ, Westert GP. Assessing the validity of quality indicators: Keep the context in mind! Eur J Public Health. 2012;22(4):452–3.
25. Lawrence M, Olesen F. Indicators of Quality in Health Care. Eur J Gen Pract. 2009;3(3):103–8.
26. Frongillo EA, Baranowski T, Subar AF, Tooze JA, Kirkpatrick SI. Establishing Validity and Cross-Context Equivalence of Measures and Indicators. J Acad Nutr Diet. 2018;1–14.
27. Marshall MN, Shekelle PG, McGlynn E a, Campbell S, Brook RH, Roland MO. Can health care quality indicators be transferred between countries? Qual Saf Health Care. 2003;12(1):8–12.

2. THE CONSENSUS PROCESS

This section explains how you will be able to access and participate in the consensus process which consists of 4 steps (Figure 2). In Table 7 the dateline for this process is shown. **If you have any concerns about your availability to participate during these time periods, please contact the principle investigator as soon as possible.**

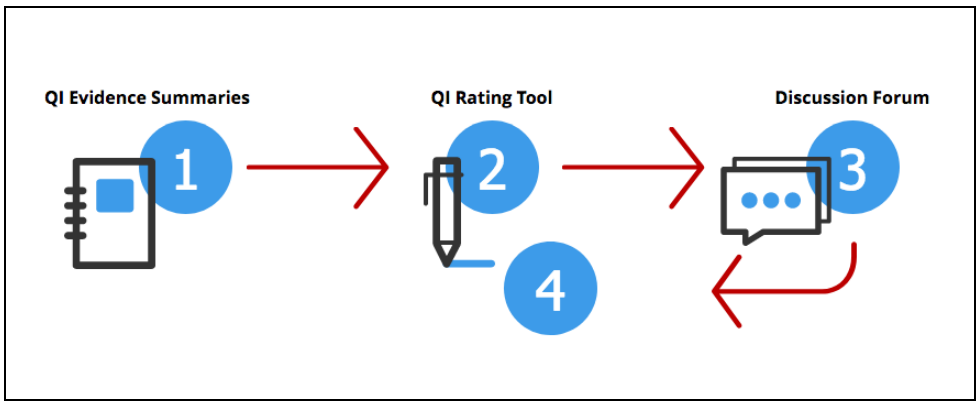


Figure 2 The Consensus Process consists of four steps: 1. Reading the evidence summaries; 2. Using the QI rating tool for the first round of rating; 3. Participating in the online discussion forum; And 4. Using the QI rating tool again for the second and final round of rating.

Table 7 Dateline for the consensus process

Date *	Activity
Friday, 22 February 2019	Panellists receive the evidence summaries. ❶
Monday, 04 March 2019	The first round of rating opens. ❷
Sunday, 17 March 2019	The first round of rating closes.
Monday, 25 March 2019	Panellists receive feedback from the first round.
Friday, 29 March 2019	The discussion forum opens. ❸
Sunday, 14 April 2019	The discussion forum closes.
Monday, 15 April 2019	The second round of rating opens. ❹
Sunday, 21 April 2019	The second round of rating closes.

(* Please note that these dates may be subject to change.)

The consensus process utilises a modified RAM. It has been modified most notably for the purpose of this study by replacing the face-to-face expert panel meeting with an online discussion forum. This modification was necessary considering the geographical locations of the expert panel members across Australia. Conducting online expert panels to facilitate

consensus finding among geographically distributed stakeholders has been found feasible in similar studies.[1]

The consensus process will take place on two web-based platforms. The rating processes will be done using a Qualtrics surveys and the online discussion will take place on Kialo. Both platforms are very user-friendly on desktop computers, laptops, tablets or mobile phones. If you experience any issues with the platforms, please don't hesitate to contact the principle investigator.

2.1. Reading the Evidence Summaries

Each evidence summary is divided into five or six sections, depending on whether or not supporting guidelines were identified during the review process. Table 7 provides descriptions of the sections. **We recommend that you work through the evidence summaries and the rating process concurrently, sub-domain by sub-domain.** Read the 'Prevalence and/or Significance' section of a particular sub-domain and then consider the summarised evidence as you rate the clarity and validity of each QI using the rating tool. In this way, your expert evaluation of the QIs clarity and validity is best informed by the available evidence.

Table 7: Descriptions of sections in each evidence summary

Section	Description
Prevalence and/or Significance	This section places the sub-domain topic in context by providing (where applicable) pertinent Australian statistics and outlining implications for practice.
Quality Indicators and Evidence	This section lists the proposed QIs. Each proposed QI is identified as a structure, process or outcome indicator and is categorised in one or more dimensions of quality (access, safety and effectiveness). This is followed by synopses of the identified evidence and their levels as detailed in Section '1.3. About the Evidence Summaries'.
Characteristics of the Evidence	In this section a brief description of the identified studies is provided.
(Supporting Guidelines)	If supporting Australian guidelines were identified during the review process, references are provided in this section.
Definitions	This initial section provides definitions of terms used in the sub-domain and its proposed QIs to ensure standardised interpretation.
References	The list of references in Vancouver style.

2.2. The First Round of Rating

A link to the online rating tool will be sent to you via email. The rating tool will be accessible for panellists to do the initial rating for two weeks as detailed in Table 7. As mentioned above, we suggest reading the evidence summaries as you work through the rating process. For your convenience, links to the respective evidence summaries are also provided in the online rating tool and the online discussion forum. You can save and come back to your rating tool as often as you like. Your responses will only be submitted once you have completed the rating and click 'submit'. The following are some important points you should remember when you rate the proposed QIs:

- **Please rate the clarity and validity of each QI using the scales. Please consider the full range of the scales from 1 to 9. Do not simply rate 1 or 9.**
- **The clarity scale asks you to rate the proposed QI in terms of the degree to which it is clear, precise and unambiguous.**
    - **A low rating means that the meaning of the proposed QI is unclear and totally ambiguous.**
    - **A high rating means that the meaning of the proposed QI is clear and totally unambiguous.**
- **The validity scale requires you to rate the proposed QI in terms of the extent to which the statement represents high-quality prehospital care in a national Australian context.**
    - **A low rating means that the proposed QI does not represent high-quality prehospital care in a national Australian context.**
    - **A mid-range rating means that you are uncertain whether the proposed QI represents high-quality prehospital care in a national Australian context, or it is equivocal.**
    - **A high rating means that the proposed QI does represents high-quality prehospital care in a national Australian context. This means that the QI is a good Australian prehospital care QI.**
- **Please consider each proposed QI independently and rate it on its own merit. Do not rate the proposed QI in relation to other ones in the sub-domain or domain, or in relation to exiting QIs or performance indicators.**
- **Please rate the validity of the proposed QI for the 'average' patient and not every possible clinical presentation or degree of complexity.**
- **Please do not consider feasibility of data collection or acceptability to ambulance service staff when rating the clarity and validity of the proposed QIs. This will be assessed in phase 3 of the project.**
- **If you think a proposed QI should be changed, please rate it first and then suggest how it could be improved in the 'comments' section.**

Towards the end of the rating tool, you will have an opportunity to suggest additional QIs. This is optional but important, especially if you feel that the proposed QIs did not sufficiently address vital aspects of prehospital care essential for quality measurement in the Australian context. Each panel member may submit up to five (5) additional QIs. These do not have to align to the proposed sub-domains. If you are aware of supporting evidence, please provide the citation in the space provided.

After the first round of rating is complete and data has been analysed you will receive individual confidential feedback showing the distribution of all experts' first round rating. Box 3 shows an example of feedback that will be provided for each proposed QI. More specifically, the feedback provides details about how all panellists rated each specific proposed QI, the median, the mean absolute deviation (MAD) from the median, and your rating. This feedback is intended to provide you with insight into areas of agreement and more importantly disagreement ahead of the discussion forum.[2]

QI-A.4.2. **A patient is identified to be in OHCA by the ambulance service call taker before the first resource arrives on scene.**

➲ Effectiveness

	1	2	3	4	5	6	7	8	9	Median	MAD
Panel ratings						1	2	4	2	8.0	0.7
Your rating							✓				

Box 3 Example of feedback provided to each panellist and for each QI

2.3. Accessing and Participating the Online Discussions

The online discussions will take place as private discussions on Kialo, an intuitive, web-based discussion platform. Being private means that only ASPIRE expert panel members can access and contribute to the discussions. Each sub-domain will have its own discussion and participants will be able to comment on individual proposed QIs (Figure 3). If you are not yet familiar with Kialo, you can take a brief tour here (https://www.kialo.com/tour).

To ensure anonymous discussions, all panellists will be assigned an individual ASPIRE Kialo username. **You will receive an email with your individual ASPIRE Kialo username.** Box 4 details the steps you need to follow to sign up to Kialo. If you require assistance in setting up

your ASPIRE Kialo account, please do not hesitate to contact the principle investigator. If you already have a Kialo account, we ask that you kindly create a separate account using your assigned ASPIRE username. This will ensure all participants remain anonymous.

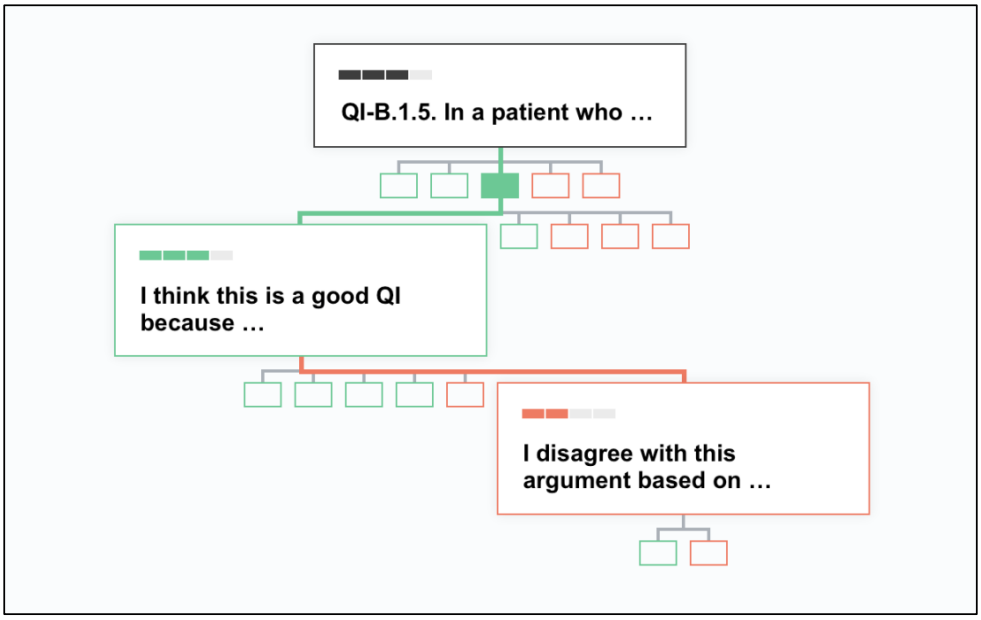


Figure 3 Kialo enables you to visualize discussions as an interactive tree of pro and con arguments. At the top is the QI (referred to 'thesis' in Kialo), which is supported or weakened by pro and con arguments underneath. Each one of these arguments can branch into subsequent arguments that support or attack them in turn. (Adapted from the Kialo website.[3])

1. Go to **https://www.kialo.com/**.
2. Click on **Sign up** in the top right-hand corner of the screen.
3. Enter your assigned username, e.g. **ASPIREX-02**
4. Enter your preferred email address.
5. Choose and enter a password.
6. Accept the terms of service and privacy policy by ticking the two boxes. *
7. Click on **Sign up**

*If you have any concerns about the terms of service or privacy policy, please contact the principle investigator.

Box 4 How to sign up to Kialo using your assigned username

2.4. The Second Round of Rating

A <u>new</u> link to the online rating tool will be sent to you via email. The second round of rating provides panellists an opportunity to change their original ratings should they feel this is necessary after having received the feedback from the first round and the online discussions with the other expert panel members. Individual panel ratings will remain confidential.

The data received from this second round will be analysed to obtain levels of agreement for each of the proposed QIs. Those QIs with levels of agreement at or above a pre-defined value will proceed as candidate QIs to phase 3 of the project.

References

1. Khodyakov D, Hempel S, Rubenstein L, Shekelle P, Foy R, Salem-schatz S, et al. Conducting Online Expert panels : a feasibility and experimental replicability study. BMC Med Res Methodol. 2011;11(1):174–82.
2. Fitch K, Bernstein SJJ, Aguilar MDD, Burnand B, LaCalle JRR, Lazaro P, et al. The RAND / UCLA Appropriateness Method User ' s Manual [Internet]. Transformation. 2001. 109 p. Available from: http://www.rand.org
3. Kialo. Kialo Tour [Internet]. 2019 [cited 2019 Jan 19]. Available from: https://www.kialo.com/tour

3. EVIDENCE SUMMARIES

DOMAIN A: ORGANISATIONAL/SYSTEM

Sub-Domain 1: General Time Intervals

NB: This evidence summary excludes QIs and evidence regarding time intervals for specific clinical conditions. These are covered in relevant clinical sub-domains.

Prevalence and/or Significance

Timeliness is an important attribute of quality. Timely access to healthcare contributes to desirable health status outcomes in time-critical patients and is valued highly by patients with real or perceived emergencies. Furthermore, similar response times across geographic areas indicates equity of access to ambulance services.[1]

In 2017-18, there were 3.7 million incidents (148.6 incidents per 1,000 people) reported to ambulance service organisations in Australia.[1] A single incident may demand more than one ambulance response. Thus, the 3.7 million incidents resulted in 4.6 million responses (183.9 responses per 1,000 people).[1] There were 1,168 response locations (2,227 first responder locations with an ambulance), 5,578 ambulance general transport and patient transport vehicles and 91 air ambulance aircraft available.[1] The number of patients assessed, treated or transported by ambulance service organisations was 3.5 million (141.5 patients per 1,000 people). Of the 3.7 million incidents, 37.3% were priorities as 'emergency', 35.8% as 'urgent' and 26.9% as 'non-emergency'.[1]

Demand for ambulance services has increased over the past five years and is expected to continue increasing on the back of a growing and ageing population.[2] Of special concern is the rising number of older Australians living alone which is expected to drive industry demand, especially for emergency responses.[2]

Response times for emergency incidents are calculated for the 50th and 90th percentile. Urban centre and state-wide response times are affected by differences across jurisdictions in the geography, personnel mix, and system type for capturing data. These differences are considered in the following QIs by referring to a range (e.g. 8 to 15 minutes) rather than one specific value for time intervals. In 2017-18, the time within which 90 per cent of first responding ambulance resources arrived at the scene of an emergency incident in capital cities ranged from 14.1 minutes (WA) to 23.8 minutes (NSW).[1] State-wide this time interval ranged from 14.7 minutes (ACT) to 29.4 minutes (Tasmania).[1] Further details can be found in Chapter 11 of the Report on Government Services (RoGS).

Quality Indicators and Evidence

QI-A.1.1-6. Response Time QIs

QI-A.1.1. **In an urban setting, an ambulance arrives on scene of an emergency incident within X minutes of the service receiving the call. (X = 4, 8, 10 or 15)**

QI-A.1.2. **In an urban setting, an ambulance arrives on scene of an urgent incident within X minutes of the service receiving the call. (X = 10, 15 or 20)**

QI-A.1.3. **In an urban setting, an ambulance arrives on scene of a non-emergency incident within X minutes of the service receiving the call. (X = 15, 20 or 30)**

QI-A.1.4. **In a rural setting, an ambulance arrives on scene of an emergency incident within X minutes of the service receiving the call. (X = 4, 8, 10, 15, 20 or 30)**

QI-A.1.5. **In a rural setting, an ambulance arrives on scene of an urgent incident within X minutes of the service receiving the call. (X = 15, 20, 30 or 45)**

QI-A.1.6. **In a rural setting, an ambulance arrives on scene of a non-emergency incident within X minutes of the service receiving the call. (X = 30, 45 or 60)**

Access

- A retrospective cohort study in a Canadian emergency medical service (EMS) setting analysed whether a response time of less than 8 minutes was associated with decreased mortality. There was no statistically significant difference in mortality between patient with a response time of ≥8 minutes (7.1%) compared to those with a response of <8 minutes (6.4%). The adjusted odds ratio (OD) of mortality for ≥8 minutes was 1.19 (95% CI 0.97 to 1.47). However, sub-analysis of patients who survived to become inpatients showed a beneficial effect of a response time of <8 minutes (adjusted OD 1.30; 95% CI 1.00 to 1.69).[3] (LOE3)

- A retrospective cohort study in a United States EMS setting examined the effects of response time on survival to hospital discharge. There was no survival benefit in patients with a response time of <8 minutes (OR 1.06; 95% CI 0.80 to 1.42) nor when response time was modelled as a continuous variable (OR 1.01; 95% CI 0.98 to 1.04). However, there was survival benefit when response time was ≤4 minutes (OR 0.70; 95% CI 0.52 to 0.95).[4] (LOE3)

- A retrospective cohort study in a United States urban EMS system explored the effects of response time on survival. There was no significant difference in median response time between survivors and non-survivors (6.4 and 6.8 minutes respectively; *p*=0.10). There was no evidence of a global inequality between observed and expected mortality rates (*p*=0.14).

However, mortality risk was lower in patient with a response time of <5 minutes (0.51%) compared to those with a response time of ≥5 minutes (1.58%; *p*=0.002).[5] (LOE3)

- A retrospective analysis of 10 years of Australian and New Zealand ambulance patient satisfaction surveys explored factors that influence ambulance satisfaction ratings. Associations were observed between overall patient satisfaction and seven service dimensions (Call connect time, call taker assistance, ambulance arrival time, ambulance ride quality, paramedic care, paramedic treatment, and paramedic explanation). 'Paramedic care' was the greatest predictor of overall satisfaction (OD 3.39; 95% CI 3.00 to 3.83). The association between 'ambulance arrival time' and satisfaction was the third strongest (OD 2.48; 95% CI 2.32 to 2.64). 'Call connect time' had the weakest but still statistically significant association (OD 1.80; 95% CI 1.66 to 1.96).[6] (LOE3)

QI-A.1.7. An ambulance departs the scene within X minutes of arriving on scene. (X = 10, 20 or 30)

Access

(No evidence identified)

QI-A.1.8. An ambulance crew hands over the patient to hospital staff and becomes available for the next call within X minutes. (X = 20, 30 or 45)

Access

(No evidence identified)

Characteristics of the Evidence

This QIES is based on a structured search of the literature and selected evidence-based healthcare databases. The evidence in this summary comes from:

- A retrospective cohort study of 7,760 ambulance responses in an urban setting.[3]
- A retrospective cohort study of 9,559 patients in an urban setting.[4]
- A retrospective cohort study of 5,516 ambulance calls in an urban setting.[5]
- A retrospective analysis of 50,349 responses to ambulance satisfaction surveys.[6]

Definitions

Incident: An event that results in a demand for ambulance services to respond.[1] Generally, ambulance service organisations prioritise incidents as 'emergency' which demands an immediate response under lights and sirens, 'urgent' requiring an undelayed response without lights and sirens, and 'non-emergency' to which a non-urgent response required.

Response time: The time interval from when the initial call for an emergency was received at the communications centre to the arrival of the first responding ambulance resource at the scene of the incident.[1] This may be divided into more specific time intervals and expanded beyond arrival at the scene as detailed in Figure 1. The RoGS differentiates between response times in urban centres and response times state-wide.[1]

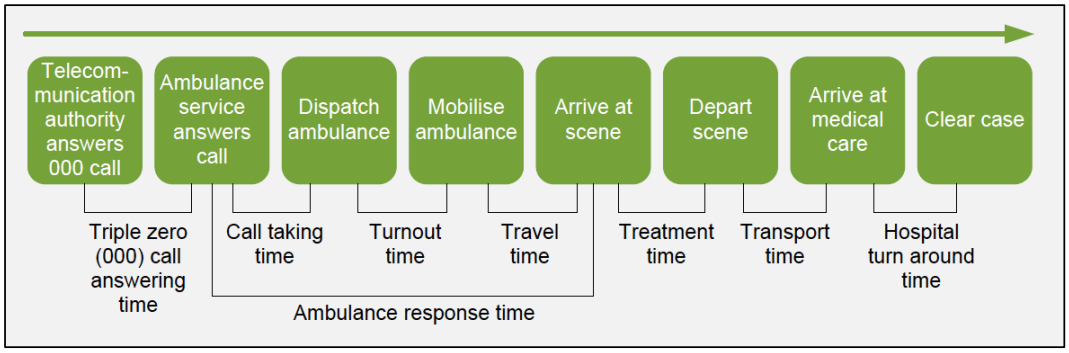


Figure 1: Terminology of time intervals in a routine ambulance service call from the Productivity Commission's 2019 Report on Government Services – Part E, Chapter 11: Ambulance Services.[1]

References

1. Australian Government Productivity Commission - Steering Committee for the Review of Government Service Provision. Report on Government Services - Chapter 11 (Ambulance Services) [Internet]. Canberra; 2019. Available from: https://www.pc.gov.au/research/ongoing/report-on-government-services/2019/health/ambulance-services
2. Harrison L. IBISWorld Industry Report Q8591 - Ambulance Services in Australia [Internet]. Melbourne; 2018. Available from: https://www.ibisworld.com.au/
3. Blanchard IE, Doig CJ, Hagel BE, Anton AR, Zygun DA, Kortbeek JB, et al. Emergency medical services response time and mortality in an urban setting. Prehospital Emerg Care. 2012;16(1):142–51.
4. Pons PT, Haukoos JS, Bludworth W, Cribley T, Pons KA, Markovchick VJ. Paramedic response time: Does it affect patient survival? Acad Emerg Med. 2005;12(7):594–600.
5. Blackwell TH, Kaufman JS. Response time effectiveness: comparison of response time and survival in an urban emergency medical services system. Acad Emerg Med. 2002;9(4):288–95.
6. Bogomolova S, Tan PJ, Dunn SP, Bizjak-Mikic M. Understanding the factors that influence patient satisfaction with ambulance services. Health Mark Q. 2016;33(2):163–80.

Sub-Domain 2: Patient Safety

Prevalence and/or Significance

The nature and setting of prehospital care inherently place it at increased risk of patient safety incidents.[1] Patient safety in the in-hospital environment has been documented extensively, however, the literature on patient safety in prehospital care is relatively scarce.[2,3] Causes of patient safety incidents during prehospital care relate to system failures, fatigue (covered in 'Sub-Domain A.6. Paramedic Health and Safety'), medication errors, miscommunication, lack of professional skills and equipment failure.[2–4] Although the Australian national ambulance services performance indicator framework provides for reporting of sentinel events, data are not yet available for reporting against this indicator.[5]

Appropriate non-conveyance is of interest to ambulance services and the healthcare system as a whole because it reduces cost and resource burden. In Australia, paramedics have no legal obligation to transport all patients to hospital.[6] However, non-conveyance of patients who do require transport with medical personnel and equipment to a healthcare facility may be associated with poor patient outcomes and thus presents a patient safety issue.[7] Accurate determination of safe non-conveyance therefore relies on paramedics' professional decision-making ability.[8] The non-conveyance decision-making process is complex and multifactorial which supports the use of supportive tools, especially by paramedics who lack applicable competencies.[9] The literature suggests that considerable variation exists in non-conveyance rates between ambulance services.[9–11] Some ambulance service factors that may be cause variation are the skill level of attending paramedics, the perceptions of paramedics about extended skill levels and the perceptions of paramedics that ambulance service management considers non-conveyance as risky.[11]

Quality Indicators and Evidence

QI-A.2.1. The ambulance service has a patient safety incident reporting system.

Safety

- A systematic review examined the effectiveness, reliability, validity and feasibility of interventions that aim to improve the governance of patient safety within emergency care, including ambulance services. Whilst none of the studies that evaluated incident reporting systems did so in the setting of prehospital care systems, the review found that the use of well-designed incident reporting systems leads to an increase of incidents reported by general practitioner out-of-hour services and emergency department staff.[3] (LOE2)

QI-A-2.2. **The ambulance service has a guideline that defines the categories of patients that should be left in the care of another clinician i.e. should <u>not</u> be left unattended.**

Safety

QI-A.2.3. **A patient who is not conveyed to a healthcare facility has been risk-assessed for likelihood of deterioration.**

Safety

QI-A.2.4. **The ambulance service has policy that describes the follow-up arrangements for patients not conveyed to a healthcare facility.**

Safety

QI-A.2.5. **For a patient who was treated and discharge on scene, there is no need to recontact the ambulance service for the same complaint within a X-hour period. (X = 12, 24, 48, or 72)**

Safety Effectiveness

QI-A.2.6. **For a patient who was treated and discharge on scene, there is no need for hospital admission within a X-hour period. (X = 12, 24, 48, or 72)**

Safety Effectiveness

- A systematic review explored non-conveyance in ambulance care from patient-safety and ambulance professional perspectives. Whilst the review provided limited evidence on the effectiveness of guidelines, risk assessment tools and follow-up arrangements, it does provide insight into factors influencing paramedics' non-conveyance decision making. Three of the included studies showed that approximately 15% on non-conveyed patients have vital signs outside normal limits. Two studies showed that additional training for paramedics was associated with higher non-conveyance rates when compared to paramedics who received standard training. There is a limited number of guides and assessment tools available to paramedics to aid them in the decision-making. Their methods of development, evidence base and validity are unclear.[9] (LOE1)

- A systematic review and meta-analysis evaluated paramedics' ability to determine the medical necessity for conveyance to a healthcare facility. The review looked exclusively at paramedics in the United States. The aggregate negative predictive value (NPV) of paramedic determinations was 0.91 (95% CI 0.71 to 0.98) disfavouring paramedic independent/unassisted decision-making regarding non-conveyance to hospital.[8] (LOE3)

Characteristics of the Evidence

This quality indicator evidence summary is based on a structured search of the literature and selected evidence-based healthcare databases. The evidence in this summary comes from:

- A systematic review of 18 quasi- and non-experimental studies.[3]
- A systematic review of 67 articles, including two systematic reviews, four experimental studies, 52 non-experimental studies, one mixed-methods study and eight qualitative studies.[9]
- A systematic review and meta-analysis of 13 non-experimental studies.[8]

Definitions

Non-conveyance: "An ambulance deployment as appropriate, where the patient after examination and/or treatment on-scene does not require conveyance with medical personnel and equipment to the healthcare facility."[12] There are a number of similar terms used to describe this circumstance, such as 'discharge at scene' or 'see and treat'.[10] It is important to differentiate non-conveyance from 'telephone advice only', a term used to describe a range of telephone responses to 000 calls whereby an ambulance is not sent to a patient.[10]

Patient safety: The concept of patient safety has various components. A consistent definition of patient safety and related terms may be compromised by varying use of language across different contexts or settings. A definition applicable across the full spectrum of healthcare was developed by means of a consensus process by the World Health Organisation (WHO) World Alliance for Patient Safety. The resulting International Classification on Patient Safety (ICPS) defines patient safety as "the reduction of risk of unnecessary harm associated with healthcare to an acceptable minimum."[13(p.18)]

Patient safety incident: "An event or circumstance which could have resulted, or did result, in unnecessary harm to a patient".[13(p.18)] Similarly, the Australian Productivity Commission's Report on Government Services defines sentinel events in the context of ambulance care as adverse events that occur because of system and process deficiencies, and which result in the death of, or serious harm to, a patient.[5] For the purpose of this evidence summary the term 'patient safety incident' will be used.

References

1. Bigham BL, Buick JE, Brooks SC, Morrison M, Shojania KG, Morrison LJ. Patient Safety in Emergency Medical Services Advancing and Aligning the Culture of Patient Safety in EMS [Internet]. Toronto; 2012. Available from: http://www.patientsafetyinstitute.ca
2. Bigham BL, Buick JE, Brooks SC, Morrison M, Shojania KG, Morrison LJ. Patient safety in emergency medical services: A systematic review of the literature. Prehospital Emerg Care. 2012;16(1):20–35.
3. Hesselink G, Berben S, Beune T, Schoonhoven L. Improving the governance of patient safety in emergency care: a systematic review of interventions. BMJ Open. 2016 Jan;6(1):e009837.
4. Cushman JT, Fairbanks RJ, O'Gara KG, Crittenden CN, Pennington EC, Wilson MA, et al. Ambulance personnel perceptions of near misses and adverse events in pediatric patients. Prehospital Emerg Care. 2010;14(4):477–84.
5. Australian Government Productivity Commission - Steering Committee for the Review of Government Service

Provision. Report on Government Services - Chapter 11 (Ambulance Services) [Internet]. Canberra; 2019. Available from: https://www.pc.gov.au/research/ongoing/report-on-government-services/2019/health/ambulance-services

6. Eburn M. Australian Emergency Law [Internet]. Do paramedics have to transport everyone? 2014 [cited 2018 Sep 24]. Available from: https://emergencylaw.wordpress.com/2014/02/03/do-paramedics-have-to-transport-everyone/
7. Shaban RZ. Paramedic Clinical Judgement and Decision-making of Mental Illness in the Pre-Hospital Emergency Care Setting: a Case Study of Accounts of Practice. Griffith University; 2011.
8. Brown LH, Hubble MW, Cone DC, Millin MG, Schwartz B, Patterson PD, et al. Paramedic determinations of medical necessity: A meta-analysis. Vol. 13. 2009.
9. Ebben RHA, Vloet LCM, Speijers RF, Tönjes NW, Loef J, Pelgrim T, et al. A patient-safety and professional perspective on non-conveyance in ambulance care: A systematic review. Scand J Trauma Resusc Emerg Med. 2017;25(1):1–20.
10. O'Cathain A, Knowles E, Bishop-Edwards L, Coster J, Crum A, Jacques R, et al. Understanding variation in ambulance service non-conveyance rates: a mixed methods study [Internet]. Vol. 6, National Institute for Health Research - Health Services and Delivery Research. 2018. Available from: https://www.journalslibrary.nihr.ac.uk/hsdr/hsdr06190
11. O'Cathain A, Jacques R, Stone T, Turner J. Why do ambulance services have different non-transport rates ? A national cross sectional study. PLoS One. 2018;13(9):e0204508.
12. Ambulances-in-zicht. Ambulances-in-zicht 2015 [Internet]. Zicht; 2015. Available from: http://www.vrgz.nl/media/1650/ambulances-in-zicht-2015.pdf
13. Runciman W, Hibbert P, Thomson R, Van Der Schaaf T, Sherman H, Lewalle P. Towards an International Classification for Patient Safety: Key concepts and terms. Int J Qual Heal Care. 2009;21(1):18–26.

Sub-Domain 3: Patient Experience and Satisfaction

Prevalence and/or Significance

It is important to note that this sub-domain deals with a fundamentally unique set of QIs in that they reflect a different stakeholder perspective. Thus, application of these QIs enables the measurement of quality of care from the patients' viewpoint. The utilisation of patient satisfaction measures is common practice in quality assessment across the health services industry, including ambulance services.[1,2] Patient experience measurement is more challenging, and initiatives are still in development.[3] Indicators of quality from the patients' perspectives provide an important contribution to a balanced suite of measures. However, several studies raise concerns and question the meaningfulness of patient experience or satisfaction and their ability to accurately identify changes in quality.[4–8]

Quality Indicators and Evidence

QI-A.3.1. **The ambulance service collects and analyses quantitative and qualitative data pertaining to patient experience and satisfaction for the purpose of quality improvement.**

Access | Safety | Effectiveness

- A systematic review investigated evidence on the links between patient experience and clinical safety and effectiveness outcomes. None of the included studies focused specifically on the prehospital setting, however, the results indicate consistent positive association between patient experience and patient safety and clinical effectiveness across a wide range of disease areas, study designs, settings, population groups and outcome measures. Amongst other, positively associated outcome measures included objective health outcomes, healthcare resource use, adverse events and technical quality of care.[9] (LOE1)

QI-A.3.2. **A patient reports that they felt that the length of time they waited to be connected to an ambulance service call taker was much quicker or a little quicker than they thought it would be.**

Access

QI-A.3.3. **A patient reports that they felt that the length of time they waited for an ambulance was much quicker or a little quicker than they thought it would be.**

Access

QI-A.3.4 **A patient reports that they felt that the level of care provided to them by paramedics was very good or good.**

◎ Effectiveness

QI-A.3.5. **A patient reports that their level of trust and confidence in paramedics and their ability to provide quality care and treatment was very high or high.**

◎ Safety Effectiveness

QI-A.3.6. **A patient reports that they were very satisfied or satisfied with the ambulance services they received in the previous 12 months.**

◎ Access Safety Effectiveness

QI-A.3.7. **A patient reports that the key elements of prehospital care* were delivered.**

◎ Access Safety Effectiveness

*Accessibility, response capacity, professionalism, transport conditions, capacity for resolving the situation

- Using focus groups and semi-structured interviews, a qualitative study evaluated and compared the perspectives of paramedics and dispatchers with those of patients about what elements of quality are most relevant for service users. There was general concurrence between the cohorts about the most relevant elements for the patients. These elements were accessibility, response capacity, professionalism, transport conditions, and capacity for resolving the situation.[1] (LOE3)

QI-A.3.8 **The ambulance service collects and analyses quantitative and qualitative data pertaining to complaints for the purpose of quality improvement.**

➲ Access Safety Effectiveness

(No evidence identified)

Characteristics of the Evidence

This quality indicator evidence summary is based on a structured search of the literature and selected evidence-based healthcare databases. The evidence in this summary comes from:

- A systematic review of 55 studies including five randomized controlled trials.[9]
- A single qualitative study.[1]

Definitions

Complaint: A complaint may be defined as an expression of dissatisfaction within a healthcare setting.[10]

Patient experience: The Beryl Institute, a global leader on improving patient experience in health care, defines patient experience as "the sum of all interactions, shaped by an organisation's culture, that influence patient perceptions across the continuum of care."[11] Interactions refer to touch-points of people, processes, communications, actions, and environment while the culture is the vision, values, people and community.[11] These influence the patient perceptions, or what is recognized, understood and remembered by patients.[11]

Patient satisfaction: Patient satisfaction is based on patient experience before, during and after the care processes and gauged against various levels of expectation.[12] Patient satisfaction is thus different to patient experience in that it is a judgement formed by the patient after comparing expectations with the actual outcome.[3] Expectations refer to the anticipated or believed encounters that a patient thinks will occur in the healthcare system.[13] In its 2019 Report of Government Services (RoGS),[14] the Australian Productivity Commission defines patient satisfaction as the quality of ambulance services, as perceived by the patient. Whilst the concepts of patient experience and patient satisfaction are similar and potentially overlap, they should be considered as related but different.[3,15]

References

1. García-Alfranca F, Puig A, Galup C, Aguado H, Cerdá I, Guilabert M, et al. Patient satisfaction with pre-hospital emergency services. A qualitative study comparing professionals' and patients' views. Int J Environ Res Public Health. 2018;15(2).
2. Bogomolova S, Tan PJ, Dunn SP, Bizjak-Mikic M. Understanding the factors that influence patient satisfaction with ambulance services. Health Mark Q. 2016;33(2):163–80.
3. LaVela S, Gallan A. Evaluation and Measurement of Patient Experience. Patient Exp J. 2014;1(1):28–36.
4. Gill L, White L. Leadership in Health Services Emerald Article : A critical review of patient satisfaction A critical review of patient satisfaction. Leadersh Heal Serv. 2009;22(1):8–19.
5. Coulter A. Can patients assess the quality of health care? BMJ. 2006;333(July):1–2.
6. Williams B, Coyle J, Healy D. The meaning of patient satisfaction: an explanation of high reported levels. Soc Sci Med. 1998;47(9):1351–9.
7. Williams B. Patient satisfaction: a valid concept? Soc Sci Med. 1994;38(4):509–16.
8. Sitzia J, Wood N. Patient satisfaction: A review of issues and concepts. Soc Sci Med. 1997;45(12):1829–43.
9. Doyle C, Lennox L, Bell D. A systematic review of evidence on the links between patient experience and clinical safety and effectiveness. BMJ Open. 2013;3(1).
10. Reader TW, Gillespie A, Roberts J. Patient complaints in healthcare systems: A systematic review and coding taxonomy. BMJ Qual Saf. 2014;23(8):678–89.
11. The Beryl Institute. Defining Patient Experience [Internet]. 2018 [cited 2018 Oct 10]. Available from: https://www.theberylinstitute.org/
12. Berkowitz B. The Patient Experience and Patient Satisfaction: Measurement of a Complex Dynamic. Online J Issues Nurs. 2016;21(1):1–5.
13. Lateef F. Patient expectations and the paradigm shift of care in emergency medicine. J Emerg Trauma Shock. 2011;4(2):163–7.
14. Australian Government Productivity Commission - Steering Committee for the Review of Government Service Provision. Report on Government Services - Chapter 11 (Ambulance Services) [Internet]. Canberra; 2019. Available from: https://www.pc.gov.au/research/ongoing/report-on-government-services/2019/health/ambulance-services
15. Siriwardena AN, Gillam S. Patient perspectives on quality. Qual Prim Care. 2014;22(1):11–5.

Sub-Domain 4: Communication and Dispatch

NB: This evidence summary excludes QIs and evidence regarding time intervals for dispatch, such as call answering time or call processing time. These shorter time intervals are included in response time (see 'Sub-Domain A.1. General Time Intervals').

Prevalence and/or Significance

A dispatch system with reliable technology and effective processes is an essential component of ambulance services. The caller must be able to swiftly access the service, the control centre taking the call must be able to dispatch the closest or most appropriate unit(s) with an accurate priority level, and the paramedics must be able to communicate with the control centre, other units and receiving facilities.[1]

One of the biggest challenges for the control centre is to dispatch ambulances accurately. Emergency Medical Dispatchers (EMDs) and Emergency Medical Dispatch Support Officers (EMDSOs) use systems such as the Medical Priority Dispatch System (MPDS) to ask scripted questions and follow algorithms to ultimately determine a criteria-based dispatch priority for each call. Many ambulance services choose to modify the off-the-shelf system to optimise it for their specific needs and circumstances. As a safety mechanism, dispatch systems are generally designed to over-triage rather than under-triage. A high-level dispatch priority will see an ambulance respond with lights and sirens which is inherently associated with increased risk of road traffic accidents. The challenge lies in eliciting accurate information from the caller to determine an appropriate dispatch priority whilst maintaining equitable ambulance utilisation and the safety of paramedics.[2]

Furthermore, most control centres provide scripted first aid advice to the caller to commence patient care whilst the ambulance resource is responding. This may be provided for any type of call, but most commonly involves dispatcher-instructed cardiopulmonary resuscitation (DI-CPR) for the caller attending to a patient in suspected or confirmed cardiac arrest. Early CPR is one of the key elements of the chain of survival for the time-critical cardiac arrest patient. Early CPR may be expedited by DI-CPR.[3]

Quality Indicators and Evidence

QI-A.4.1. **A call is assigned an accurate level of urgency and/or dispatch priority.**

Access | Safety | Effectiveness

(No evidence identified)

QI-A.4.2. **A patient is identified to be in OHCA by the ambulance service call-taker before the first resource arrives on scene.**

Effectiveness

QI-A.4.3. **A caller requesting assistance for suspected/confirmed adult cardiac arrest is offered instructions (audio, or video if possible) in chest-compression-only cardiopulmonary resuscitation (CPR).**

Effectiveness | ⇨ Guidelines[A]

- A Cochrane systematic review and meta-analysis investigated the effects of continuous chest compressions versus conventional CPR of non-asphyxial out-of-hospital cardiac arrest (OHCA). Three of the four included RCTs evaluated CPR provided by untrained bystanders. There was 2.4% higher survival to hospital discharge in patient who received chest-compression-only CPR compared to those who received CPR interrupted with pauses for rescue breaths (14% versus 11.6%; RR 1.21; 95% CI 1.01 to 1.46). However, there was insufficient evidence to determine the effect of the two strategies on neurological outcomes at hospital discharge (10-18% versus 11% respectively; RR 1.25; 95% CI 0.94 to 1.66). There were no data available for return of spontaneous circulation (ROSC), survival at one year, quality of life, or adverse effects.[4] (LOE1)

- A systematic review and meta-analysis aimed at comparing chest-compression-only CPR with standard CPR as a method for bystander CPR. The primary meta-analysis of pooled data from three RCTs was identical to the analysis performed in the Cochrane review above. However, a secondary meta-analysis of seven observational cohort studies showed no difference in chance of survival between the two strategies (8% versus 7%; RR 0.96; 95% CI 0.83 to 1.11).[5] (LOE1)

- A systematic review investigated if the provision of DI-CPR as opposed to no instructions improved patient outcome. Survival after adult cardiac arrest was improved in two of the five studies included; a retrospective cohort study (43.1% vs 31.7% respectively) and a before-and-after study (38% vs 32% respectively when response time was <4 min; 50% vs 24%

respectively when response time was >4 min). Survival after cardiac arrest was worse in one retrospective cohort study (15.1% vs 21.4% respectively) and two before-and after studies (21% vs 24% respectively and 3% and 4.8% respectively).[6] (LOE3)

- A systematic review and meta-analysis compared the effect of video-assistance and audio-assistance on quality of DI-CPR. The analysis showed that, compared to audio-assistance, video-assistance resulted in higher chest compression rate (80.6 versus 104.8; 95% CI 10.50 to 29.38). Although a trend towards better hand-positioning was observed in the video-assistance group, the number of studies was insufficient to provide robust evidence. Initiation of chest compressions was occurred later in the video-assistance group (median delay 31.5s; 95% CI 10.94-52.09).[7] (LOE1)

- A systematic review and meta-analysis investigated the effects of chest-compression-only CPR versus conventional CPR provided by bystanders for paediatric OHCA. Five observational cohort studies were included in the analysis which indicated that children who received conventional CPR had a higher 30-day survival (OR 1.49; 95% CI 1.27-1.74) and higher 30-day neurologically intact survival (OR 1.63; 95% CI 1.30-2.04) compared to those who received chest-compression-only CPR.[8] (LOE3)

Characteristics of the Evidence

This quality indicator evidence summary is based on a structured search of the literature and selected evidence-based healthcare databases. The evidence in this summary comes from:

- A Cochrane systematic review and meta-analysis of three RCTs and one cluster-RCT.[4]
- A systematic review and meta-analysis of three RCTs and seven observational cohort studies.[5]
- A systematic review and meta-analysis of two observational cohort studies and three before-and-after studies.[6]
- A systematic review and meta-analysis of six RCTs.[7]
- A systematic review and meta-analysis of five observational studies.[8]

Supporting Australian Guidelines

A. Australian Resuscitation Council (ARC). ANZCOR Guideline 8 - Cardiopulmonary Resuscitation (CPR) [Internet]. Melbourne: ARC; 2016. Available from: https://resus.org.au/guidelines/

Definitions

Dispatch: The utilisation of professional Emergency Medical Dispatchers (EMD) and Emergency Medical Dispatch Support Officers (EMDSO) to gather information, assign resources, and coordinate callers and ambulance service responders in the prehospital setting.[9,10]

References

1. Mund EL. Foundations of EMS Systems. New Jersey: Pearson; 2015.
2. Bohm K, Kurland L. The accuracy of medical dispatch - a systematic review. Scand J Trauma Resusc Emerg Med. 2018;26(1):1–10.
3. Bobrow BJ, Panczyk M, Subido C. Dispatch-assisted cardiopulmonary resuscitation: The anchor link in the chain of survival. Curr Opin Crit Care. 2012;18(3):228–33.
4. Zhan L, Yang L, Huang Y, He Q, Liu G. Continuous chest compression versus interrupted chest compression for cardiopulmonary resuscitation of nonasphyxial out-of-hospital cardiac arrest (Review). Cochrane Database Syst Rev. 2017;(3).
5. Hüpfl M, Selig HF, Nagele P. Chest-compression-only versus standard cardiopulmonary resuscitation: A meta-analysis. Lancet. 2010;376(9752):1552–7.
6. Bohm K, Vaillancourt C, Charette ML, Dunford J, Castrén M. In patients with out-of-hospital cardiac arrest, does the provision of dispatch cardiopulmonary resuscitation instructions as opposed to no instructions improve outcome: A systematic review of the literature. Resuscitation. 2011;82(12):1490–5.
7. Lin YY, Chiang WC, Hsieh MJ, Sun JT, Chang YC, Ma MHM. Quality of audio-assisted versus video-assisted dispatcher-instructed bystander cardiopulmonary resuscitation: A systematic review and meta-analysis. Resuscitation. 2018;123:77–85.
8. Zhang X, Zhang W, Wang C, Tao W, Dou Q, Yang Y. Chest-compression-only versus conventional cardiopulmonary resuscitation by bystanders for children with out-of-hospital cardiac arrest: a systematic review and meta-analysis. Resuscitation. 2018;[ahead of print].
9. Kashani S, Sanko S, Eckstein M. The Critical Role of Dispatch. Cardiol Clin [Internet]. 2018;36(3):343–50. Available from: https://doi.org/10.1016/j.ccl.2018.03.001
10. Paramedics Australasia. Paramedicine Role Descriptions [Internet]. Melbourne: Paramedics Australasia; 2012. p. 1–23. Available from: https://www.paramedics.org/content/2009/07/PRD_211212_WEBONLY.pdf

Sub-Domain 5: Resources and Resource Management

Prevalence and/or Significance

Despite increasing demand for ambulance services, there is relative scarcity in scholarly work and research in this area.[1] There are numerous factors which result in increasing requirements for ambulance services.[1] In Australia, demand for ambulance services has increased over the last five years mostly due to its growing and aging population.[2,3] This population growth and aging is anticipated to continue over the next five years and, together with general expectations to have increased responsibility to reduce unnecessary hospital triage, will place increasing pressure on ambulance services.[2]

There are 17,883 full-time salaried and 6,654 volunteer personnel in Australia.[4] There are an additional 3,108 community first responders (personnel trained to respond and provide first aid for but without transport capacity before ambulance arrival).[4] There are 1,168 response locations (2,227 first responder locations with an ambulance), 5,578 ambulance general transport and patient transport vehicles, and 91 air ambulance aircraft.[4]

Nationally in 2017-18, there were 4.6 million ambulance responses (183.9 per 1,000 people) to 3.7 million reported incidents (148.6 incidents per 1,000 people) in which 3.5 million patients were assessed, treated and/or transported (141.5 patients per 1,000 people).[4]

Quality Indicators and Evidence

QI-A.5.1. **The ambulance service has a policy that defines how many staffed ambulances should be in service per 100,000 population.**

Access

(No evidence identified)

QI-A.5.2. **The ambulance service has a policy that defines a minimum equipment list for an ambulance.**

Access

(No evidence identified)

QI-A.5.3. The ambulance service has a policy detailing which resource(s) should respond to each category/type of call.

Access

- A systematic review compared the effectiveness of advanced life support (ALS) with basic life support (BLS) prehospital care. Whilst the benefit of ALS over BLS in unselected patient cohorts was not clear, there appear to be advantages of ALS interventions amongst patients with specific aetiologies, such as epileptic seizures or respiratory distress.[5] (LOE1)

- A systematic review investigated which critical care paramedic (CCP) interventions may have potential benefits and for which patient cohorts. The review found a general lack of evidence in support of CCP-level prehospital care. However, an Australian RCT included in the review showed benefit from prehospital rapid sequence intubation (RSI) carried out by CCPs in patients with severe traumatic brain injury.[6] (LOE1)

- A systematic review investigated the impact of extended care paramedics (ECPs) with expanded scope of skills in patient assessment and treatment. The review identified that paramedics with additional training can accurately identify health and social problems in patients and safely manage acute minor conditions.[7] (LOE1)

- A systematic review perused the international literature to identify evidence for or against the utilisation of ECPs. The authors found paucity of applicable literature and heterogeneity in the included studies hampered the review. However, the one RCT and 10 cohort studies/ qualitative surveys included suggested that community paramedicine is beneficial to patients and health systems.[8] (LOE1)

- A systematic review and meta-analysis investigated the effectiveness of ALS, as opposed to BLS, in increasing patient survival. In trauma patients, ALS did not increase survival compared to BLS (pooled OR 0.892; 95% CI 0.775 to 1.026). In OHCA, ALS increased survival compared to BLS (OR 1.468; 95% CI 1.257 to 1.715).[9] (LOE2)

- A systematic review examined the evidence for prehospital critical care for out-of-hospital cardiac arrest (OHCA), when compared to standard ALS care. Three of the six included publications showed benefit from prehospital critical care delivered by physicians. However, an imbalance of prognostic factors and hospital treatment in these studies systematically favoured the prehospital teams of physicians and paramedics providing critical care.[10] (LOE4)

QI-A.5.4. A patient who suffers low- or medium-acuity illness or injury is treated and discharged on scene or referred to other appropriate clinical pathways, unless service-defined exclusion criteria exist.

Access

- A systematic review of systematic reviews examined the effectiveness, safety and cost of managing acute medical conditions in settings other than routine in-hospital units. The review excluded studies involving obstetric, surgical and psychiatric patient cohorts. The authors found that generally, for patients who had been assessed to be low-risk, the evidence suggests that alternative clinical pathways can achieve clinical outcomes and patient satisfaction which are comparable to the hospital setting or improved at lower cost.[11] (LOE1)

- A systematic review aimed to explore the effectiveness and safety of admission alternatives for older patients. Amongst other interventions, out-of-hospital paramedic assessment and management was examined. The three included studies related to this specific intervention all showed reduced admission. However, one study suggested increased subsequent unplanned contacts with secondary care. The participating ambulance services all utilised ECPs.[12] (LOE1)

- A systematic review investigated the impact of paramedics with expanded scope of skills in patient assessment and treatment. The review identified that paramedics with additional training can accurately identify health and social problems in patients and safely manage acute minor conditions.[7] (LOE1)

- A systematic review and meta-analysis investigated the impact of newly introduced paramedics with expanded scope of clinical practice in patient assessment and treatment. Overall, the review and meta-analysis showed that the additional skills in assessing and treating patients resulted in increased non-conveyance (OR 0.09; 95% CI 0.04 to 0.18) and discharge on the scene (OR 10.5; 95% CI 5.8 to 19) without evidence of compromised patient safety.[13] (LOE2)

- A systematic review examined the impact of paramedics with extended primary care skills and knowledge have in the National Health Services (NHS). Amongst other outcomes, several of the included studies reported on patient referrals and/or avoidance of admissions. Generally, the findings suggest that more patients can be treated at the scene with less transports to emergency departments. This was not necessarily only related to the improved decision-making skills of the ECPs but may have been based on the nature and severity of the patients' conditions.[14] (LOE3)

Characteristics of the Evidence

This quality indicator evidence summary is based on a structured search of the literature and selected evidence-based healthcare databases. The evidence in this summary comes from:

- A systematic review of 46 studies including one RCT and 45 quasi-experimental and observational studies.[5]
- A systematic review of 11 studies including one RCT, 10 cohort studies and one quasi-randomised cohort study.[6]
- A systematic review of 19 studies including one systematic review, two cluster RCTs, eight quasi-experimental studies, six descriptive studies and two qualitative studies.[7]
- A systematic review of 11 studies including one cluster RCT, one quasi-experimental non-RCT study, three prospective cohort studies, five qualitative studies, one economic analysis and one mixed-methods study.[8]
- A systematic review and meta-analysis of 18 RCTs, controlled before-and-after trials and other controlled trials.[9]
- A systematic review including six observational studies.[10]
- A systematic review of 25 systematic review.[11]
- A systematic review of three applicable studies including one cluster RCT, one quasi-experimental trial and one observational study.[12]
- A systemactic review of 13 studies including one cluster RCT, one quasi-experimental study and 11 observational studies with analytic and descriptive designs.[13]
- A systematic review of six project reports and 15 studies, including non-specified observational studies with analytic and descriptive designs, nine studies with mixed methods and one qualitative study.[14]

Definitions

Advanced Life Support (ALS): ALS generally refers to sophisticated prehospital care using invasive methods, such as intravenous fluids, medications and advanced airway devices.

Basic Life Support (BLS): The provision of more essential and non-invasive patient care. However, the concepts associated with ALS and BLS are diverse and differ between countries.[5] The Australian ambulance service staff described in Table 1, including paramedics, all practice at what would internationally be considered ALS level, although service-specific qualifications and associated scope of practice varies.

Demand: In the context of health care, demand may be defined as the willingness and ability to access, use and, in some settings, pay for health care services as well as the associated expectations by individuals or communities.[15,16]

Deployment: The strategies used by ambulance services to place in service and manoeuvre its ambulances in an effort to optimise response time.[17] Table 1 provides definitions of clinical staff within paramedicine in Australia. Considering the

unique mobile health care circumstances of ambulance services, staffing and deployment of vehicles plays a crucial role in resource management.

Resources: Resources are all inputs (also referred to as 'structures' in the Donabedian model) required to enable health care systems to work, i.e. human and financial resources, drugs, supplies and equipment, vehicles and other infrastructure.[16]

Resource management: The process aimed at attaining the most rational utilisation of manpower, skills and knowledge, facilities and funds to achieve the intended purposes with the greatest effect and with the least outlay.[15] In other words, the primary aim of resource management is to ensure maximum efficiency and equity whilst maintaining safety.

Table 1 Definitions of clinical ambulance service staff

Role	Definition
Paramedic	A paramedic is a health professional who provides rapid response, emergency medical assessment, treatment and care in the out-of-hospital environment.[18]
Intensive Care Paramedic	An intensive care paramedic (ICP) is an advanced clinical practitioner in paramedicine who provides medical assessment, treatment and care in the out-of-hospital environment for acutely unwell patients with significant illness or injury.[18]
Critical Care Paramedic	A critical care paramedic (CCP) is an advanced clinical practitioner in paramedicine who provides medical assessment, treatment and care in the out-of-hospital environment to facilitate the safe and effective transfer of critically unwell patients to a specialist receiving facility.[18]
Extended Care Paramedic	An extended care paramedic (ECP) is an advanced clinical practitioner in paramedicine who specialises in facilitating a comprehensive medical history/assessment, initiation of relevant treatment and appropriate referral for low and medium acuity patients in a variety of community and clinical settings with an emphasis on managing a patient in their own environment/context.[18]

References

1. William B. Management of Emergency Demand. In: Wankhade P, Mackway-Jones K, editors. Ambulance Services: Leadership and Management Perspectives. Cham: Springer; 2015. p. 43–50.
2. Harrison L. IBISWorld Industry Report Q8591 - Ambulance Services in Australia [Internet]. Melbourne; 2018. Available from: https://www.ibisworld.com.au/
3. Lowthian JA, Jolley DJ, Curtis AJ, Currell A, Cameron PA, Stoelwinder JU, et al. The challenges of population ageing: Accelerating demand for emergency ambulance services by older patients, 1995-2015. Med J Aust. 2011;194(11):574–8.
4. Australian Government Productivity Commission - Steering Committee for the Review of Government Service Provision. Report on Government Services - Chapter 11 (Ambulance Services) [Internet]. Canberra; 2019. Available from: https://www.pc.gov.au/research/ongoing/report-on-government-services/2019/health/ambulance-services
5. Ryynänen OP, Iirola T, Reitala J, Pälve H, Malmivaara A. Is advanced life support better than basic life support in prehospital care? A systematic review. Scand J Trauma Resusc Emerg Med. 2010;18(1):62.
6. Von Vopelius-Feldt J, Wood J, Benger J. Critical care paramedics: Where is the evidence? A systematic review. Emerg Med J. 2014;31(12):1016–24.
7. Evans R, McGovern R, Birch J, Newbury-Birch D. Which extended paramedic skills are making an impact in emergency care and can be related to the UK paramedic system? A systematic review of the literature. Emerg Med J. 2014;31(7):594–603.
8. Bigham BL, Kennedy SM, Drennan I, Morrison LJ. Expanding paramedic scope of practice in the community: A systematic review of the literature. Prehospital Emerg Care. 2013;17(3):361–72.
9. Bakalos G, Mamali M, Komninos C, Koukou E, Tsantilas A, Tzima S, et al. Advanced life support versus basic life

support in the pre-hospital setting: A meta-analysis. Resuscitation [Internet]. 2011;82(9):1130–7. Available from: http://dx.doi.org/10.1016/j.resuscitation.2011.04.006

10. von Vopelius-Feldt J, Brandling J, Benger J. Systematic review of the effectiveness of prehospital critical care following out-of-hospital cardiac arrest. Resuscitation. 2017;114:40–6.
11. Conley J, O'Brien CW, Leff BA, Bolen S, Zulman D. Alternative strategies to inpatient hospitalization for acute medical conditions: A systematic review. JAMA Intern Med. 2016;176(11):1693–702.
12. Huntley AL, Chalder M, Shaw ARG, Hollingworth W, Metcalfe C, Benger JR, et al. A systematic review to identify and assess the effectiveness of alternatives for people over the age of 65 who are at risk of potentially avoidable hospital admission. BMJ Open. 2017;7(7):1–7.
13. Tohira H, Williams TA, Jacobs I, Bremner A, Finn J. The impact of new prehospital practitioners on ambulance transportation to the emergency department: a systematic review and meta-analysis. Emerg Med J. 2014;31(e1):e88–94.
14. Hill H, McMeekin P, Price C. A systematic review of the activity and impact of emergency care practioners in the NHS. Emerg Med J. 2014;31(10):853–60.
15. World Health Organisation (WHO) Centre for Health Development. A glossary of terms for community health care and services for older persons. Geneva; 2004.
16. World Health Organization (WHO). Health Systems Strengthening Glossary [Internet]. [cited 2019 Jan 4]. Available from: https://www.who.int/healthsystems/hss_glossary/en/index3.html
17. Bledsoe BE, Porter RS, Cherry RA, editors. Essentials of Paramedic Care. 2nd ed. Upper Saddle River, NJ: Pearson Prentice Hall; 2011.
18. Paramedics Australasia. Paramedicine Role Descriptions [Internet]. Melbourne: Paramedics Australasia; 2012. p. 1–23. Available from: https://www.paramedics.org/content/2009/07/PRD_211212_WEBONLY.pdf

Sub-Domain 6: Paramedic Health and Safety

NB: QIs A.6.1 to A.6.5 relate to paramedic fatigue and thus indirectly address aspects of patient safety too. To avoid duplication, these are not listed in 'Sub-Domain A.2. Patient Safety'.

Prevalence and/or Significance

Shift work disrupts regular patterns of sleep and misaligns circadian rhythms and thus contributes to fatigue.[1] Fatigue frequently affect paramedics and has been linked to paramedic health, safety and wellness risks as well as patient safety incidents.[2,3] The problem of fatigued ambulance personnel may be more prevalent than generally assumed and not isolated to one type of ambulance operation or category of prehospital care clinician.[3,4] An Australian study found that 55 out of 60 participating paramedics (92%) reported having experienced fatigue in the 6 months preceding the survey, with 53 (88%) believing it had negatively affected their performance at work.[5]

The risk of serious injury amongst Australian paramedics is more than seven times higher than the Australian national average.[6] Between 2000 and 2010, the rate of serious injuries reported by paramedics in Australia was 80 per 1000 workers per year.[6] The largest injury category contributing to 6728 paramedic injuries was 'muscular stress from lifting, carrying, or putting down objects' (*n*=2945, 44%).[6] Assault by a person or people occurred in 100 cases (1%).[6]

A recent systematic review and meta-analysis investigated the prevalence of PTSD and other common mental health conditions amongst ambulance personnel worldwide. The review found estimated prevalence rates of 11% for PTSD, 15% for depression, 15% for anxiety, and 27% for general psychological distress.[7] A similar systematic review and meta-analysis found the worldwide pooled current prevalence of PTSD amongst rescue workers to be 10%.[8] Contributions from Paramedics Australasia to a current Senate inquiry into the role of Commonwealth, state and territory Governments in addressing the high rates of mental health conditions experienced by first responders, emergency service workers and volunteers suggests that the level of PTSD in the Australian paramedic population is consistent with these international findings.[9,10]

Results from a recent national survey, conducted as part of the National Mental Health and Wellbeing Study of Police and Emergency Services,[11] show that compared with the general adult population, employees in the police and emergency services sector had substantially higher rates of psychological distress, probable PTSD and lower levels of positive wellbeing.[12] Amongst participating ambulance employees (*n*=18,600), the survey found that 8% had very high levels of psychological distress, which is indicative of serious mental illness.[12] The prevalence of probable PTSD amongst ambulance employees was 8.2%.[12] 39% of all participating ambulance employees had previously been diagnosed with a mental health condition (anxiety disorder, depression, PTSD or other mental

health condition) and 22.1% had a diagnosed mental health condition at the time of survey completion.[12] However, the survey data also demonstrated that participants had high levels of resilience. Using the Brief Resilience Scale,[13] the survey showed that 56.2% of ambulance employees had high resilience.[12]

A survey utilising a validated burnout assessment tool aimed at describing the prevalence of burnout in Australian paramedics.[14] Of the 893 paramedics participating in the study, 55.9% were determined to have total burnout.[14] The proportion of participants with patient-related burnout and work-related burnout were 43.4% and 62.7% respectively.[14]

Quality Indicators and Evidence

QI-A.6.1. The ambulance service utilises a fatigue/sleepiness screening instrument to measure and monitor fatigue in paramedics.

Safety

- A systematic review perused the literature to assess the validity and reliability of instruments for measuring fatigue among paramedics. Included studies evaluated a total of 14 different instrument. The reviewers found that the number of studies reporting on validity and/or reliability of fatigue (and/or sleepiness) instruments was limited. Only a few studies evaluated both. None of the studies assessed sensitivity or specificity of the instruments. Overall the review found limited, but positive, evidence of the validity and reliability of the included instruments to assess the fatigue (and/or sleepiness) of paramedics.[15] (LOE1)

QI-A.6.2. The ambulance service schedules paramedics to work shifts shorter than 24 hours in duration.

Safety

- A systematic review evaluated the relationship between shift duration and fatigue and/or fatigue-related risks in paramedics or similar workers. There was no clear advantage of either, eight-hour shifts or 12-hour shifts, over the other. One study indicated that shift duration <24 hours in duration had a positive effect on reducing patient and paramedic safety risks.[16] (LOE)

QI-A.6.3. **The ambulance service provides access for paramedics to caffeine as a fatigue counter measure.**

Safety

- A systematic review and meta-analysis investigated the effectiveness of of caffeine as a countermeasure to fatigue in paramedics and related shift workers.
  The search did not identify any studies that investigate caffeine use and its effects on paramedics or on patient safety. Four of eight studies in other shift workers showed that caffeine improved psychomotor vigilance. Caffeine decreased the number of lapses on a standardized test of performance (SMD 0.75; 95% CI 0.30 to 1.19; *p*=0.001), and lessened the slowing of reaction time at the end of shifts (SMD 0.52; 95% CI 0.19 to 0.85; *p*=0.002).[17] (LOE1)

QI-A.6.4. **The ambulance service provides opportunity for paramedics to nap while on duty to mitigate fatigue.**

Safety

- A systematic review and meta-analysis examined the impact of scheduled naps on fatigue-related outcomes for paramedics and similar shift workers. The effect of napping on reaction time measured at the end of shift was small and non-significant (SMD 0.12; 95% CI −0.13 to 0.36; *p*=0.34). Napping during work did not change reaction time from the beginning to the end of the shift (SMD −0.01; 95% CI −25.0 to 0.24; *p*=0.96). Naps had a moderate, significant effect on sleepiness measured at the end of shift (SMD 0.40; 95% CI 0.09 to 0.72; *p*=0.01). The difference in sleepiness from the start to the end of shift was moderate and statistically significant (SMD 0.41; 95% CI 0.09 to 0.72; *p*=0.01).[18] (LOE1)

QI-A.6.5. **The ambulance service provides fatigue training to its paramedics.**

Safety

- A systematic review and meta-analysis investigated the impact of fatigue training on fatigue-related outcomes for ambulance service personnel and similar shift worker groups. Three of 18 included studies demonstrated that fatigue training improved personal safety. (Two studies had findings favourable for patient safety.) Similarly, included studies showed improved ratings of acute fatigue and reduced stress and burnout. A meta-analysis of five studies showed improvement in sleep quality (Fixed effects SMD −0.87; 95% CI −1.05 to −0.69; *p*<0.00001; Random effects SMD−0.80; 95% CI −1.72, 0.12; p<0.00001).[19] (LOE1)

QI-A.6.6. **The ambulance service provides mental health programs, including pre-incident preparedness training, to its paramedics.**

Safety

- A systematic review conducted for the development of the Australian Guidelines for the Treatment of Acute Stress Disorder (ASD) and PTSD investigated the effectiveness of early psychological interventions. The included studies demonstrated no benefit in reducing traumatic stress symptoms from early one-session individual or group debriefing interventions. However, two or more sessions of information and support by a domain-specific expert may have utility.[20] (LOE1)

- A systematic review conducted for the development of the Australian Guidelines for the Treatment of Acute Stress Disorder (ASD) and PTSD investigated the effectiveness of pre-incident preparedness training. Only one study was included in the review which suggested that education prior to assault may result in less PTSD.[20] (LOE3)

- The National Mental Health and Wellbeing Study of Police and Emergency Services showed that 42.3% of ambulance employees perceived a need for help or support for an emotional or mental health issue in the 12 months preceding the survey. The strongest need for help was perceived by those with PTSD. 78.6% of participating ambulance staff sought support or treatment for an emotional or mental health issue in the 12 months preceding the survey. In contrast, only 59.3% of participating ambulance employees perceived they received adequate support for mental and emotional problems. 24.9% thought they needed a little more help and 15.9% thought they needed a lot more help.[11] (LOE4)

QI-A.6.7. **The ambulance service utilises a post-exposure PTSD screening instrument designed for emergency service personnel to identify PTSD in paramedics.**

Safety ⇨ Guidelines[A]

(No evidence identified)

QI-A.6.8. **The ambulance service collects and analysis quantitative and qualitative data pertaining to staff satisfaction.**

Access Safety Effectiveness

(No evidence identified)

Characteristics of the Evidence

This quality indicator evidence summary is based on a structured search of the literature and selected evidence-based healthcare databases. The evidence in this summary comes from:

- A systematic review of 34 experimental and non-experimental studies.[15]
- A systematic review of 100 experimental and non-experimental studies.[16]
- A systematic review and meta-analysis of eight experimental studies and meta-analysis of four.[17]
- A systematic review and meta-analysis of 13 experimental studies and meta-analysis of three.[18]
- A systematic review of 18 experimental and non-experimental study designs and meta-analysis of five included quasi-experimental studies.[19]
- A systematic review of 21 studies including 10 RCTs and 11 quasi-experimental and observational studies.[20]
- A systematic review including only one observational study.[20]
- A survey involving a total of 117,500 employees (and 237,800 volunteers) in the police and emergency services sector including 18,600 ambulance service employees (and 6,900 volunteers).[12]

Supporting Australian Guidelines

A. Phoenix Australia - Centre for Posttraumatic Mental Health. Australian Guidelines for the Treatment of Acute Stress Disorder & Posttraumatic Stress Disorder [Internet]. Melbourne: Phoenix Australia - Centre for Posttraumatic Mental Health; 2013. 200 p. Available from: https://phoenixaustralia.org

Definitions

Burnout syndrome: A prolonged response to chronic emotional and interpersonal stressors at work, determined by the dimensions of mental exhaustion, cynicism, and inefficacy.[21]

Fatigue: An "unpleasant symptom incorporating feelings of tiredness to exhaustion creating conditions (physical and mental) that interfere with the ability to function in a normal capacity".[22(p.520)] Fatigue is a complex concept and comprised of several attributes. It is a subjective, unpleasant, total-body feeling and experience, encompassing physical, cognitive and emotional dimensions.[22]

Mental exhaustion: The feeling of not being able to offer any more of oneself at an emotional level; cynicism a detached attitude towards work, the people being served by it and colleagues; and inefficacy the feeling of not performing tasks adequately and of being incompetent at work.[23]

Occupational injury: An occupational injury is defined as any personal injury, disease or death resulting from an occupational accident. An occupational accident is an unexpected and unplanned occurrence, including acts of violence, arising out of or in connection with work which results in one or more workers incurring a personal injury, disease or death.[24]

Post-traumatic stress disorder (PTSD): A form of anxiety disorder which develops from witnessing a single event that is interpreted as traumatic or can arise from multiple less severe traumas ('microtraumas').[25]

References

1. Drake C, Wright K. Shift Work, Shift-Work Disorder, and Jet Lag. In: Meir K, Roth T, Dement W, editors. Principles and Practice of Sleep Medicine. 6th ed. St. Louis, MO: Elsevier Saunders; 2017. p. 714–25.
2. Patterson PD, Weaver MD, Hostler D. EMS provider wellness. In: Cone D, Brice J, Delbridge T, Myers J, editors. Emergency Medical Services: Volume 2 - Clinical Practice and Systems Oversight. New York: John Wiley & Sons, Incorporated; 2014. p. 2011–6.
3. Patterson P, Weaver M, Frank R, Warner C, Martin-Gill C, Francis X, et al. Association between poor sleep, fatigue, and safety outcomes in Emergency Medical Services providers. Prehosp Emerg Care. 2012;16(1):86–97.
4. Pyper Z, Paterson JL. Fatigue and mental health in Australian rural and regional ambulance personnel. EMA - Emerg Med Australas. 2016;28(1):62–6.
5. Sofianopoulos S, Williams B, Archer F, Thompson B. The exploration of physical fatigue, sleep and depression in paramedics: a pilot study. J Emerg Prim Heal Care. 2011;9(1):1–33.
6. Maguire BJ, O'Meara PF, Brightwell RF, O'Neill BJ, Fitzgerald GJ. Occupational injury risk among australian paramedics: An analysis of national data. Med J Aust. 2014;200(8):477–80.
7. Petrie K, Milligan-Saville J, Gayed A, Deady M, Phelps A, Dell L, et al. Prevalence of PTSD and common mental disorders amongst ambulance personnel: a systematic review and meta-analysis. Soc Psychiatry Psychiatr Epidemiol [Internet]. 2018;53(9):897–909. Available from: http://dx.doi.org/10.1007/s00127-018-1539-5
8. Berger W, Figueira I, Sá S De, Janeiro R De, Marques-portella C, Sá S De, et al. Rescuers at risk: a systematic review and meta-regression analysis of the worldwide current prevalence and correlates of PTSD in rescue workers. Soc Psychiatry Psychiatr Epidemiol. 2014;47(6):1001–11.
9. Paramedics Australasia (PA). Contribution to Senate inquiry into the role of Commonwealth, state and territory Governments in addressing the high rates of mental health conditions experienced by first responders, emergency service workers and volunteers. Melbourne; 2018.
10. Parliament of Australia. The role of Commonwealth, state and territory Governments in addressing the high rates of mental health conditions experienced by first responders, emergency service workers and volunteers. Senate Inquiry. 2019.
11. Beyond Blue. National Mental Health and Wellbeing Study of Police and Emergency Services [Internet]. 2018 [cited 2019 Jan 23]. Available from: https://www.beyondblue.org.au/about-us/about-our-work/workplace-mental-health/pes-program/national-mental-health-and-wellbeing-study-of-police-and-emergency-services
12. Lawrence D, Kyron M, Rikkers W, Bartlett J, Hafekost K, Goodsell B, et al. Answering the call: National Survey of the Mental Health and Wellbeing of Police and Emergency Services - Detailed Report. Perth; 2018.
13. Smith BW, Dalen J, Wiggins K, Tooley E, Christopher P, Bernard J. The brief resilience scale: Assessing the ability to bounce back. Int J Behav Med. 2008;15(3):194–200.
14. Thyer L, Lecturer S, Simpson P, Lecturer S, Sydney W, Van B. Burnout in Australian paramedics. Int Paramed Pract. 2018;8(3):48–55.
15. Patterson PD, Weaver MD, Fabio A, Teasley EM, Renn ML, Curtis BR, et al. Reliability and Validity of Survey Instruments to Measure Work-Related Fatigue in the Emergency Medical Services Setting: A Systematic Review. Prehospital Emerg Care. 2018;22:17–27.
16. Patterson PD, Runyon MS, Higgins JS, Weaver MD, Teasley EM, Kroemer AJ, et al. Shorter Versus Longer Shift Durations to Mitigate Fatigue and Fatigue-Related Risks in Emergency Medical Services Personnel and Related Shift

Workers: A Systematic Review. Prehospital Emerg Care. 2018;22(S1):28–36.

17. Temple JL, Hostler D, Martin-Gill C, Moore CG, Weiss PM, Sequeira DJ, et al. Systematic Review and Meta-analysis of the Effects of Caffeine in Fatigued Shift Workers: Implications for Emergency Medical Services Personnel. Prehospital Emerg Care. 2018;22(S1):37–46.
18. Martin-Gill C, Barger LK, Moore CG, Higgins JS, Teasley EM, Weiss PM, et al. Effects of Napping During Shift Work on Sleepiness and Performance in Emergency Medical Services Personnel and Similar Shift Workers: A Systematic Review and Meta-Analysis. Prehospital Emerg Care. 2018;22(S1):47–57.
19. Barger LK, Runyon MS, Renn ML, Moore CG, Weiss PM, Condle JP, et al. Effect of Fatigue Training on Safety, Fatigue, and Sleep in Emergency Medical Services Personnel and Other Shift Workers: A Systematic Review and Meta-Analysis. Prehospital Emerg Care [Internet]. 2018;22(S1):58–68. Available from: https://doi.org/10.1080/10903127.2017.1362087
20. Phoenix Australia - Centre for Posttraumatic Mental Health. Australian Guidelines for the Treatment of Acute Stress Disorder & Posttraumatic Stress Disorder. Melbourne: Phoenix Australia - Centre for Posttraumatic Mental Health; 2013. 200 p.
21. Maslach C, Schaufeli WB, Leiter MP. Job Burnout. Annu Rev Psycholoy. 2001;52:397–422.
22. Ream E, Richardson A. Fatigue: A concept analysis. Int J Nurs Stud. 1996;33(5):519–29.
23. Montero-Marín J, García-Campayo J. A newer and broader definition of burnout: Validation of the “Burnout Clinical Subtype Questionnaire (BCSQ-36).” BMC Public Health. 2010;10(302):1–16.
24. International Labour Organization (ILO). Concepts and Definitions [Internet]. 2018 [cited 2019 Jan 14]. Available from: https://www.ilo.org/global/lang--en/index.htm
25. Seides R. Should the current DSM-IV-TR definition for PTSD be expanded to include serial and multiple microtraumas as aetiologies? J Psychiatr Ment Health Nurs. 2010;17(8):725–31.

Sub-Domain 7: Training, Education and Research

Prevalence and/or Significance

Whilst the entry-level education of paramedics in Australia has almost completely transitioned from vocational training programs to university-based education programs,[1] in-service training and education remains a critical component of ambulance services. Clinical supervision is recognised as critical component of training and education. However, a universally recognised definition and consensus on its role appear to be elusive in the literature. Clinical supervision may be applied to enable professional, personal or educational development, provide emotional support or clarify the organisational requirements for the supervisee, and ultimately contribute to high-quality patient care and patient safety.[2–4] Compared to other countries, Australia has a significant prehospital care and paramedicine research capacity.[5] It is therefore well-positioned to be at the forefront of driving evidence-based ambulance service policy and prehospital practice.[5]

Quality Indicators and Evidence

QI-A.7.1. **The ambulance service has a policy that describes the process for supervision of paramedics in training.**

Safety | Effectiveness

- A systematic review and meta-analysis examined whether clinical supervision of health professionals improves patient safety. The included studies focused predominantly on the medical profession which generally performs more invasive interventions carrying more significant patient safety risks. Results of the analyses suggested that supervision of medical professionals reduced the risk of mortality (RR 0.76; 95% CI 0.60 to 0.95) and supervision of medical professionals and paramedics reduced the risk of complications (RR 0.69; 95% CI 0.53 to 0.89). Further analysis also indicated that direct supervision of medical professionals conducting non-surgical invasive procedures significantly reduced the risk of complications (RR 0.33; 95% CI 0.24 to 0.46).[6] (LOE2)

- A systematic review perused the evidence relating to clinical supervision for nurses, midwives and allied health professionals. The reviewers found that despite widespread acceptance that clinical supervision is beneficial to clinicians, patients and organisations, there remains no convincing empirical evidence to support clinical supervision. There appears to be significant variation in how clinical supervision is provided and insufficient evidence to advocate any specific supervision model or models.[7] (LOE1)

- A systematic review investigated the evidence for clinical supervision for health professionals. The reviewers found a lack of convincing evidence for clinical supervision amongst allied health professionals and other health professionals. Nevertheless, clinical supervision was generally held to be a positive experience and tends to be provided without a clear definition or model, using novel or unproven tools.[8] (LOE1)

- A qualitative study examined group supervision and its impact on the participants' (Swedish nurses and emergency medical technicians working in the ambulance service) personal and professional development. Analysed results from interviews conducted with participants after they had partaken in group supervision suggest that this form of supervision had a positive impact on personal and professional development. The structure of the model appears to make it easier for the inexperienced clinicians to more rapidly develop expertise.[9] (LOE3)

- A mixed methods study investigated the effectiveness of the clinical supervision in allied health professions from the supervisor's perspective. Although the participating allied health disciplines did not include paramedicine, the study's results may be applicable to supervision in prehospital care provided by ambulance services. There appears to be confusion between clinical supervision, line and performance management and mentoring. Nevertheless, clinical supervision was perceived to contribute to the quality of patient care and reflective practice. Clinical supervision was thought to improve patient care and staff satisfaction by empowerment through education, resources development, streamlined documentation and use of best practice protocols.[10] (LOE3)

QI-A.7.2. **The ambulance service staff have access to electronic/online medical education resources.**

☐ Safety Effectiveness

(No evidence identified)

QI-A.7.3. **The ambulance service has a dedicated training and education unit.**

☐ Safety Effectiveness

(No evidence identified)

QI-A.7.4. **The ambulance service has a dedicated research unit.**

☐ Access Safety Effectiveness

(No evidence identified)

QI-A.7.5. **The ambulance service has a formal collaborative research agreement with a partnering university offering paramedicine programs.**

☐ Access Safety Effectiveness

(No evidence identified)

QI-A.7.6. **The ambulance service has a guideline which details the criteria by which it assesses proposals to conduct research by its staff or in collaboration with external parties.**

☐ Safety

(No evidence identified)

Characteristics of the Evidence

This quality indicator evidence summary is based on a structured search of the literature and selected evidence-based healthcare databases. The evidence in this summary comes from:

- A systematic review and meta-analysis of 32 studies, including 15 retrospective cohort studies, eight prospective cohort studies and nine pre-post design studies.[6]
- A systematic review of 26 systematic and non-systematic review, and 47 studies including 22 surveys/questionnaires, five case reports, five mixed methods studies, five qualitative studies, five clinical trials, four action research studies and one cohort study.[7]
- A systematic review of 31 studies including eight systematic reviews, one RCT, one quasi-experimental study, 12 cross-sectional survey studies and nine interview studies.[8]
- A qualitative study utilising focus groups and involving ten participants.[9]
- A mixed-methods study utilising focus groups and a questionnaire and involving 14 and 26 supervisors respectively.[10]

Definitions

Clinical supervision: May be defined as the facilitation of support and learning for healthcare practitioners enabling safe, competent practice and the provision of support to individual professionals who may be working in stressful situations.[7]

Training and education: Training and education in this context of QIs for prehospital care refers to in-service teaching activities aimed at learning specific skills and gaining theoretical knowledge to maintain and develop relevant competencies.

References

1. O'Brien K, Moore A, Dawson, D A, Hartley, P R. An australian story: paramdeic eduction and practice in transition. Australas J Paramed. 2014;11(3):1–13.
2. Milne D. An empirical definition of clinical supervision. Br J Clin Psychol. 2007;46(4):437–47.
3. Kilminster S, Cottrell D, Grant J, Jolly B. AMEE Guide No. 27: Effective educational and clinical supervision. Med Teach. 2007;29(1):2–19.
4. Kliminster S, Jolly B. Effective supervision in clinical practice settings: a literature review. Med Educ. 2000;34:8227–40.
5. O'Meara P, Maguire B, Jennings P, Simpson P. Building an Australasian paramedicine research agenda: a narrative review. Health Res Policy Syst. 2015;13(1):79.
6. Snowdon DA, Hau R, Leggat SG, Taylor NF. Does clinical supervision of health professionals improve patient safety? A systematic review and meta-analysis. Int J Qual Heal Care. 2016;28(4):447–55.
7. Pollock A, Campbell P, Deery R, Fleming M, Rankin J, Sloan G, et al. A systematic review of evidence relating to clinical supervision for nurses, midwives and allied health professionals. J Adv Nurs. 2017;73(8):1825–37.
8. Dawson M, Phillips B, Leggat S. Clinical supervision for allied health professionals: A systematic review. J Allied Health. 2013;42(2):65–73.
9. Brink P, Bäck-Pettersson S, Sernert N. Group supervision as a means of developing professional competence within pre-hospital care. Int Emerg Nurs. 2012;20(2):76–82.
10. Dawson M, Phillips B, Leggat SG. Effective clinical supervision for regional allied health professionals: The supervisor's perspective. Aust Heal Rev. 2013;37(2):262–7.

Sub-Domain 8: Other

Prevalence and/or Significance

- *Consultation*

The concept of consultation is well-established and routinely practiced in the medical profession. Consultation is different to medical direction in that it seeks input in the form of advice and recommendations on a particular patient and their medical management rather than regimented instructions. Consultation is also different to referral in that the responsibility of evaluating and managing the patient remains with the consulting clinician rather than being transferred to the consultant.[1] Consultation is indicated when needed in doubtful or difficult cases, or when they enhance the quality of care.[2] Whilst medical direction is common in US paramedic systems and transferring responsibility to a higher clinical level (e.g. intensive care paramedic) within the ambulance service is widely applied prehospital practice, telephonic consultation is less established within ambulance services. This may be surprising considering the independent practice of paramedics and especially the relatively isolated environment in which prehospital care is provided. The literature on consultation in paramedicine is scarce and appears to refer mostly to consultation with a physician. However, 'senior clinical colleague' in QI-A.8.1. may equally refer to senior paramedics (e.g. clinical team leader or consultant paramedic) providing consultation over the phone or other media.

- *Mental Health Disorders*

The number of Australians with mental health conditions is increasing. In 2017-18, one in five (20.1%; *n*=4.8 million) Australians had a mental or behavioural condition, an increase from 4.0 million (17.5%) in 2014-15.[3] There were 26,062 hospitalisations due to self-harm in 2010-11.[4] In this period, poisons (except gas), contact with sharp objects and hanging accounted for 80.6%, 12.0% and 2.2% of all hospitalisations due to intentional self-harm respectively.[4]

- *Quality Improvement*

Quality improvement is an integral part of any modern health care organisation, including ambulance services. With the growing evidence base for prehospital care as well as pressure to function in progressively complex and demanding environments,[5] the success of out-of-hospital care systems is becoming increasingly dependent on effective implementation and broader quality improvement strategies. Quality improvement entails system thinking, understanding variation, psychology of change, and the theory of knowledge that are applied to improve the performance of processes and systems.[6]

Quality Indicators and Evidence

QI-A.8.1. The ambulance service has arrangements in place enabling paramedics to consult with senior clinical colleagues when dealing with a patient.

Safety Effectiveness

- A Danish before-after pilot study investigated whether telephone consultation from ambulance personnel to a physician at a communication centre would increase the proportion of non-urgent patients being treated and discharged. Compared to the control period, the proportion of patients treated and discharged in the intervention period increased from 21% (n=137) to 29% (n=221) (OR 1.46; 95% CI 1.14 to 1.89, *p*=0.002). Hospital admissions or mortality among patients treated and discharged did not increase. A patient satisfaction survey with the patient cohort indicated that 98.4% (95% CI 91.3 to 99.9) were very satisfied or satisfied with their treatment.[7] (LOE2)

- A Dutch observational study analysed the number of patients without clear ST-elevation myocardial infarction (STEMI) criteria undergoing primary PCI within 90 minutes after implementation of an ECG transmission and consultation protocol. The ECGs of patients who did not meet clear STEMI criteria were transmitted for expert consultation. Of the 1,076 patients with acute ischaemic chest pain who did not meet the automated STEMI criteria 735 (68%) were directly transported to a PCI hospital for further treatment. PCI within 90min was performed in 115 patients.[8] (LOE3)

QI-A.8.2. The ambulance service has arrangements in place enabling paramedics to consult with specialist mental health professionals when dealing with a patient with a mental health disorder.

Safety Effectiveness

- A scoping review examined the extent, range, and nature of research activity associated with the paramedic management of mental health related presentations. The review identified three major themes, namely (a) education and training; (b) organisational factors; and (c) clinical decision making. A number of included studies showed that there is insufficient education and training for paramedics to effectively manage patients with mental health disorders. Paramedic perceptions appear to be that they feel inadequately prepared for these cases. A number of studies also suggested that organisational support is generally inadequate. One study indicated that paramedic see their working relationship with mental health services as being ineffective. The review also suggested that paramedic decision-

making for the mental health patient may generally not be as developed yet as it is for clinical situations.[9] (LOE1)

QI-A.8.3. The ambulance service has a procedure for dealing with patients who refuse care or transportation for the physical effects of self-harm.

☐ Safety Effectiveness

- A systematic review and meta-synthesis investigated the perceptions of paramedics and other prehospital emergency care personnel who provide care for people who self-harm. The review did not identify any studies that specifically examined *paramedic* care for self-harm. The search yielded studies for inclusion which dealt with paramedic or emergency care personnel for patients within the wider context of mental health problems. Furthermore, hospital-based studies with emergency physicians and nurses were found that explored self-harm care. The reviewers found the following emerging metaphors: (a) frustration, futility and legitimacy of care; (b) first contact in the pre-hospital environment: talking, immediate and lasting implications of the moral agent; (c) decision making in self-harm: balancing legislation, risk and autonomy; and (d) paramedics' perceptions: harnessing professionalism and opportunities to contribute to the care of self-harm.[10] (LOE1)

QI-A.8.4. The ambulance service operates a complete quality program that includes quality assessment/measurement, control and improvement.

☐ Access Safety Effectiveness

- A systematic review evaluated the effectiveness and benefits of quality improvement collaboratives. Thirty-two of the 39 included studies reported an improvement one or more of the study's primary effect measures. This included a study within English ambulance services (see below). Eight studies demonstrated that the interventions' effect was maintained 6 months to 2 years after the end of the collaborative. General characteristics of successful quality improvement collaboratives appear to address relatively uncomplicated aspects of care, have a strong evidence base and are aimed at a specific evidence-practice gap in an accepted clinical pathway or guideline.[11] (LOE1)

- A quasi-experimental time series study examined the effect of a national quality improvement collaborative on change in delivery of care bundles for acute myocardial infarction (AMI) and stroke in English National Health Service (NHS) ambulance services. The collaborative involved a national expert group coordinating local ambulance service quality improvement teams and providing workshops on quality improvement methods. Regular communication was maintained between the national expert group and the local ambulance service quality

improvement teams as well as between leads of the teams. Control charts were used to measure performance and provide feedback. The investigators found statistically significant improvements in care bundles in nine of the 12 NHS ambulance service trusts for AMI (OR 1.04; 95% CI 1.04 to 1.04), nine for stroke (OR 1.06; 95% CI 1.05 to 1.07), 11 for either AMI or stroke, and seven for both conditions. Overall care bundle performance for AMI increased in all NHS ambulance services from 43 to 79% and for stroke from 83 to 96%. Specific quality improvement interventions linked to the success included engagement with front-line clinicians, feedback using annotated control charts, expert support, and shared learning between participants and organizations.[12] (LOE2)

Characteristics of the Evidence

This quality indicator evidence summary is based on a structured search of the literature and selected evidence-based healthcare databases. The evidence in this summary comes from:

- A before-after pilot study involving 1,415 patients.[7]
- An observational study without a control group involving 1,076 patients.[8]
- A scoping review of 14 studies, including one systematic review, two cohort studies, two retrospective data analyses, one cross-sectional survey, four qualitative studies and four literature reviews.[9]
- A systematic review 12 qualitative and mixed-methods studies.[10]
- A systematic review of 64 studies including 10 cluster RCTs, 24 controlled before-after studies and 30 interrupted time series studies.[11]
- A quasi-experimental time series study involving all 12 NHS ambulance services.[12]

Definitions

Mental health disorder: A mental health disorder or illness is characterised by a disturbance in a person's cognition, emotional regulation, or behaviour that indicates a dysfunction in the psychological, biological, or developmental processes underlying mental functioning.[13]

Quality improvement collaborative (QIC): An organised, multifaceted approach that includes teams from multiple healthcare sites coming together to learn, apply and share improvement methods, ideas and data on service performance for a given healthcare topic.

References

1. Guertler AT, Cortazzo JM, Rice MM. Referral and Consultation in Emergency Medicine Practice. Acad Emerg Med. 1994;1(6):555–71.
2. Cohn SL. The role of the medical consultant. Med Clin North Am. 2003;87(1):1–6.
3. Australian Bureau of Statistics. National health survey: first results, Australia 2017-18 [Internet]. Canberra; 2018. Available from: http://www.abs.gov.au
4. Australian Institute of Health and Welfare (AIHW). Suicide and hospitalised self-harm in Australia: trends and analysis [Internet]. Canberra; 2014. Available from: https://www.aihw.gov.au/
5. Harrison L. IBISWorld Industry Report Q8591 - Ambulance Services in Australia [Internet]. Melbourne; 2018. Available from: https://www.ibisworld.com.au/
6. Perla RJ, Provost LP, Parry GJ. Seven propositions of the science of improvement: exploring foundations. Qual Manag Health Care. 2013;22(3):170–86.
7. Raaber N, Bøtker MT, Riddervold IS, Christensen EF, Emmertsen NC, Grøfte T, et al. Telemedicine-based physician consultation results in more patients treated and released by ambulance personnel. Eur J Emerg Med. 2018;25(2):120–7.
8. Anroedh SS, Kardys I, Akkerhuis KM, Biekart M, van der Hulst B, Deddens GJ, et al. e-Transmission of ECGs for expert consultation results in improved triage and treatment of patients with acute ischaemic chest pain by ambulance paramedics. Netherlands Hear J. 2018;26(11):562–71.
9. Emond K, O'Meara P, Bish M. Paramedic management of mental health related presentations: a scoping review. J Ment Heal [Internet]. 2018;0(0):1–8. Available from: https://www.tandfonline.com/doi/full/10.1080/09638237.2018.1487534
10. Rees N, Rapport F, Snooks H. Perceptions of paramedics and emergency staff about the care they provide to people who self-harm: Constructivist metasynthesis of the qualitative literature. J Psychosom Res [Internet]. 2015;78(6):529–35. Available from: http://dx.doi.org/10.1016/j.jpsychores.2015.03.007
11. Wells S, Tamir O, Gray J, Naidoo D, Bekhit M, Goldmann D. Are quality improvement collaboratives effective? A systematic review. BMJ Qual Saf. 2018;27(3):226–40.
12. Siriwardena AN, Shaw D, Essam N, Togher FJ, Davy Z, Spaight A, et al. The effect of a national quality improvement collaborative on prehospital care for acute myocardial infarction and stroke in England. Implement Sci. 2014;9(1):1–9.
13. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders. (DSM-5VR). Washington, D.C.: American Psychiatric Association; 2013.

DOMAIN B: CLINICAL

DOMAIN B: CLINICAL

Sub-Domain 1: Airway Management, Ventilation and Oxygen Therapy

This evidence summary excludes QIs and evidence regarding airway management, ventilation and oxygen therapy for specific patient cohorts, e.g. acute coronary syndrome (ACS). These are covered in the relevant disease-specific sub-domains.

Prevalence and/or Significance

Oxygen is essential for aerobic cellular metabolism producing energy, one of the hallmarks of vertebrate physiology.[1] Patients suffering critical illness or injury may lose their ability to self-maintain their airway and/or effective ventilation and oxygenation. Failure to establish a patent airway or failure to recognize potential airway compromise may be associated with negative outcomes. Even when deprived of oxygen for only short periods of time, neuronal and myocardial tissue may undergo pathophysiological processes associated with the low-oxygen state and experience time-dependent, irreparable damage.[2] Hypoventilation and especially apnoea are thus some of the fastest ways to produce hypoxaemia and subsequent irreversible hypoxic brain injury or death.[3] Aspiration of foreign substances, gastric content or secretions also carries a significantly increased risk of morbidity and mortality.

It follows that attempting to stabilize a patient is futile if airway patency, ventilation and oxygenation cannot be achieved and maintained. Therefore, airway management, ventilation and oxygen therapy are some of the fundamental skills of prehospital emergency care that demand competency in time-critical clinical interventions from the paramedic or other prehospital healthcare provider.[4–6] The incidence of patient requiring airway management amongst patients seen by ambulance services in Australia is unclear.

Quality Indicators and Evidence

QI-B.1.1. **A patient with a decreased level of consciousness (Glasgow Coma Score ≤14), has their airway patency assessed.**

Effectiveness | ⇨ Guidelines[A]

- A prospective observational study described the relationship of gag and cough reflexes to Glasgow coma score (GCS) in 208 adult patients requiring critical care. Reduced gag and cough reflexes were found to be significantly related to reduced GCS (p = 0.014 and 0.002, respectively). However, of 33 patients with a GCS ≤ 8, 12 (36.4%) had normal gag reflexes and 8 (24.2%) had normal cough reflexes. Of 62 patients with a GCS of 9-14, 23 (37.1%) had

absent gag reflexes and 27 (43.5%) had absent cough reflexes. In 113 patients with a GCS of 15, 25 (22.1%) had absent gag reflexes and 29 (25.7%) had absent cough reflexes. Thus, a considerable proportion of patients with a GCS ≤ 8 had intact airway reflexes and may have been capable of maintaining their own airway, whilst many patients with a GCS > 8 had impaired airway reflexes and may have been at risk of aspiration.[7] (LOE3)

- A retrospective trauma registry-based study of 120 patients with a GCS <14 evaluated the need for emergency intubation in the field (or emergency department) and compared this to computed tomography (CT) scan findings. The patients in GCS group 3-5 were all intubated, 73% had abnormal CT scans; 73% of patients with GCS 6-7 were intubated, 36% had abnormal CT scans; 62% of patients with GCS 8-9 were intubated, 62% had abnormal CT scans; 20% of patients with GCS 10-13 required intubation, 23% had abnormal CT scans. Patients with GCS ≤9 represent candidates for airway management.[8] (LOE4)

QI-B.1.2. **A hypoxaemic patient (SpO_2 <94%) is administered oxygen, unless contraindicated.**

Effectiveness ⇨ Guidelines[B]

- An observational study analysed the SpO_2 range of 37,593 acutely ill patients breathing room air at the time of measurement and showed a step-wise increase in mortality. The mortality for patients with initial SpO_2 values of 97%, 96% and 95% was 3.65% (95% CI 3.22 to 4.13); 4.47% (95% CI 3.99 to 5.00); and 5.67% (95% CI 5.03 to 6.38), respectively. This continued to increase incrementally to mortality above 25% among patients with saturation <88%.[9] (LOE3)

QI-B.1.3. **A normoxaemic patient (SpO_2 ≥94%) is <u>not</u> administered oxygen, unless specifically indicated.**

Effectiveness ⇨ Guidelines[B]

- A systematic review and meta-analysis compared liberal versus conservative oxygen therapy in acutely ill adults. Compared with a conservative oxygen strategy, a liberal oxygen strategy (median baseline saturation of peripheral oxygen [SpO_2] across trials, 96% [range 94-99%, IQR 96-98]) increased mortality in-hospital (RR 1.21; 95% CI 1.03 to 1.43), at 30 days (RR 1.14; 95% CI 1.01 to 0.29), and at longest follow-up (RR 1.10; 95% CI 1.00 to 1.20). Morbidity outcomes were similar between groups. In acutely ill adults, high-quality evidence shows that liberal oxygen therapy increases mortality without improving other patient-important outcomes. Supplemental oxygen might become unfavourable above an SpO_2 range of 94-96%.[10] (LOE1)

QI-B.1.4. **A patient who has a supraglottic airway inserted, meets appropriate indications for the airway intervention.**

Effectiveness

- A systematic review compared ETI to alternative airway techniques (AAT), such as bag-mask ventilation or extraglottic devices, performed by paramedics in the prehospital setting. Outcome measures assessed were survival, neurologic outcome, complications as well as success rates. The review found no difference in these outcomes between ETI and AAT. However, the review included only five pseudo-RCTs, one of which enrolled pediatric patients. The other four enrolled patients in cardiac or respiratory arrest.[11] (LOE1)

- A systematic review of three RCTs compared outcomes in terms of survival, degree of disability at discharge or length of stay and complications between patient who received ETI as opposed to other airway management techniques. The two trials of adults in non-traumatic cardiac arrest found non-significant survival disadvantage in patients who received physician-operated ETI versus a combi-tube (RR 0.44; 95% CI 0.09 to 1.99) and those who received paramedic-operated ETI versus an esophageal gastric airway (RR 0.86; 95% CI 0.39 to 1.90). The one trial of paediatric patients showed no difference in survival (OR 0.82; 95% 0.61 to 1.11) or neurologic outcome (OR 0.87; CI 95% 0.62 to 1.22) between prehospital ETI and prehospital ETI followed by emergency department ETI.[12] (LOE1)

QI-A.1.5. **In a patient who has a supraglottic airway inserted, the correct position of the supraglottic airway is assessed using an exhaled CO2 detector.**

Effectiveness

(No evidence identified)

QI-A.1.6. **A patient who is endotracheally intubated, meets appropriate indications for the procedure.**

Effectiveness

- *(As listed for QI-B.1.4. above.)* A systematic review compared ETI to AAT, such as bag-mask ventilation or extraglottic devices, performed by paramedics in the prehospital setting. Outcome measures assessed were survival, neurologic outcome, complications as well as success rates. The review found no difference in these outcomes between ETI and AAT. However, the review included only five pseudo-RCTs, one of which enrolled paediatric patients. The other four enrolled patients in cardiac or respiratory arrest.[11] (LOE1)

- *(As listed for QI-A1.4. above.)* A systematic review of three RCTs compared outcomes in terms of survival, degree of disability at discharge or length of stay and complications between patient who received ETI as opposed to other airway management techniques. The two trials of adults in non-traumatic cardiac arrest found non-significant survival disadvantage in patients who received physician-operated ETI versus a combi-tube (RR 0.44; 95% CI 0.09 to 1.99) and those who received paramedic-operated ETI versus an esophageal gastric airway (RR 0.86; 95% CI 0.39 to 1.90). The one trial of paediatric patients showed no difference in survival (OR 0.82; 95% 0.61 to 1.11) or neurologic outcome (OR 0.87; CI 95% 0.62 to 1.22) between prehospital ETI and prehospital ETI followed by emergency department ETI.[12] (LOE1)

- A systematic review and meta-analysis compared the mortality rates of adult trauma patients undergoing prehospital intubation to those receiving intubation in the emergency department (ED). The median mortality rate in patients undergoing prehospital intubation was 48% (range 8-94%), compared to 29% (range 6-67%) in patient undergoing ED intubation. Odds ratios were in favour of ED intubation both in crude and adjusted mortality, 2.56 (95% CI 2.06 to 3.18) and 2.59 (95% CI 1.97 to 3.39) respectively. However, subgroup analyses of studies in which all patients intubated prehospitally had access to Rapid Sequence Intubation (RSI) showed a less negative trend than for the studies in which RSI was not available for all, which suggests that access to prehospital RSI is of importance.[13] (LOE3)

QI-A.1.7. A patient who is intubated, is successfully endotracheally intubated.

➲ Effectiveness

- A systematic review and meta-analysis compared RSI success and adverse events between physicians and non-physicians (paramedics and nurses) in the prehospital setting. The analysis indicated that RSI success was higher in physicians (99%; 95% CI 98% to 99%) compared to non-physicians (97%; 95% CI 95% to 99%) and mostly lower rates of adverse events.[14] (LOE1)

- A systematic review and meta-analysis compared the ETI success rates of physicians and non-physicians, and those of non-physicians using different levels of drug assistance. All physicians had access to standard RSI drugs. The median ETI success rates for physicians and non-physicians were 0.991 (range 0.973 to 1.000) and 0.849 (range 0.491 to 0.990). When comparing physicians with non-physicians who had access to standard RSI drugs, physicians still had better success rates: 0.991 (range 0.974 to 1.000) and 0.955 (range 0.758 to 0.990) respectively (p=0.047).[15] (LOE1)

- A systematic review and meta-analysis compared prehospital ETI (RSI, non-RSI and OHCA) success by different providers. The overall intubation success rate was 0.969 (range 0.616 to 1.000) and the crude median reported intubation success rate for non-physicians and physicians were 0.917 (range 0.616 to 1000) and 0.988 (range 0.781 to 1.000) respectively (p=0.0003). Less experienced providers performed less well.[16] (LOE1)

- A systematic review and meta-analysis compared success rates of ETI across various groupings. Across all clinicians and all oral ETIs, the pooled success rate was 89.2% (95% CI 87.7 to 90.5). Further pooled estimates and 95% CI for success for non-physicians were as follows: oral ETI for non-cardiac arrest patients: 69.8% (50.9 to 83.8); drug-facilitated intubation (DFI): 86.8% (80.2 to 91.4); and RSI: 96.7% (94.7 to 98.0). For paediatric patients, the paramedic oral ETI success rate was 83.2% (55.2 to 95.2).[17] (LOE2)

QI-A.1.8. For an endotracheally intubated patient, the correct position of the endotracheal tube is assessed using an exhaled CO2 detector.

➲ Effectiveness

- A systematic review performed by International Liaison Committee on Resuscitation (ILCOR) Advanced Life Support (ALS) Task Force compared several devices (waveform capnography, CO2 detection device, oesophageal detector device, or tracheal ultrasound) to no device to confirm correct endotracheal tube placement. The review was aimed at OHCA but included studies with non-cardiac arrest or mixed cardiac arrest/non-cardiac arrest patients. One observational study with 153 critically ill patients (51 in cardiac arrest) indicated that the use of waveform capnography compared with no waveform capnography decreased the occurrence of unrecognized oesophageal intubation on hospital arrival from 23% to 0% (OR, 29; 95% CI 4 to 122). Three observational studies involving 401 patients and one randomized study involving 48 patients showed that the specificity for waveform capnography was 100% (95% CI 87% to 100%). The sensitivity was 100% in one study when waveform capnography was used in the prehospital setting immediately after intubation. The sensitivity was between 65% and 68% in the other three studies when the device was used in OHCA patients after intubation in the emergency department. Seven observational studies including 1,119 patients investigated the accuracy of colorimetric CO2 devices. The specificity was 97% (95% CI 84 to 99), the sensitivity was 87% (95% CI 85 to 89), and the FPR was 0.3% (95% CI 0 to 1).[18] (LOE1)

QI-A.1.9. A patient who is endotracheally intubated has their pulse oximetry continuously monitored during the procedure.

➲ Effectiveness

- An observational study involving 191 adult patients undergoing ETI assessed whether continuous pulse oximetry improves the recognition and management of hypoxemia (SpO_2 <90%) during emergency endotracheal intubation. Hypoxaemia occurred more frequently during unmonitored than during monitored ETI attempts (30 of 111 vs. 15 of 100; p<0.05). The duration of severe hpoxaemia (SpO_2 <85%) was significantly longer for unmonitored attempts(p<0.05).[19] (LOE3)

QI-A.1.10. A patient who receives cricothyrotomy, meets appropriate indications for the procedure.

➲ Effectiveness

(No evidence identified)

QI-A.1.11. A patient who receives cricothyrotomy, has the procedure performed successfully.

➲ Effectiveness

- A systematic review and meta-analysis included an examination of the pooled estimates of success rates of needle cricothyrotomy and surgical cricothyrotomy. Twenty-one studies including a total of 512 patients were included. Pooled estimates for intervention success across all clinicians and patients were 65.8% (95% CI 42.3 to 83.6) for needle cricothyrotomy and 90.5% (95% CI 84.8 to 94.2) for surgical cricothyrotomy. Subgroup analysis of all non-physicians indicated pooled estimates of 55.6% (95% CI 24.5 to 82.9) for needle cricothyrotomy and 90.4% (95% CI 83.3 to 94.6) for surgical cricothyrotomy.[20] (LOE2)

Characteristics of the Evidence

This QIES is based on a structured search of the literature and selected evidence-based healthcare databases. The evidence in this summary comes from:

- An observational study of 208 patients.[7]
- A retrospective trauma registry-based study of 120 patients.[8]
- An observational study of 37,593 patients.[9]
- A systematic review and meta-analysis of 25 RCTs.[10]

- A systematic review of five RCTs or quasi-RCTs involving 1,559 patients.[11]
- A Cochrane systematic review of three RCTs involving 347 adult and 830 paediatric patients.[12]
- A systematic review and meta-analysis of 21 studies involving 35,838 patients, including 1 RCT, 2 observational cohort studies and 18 retrospective data set studies.[13]
- A systematic review and meta-analysis of 89 studies including two RCTs, 11 nonrandomized trials, 25 prospective and 51 retrospective studies.[14]
- A systematic review and meta-analysis of 58 studies including 2 RCTs and 56 other study designs.[15]
- A systematic review and meta-analysis of 38 studies, including 2 RCTs and 36 other study designs.[16]
- A systematic review and meta-analysis of 117 studies reporting prehospital oral ETI including 56 prospective studies, eight studies with before-after design, and 53 retrospective studies.[17]
- A systematic review performed by the LCOR ALS Task Force including 1 pseudo-RCTs involving 48 patients and four observational studies involving 554 patients.[18]
- A prospective observational study without a control group.[19]
- A systematic review and meta-analysis of 56 studies involving 10,684 patients using quasi-experimental and other lower study designs.[20]

Supporting Australian Guidelines and ACSQHC Clinical Care Standards

A. Australian and New Zealand Committee on Resuscitation (ANZCOR). ANZCOR Guideline 4 – Airway [Internet]. Melbourne: ANZCOR; 2016. p. 1–7. Available from: https://resus.org.au/guidelines/

B. Australian and New Zealand Committee on Resuscitation (ANZCOR). ANZCOR Guideline 11.6.1 – Targeted Oxygen Therapy in Adult Advanced Life Support [Internet]. Melbourne: ANZCOR; 2016. p. 1–9. Available from: https://resus.org.au/guidelines/

Definitions

Airway Management: Airway management may be defined as the interventions that provide and maintain an open and clear passageway to facilitate ventilation, which is airflow through the conducting airways of the respiratory system.[21] **Basic airway management** includes manual airway manoeuvres (e.g. jaw-thrust) and insertion of basic airway adjuncts (e.g. oropharyngeal/Guedel airway).

Endotracheal Intubation (ETI): The procedure of passing an **endotracheal tube (ETT)** through the vocal cords to sit in the trachea. ETI is widely regarded as the gold standard in airway management. There are various direct and indirect

laryngoscopes designed to enable viewing of the vocal cords for the purpose of endotracheal intubation (ETI). This may be done without any medication, facilitated by sedatives and analgesics, or, in the case of **rapid or delayed sequence intubation (RSI/DSI)** enabled by the administration of anaesthetic and paralytic agents. A last-resort airway intervention in a failed airway situation may be **emergency cricothyrotomy**, which involves passing an over-the-needle catheter through the cricothyroid membrane or making a surgical incision at this site to insert a relatively small-sized ETT. This is aimed at enabling percutaneous translaryngeal ventilation.

Oxygenation: The physiological process of oxygen diffusing passively from the alveoli to the pulmonary capillaries, where it binds to haemoglobin in red blood cells or dissolves into the plasma.[22] Strictly defined, **hypoxaemia** is an arterial blood partial pressure of oxygen (PaO_2) below normal.[23] In the absence of respiratory pathology, a PaO_2 of <8 kPa or 60 mmHg, corresponding to an arterial oxygen saturation (SpO_2) of about 90%, is frequently used to define hypoxaemia requiring treatment; for patients with chronic obstructive pulmonary disease (COPD), a value of <8 kPa (SpO2 <90%) may be 'normal'.[23] In nearly all patients, the initial treatment of hypoxaemia is oxygen therapy,[23,24] i.e. increasing the inspired oxygen concentration. Patients whose ventilations are insufficient to maintain adequate PaO_2/SpO_2 despite oxygen therapy, or who are apnoeic, need oxygen therapy using a manual or mechanical ventilation device.[23] Furthermore, hypoventilation is associated with hypercapnia due to an inverse relationship between alveolar ventilation and arterial partial pressure of carbon dioxide ($PaCO_2$).[23] The simplest and most widely used manual device is the **bag-valve-mask (BVM)**. Clinically more advanced paramedics and physicians may utilise mechanical transport ventilators in prehospital care and especially during inter-hospital intensive care transfers.

Supraglottic Airways (SGA): These may also be referred to as **Alternative Airway Devices (AADs)** or **Extraglottic Airways Devices (EADs).** Commonly used examples include the laryngeal mask airway (LMA) and the iGel LMA. They are airway devices that facilitate ventilation without any part of it passing through the vocal cords. SGAs are commonly used in OHCA, but also in the non-OHCA patient who presents with unconsciousness and absent airway reflexes or as a rescue airway device after failed endotracheal intubation.

Ventilation: Ventilation may take place spontaneously or may be assisted or produced artificially by manual or mechanical means.

References

1. Lane N. Oxygen: The Molecule That Made the World. Oxford: Oxford University Press; 2012.
2. Brown III CA, Careleton SC, Reardon RF. Supplemental Oxygen. In: Walls RM, Murphy M, editors. Manual of Emergency AIrway Management. Philadelphia: Wolters Kluwer Health; 2012.
3. Farmery AD, Roe PG. A model to describe the rate of oxyhaemoglobin desaturation during apnoea. Br J Anaesth. 1996;76(2):284–91.
4. Kovacs G, Law JA, editors. Airway Management in Emergencies - a free open access living textbook [Internet]. Infinity e. Halifax; 2018. Available from: http://www.aimeairway.ca/book#/
5. Burtenshaw A, Benger J, Nolan J, editors. Emergency airway management. 2nd ed. Cambridge: Cambridge University Press; 2015.
6. Walls R, Murphy M, editors. Manual of Emergency Airway Management. 4th ed. Philadelphia: Wolters Kluwer Health; 2012.
7. Rotheray KR, Cheung PSY, Cheung CSK, Wai AKC, Chan DYS, Rainer TH, et al. What is the relationship between the Glasgow coma scale and airway protective reflexes in the Chinese population? Resuscitation. 2012;83(1):86–9.
8. Hsiao AK, Michelson SP, Hedges JR. Emergent intubation and CT scan pathology of blunt trauma patients with Glasgow Coma Scale scores of 3-13. Prehosp Disaster Med. 1993;8(3):229–36.
9. Smith GB, Prytherch DR, Watson D, Forde V, Windsor A, Schmidt PE, et al. SpO2 values in acute medical admissions breathing air-Implications for the British Thoracic Society guideline for emergency oxygen use in adult patients? Resuscitation. 2012;83(10):1201–5.
10. Chu DK, Kim LHY, Young PJ, Zamiri N, Almenawer SA, Jaeschke R, et al. Mortality and morbidity in acutely ill adults

treated with liberal versus conservative oxygen therapy (IOTA): a systematic review and meta-analysis. Lancet. 2018;391(10131):1693–705.

11. Jensen JL, Cheung KW, Tallon JM, Travers AH. Comparison of tracheal intubation and alternative airway techniques performed in the prehospital setting by paramedics: A systematic review. Can J Emerg Med. 2010;12(2):135–40.
12. Lecky F, Bryden D, Little R, Tong N, Moulton C. Emergency intubation for acutely ill and injured patients. Cochrane Database Syst Rev. 2008;16(2):CD001429.
13. Fevang E, Perkins Z, Lockey D, Jeppesen E, Lossius HM. A systematic review and meta-analysis comparing mortality in pre-hospital tracheal intubation to emergency department intubation in trauma patients. Crit Care. 2017;21(1).
14. Fouche PF, Stein C, Simpson P, Carlson JN, Doi SA. Nonphysician Out-of-Hospital Rapid Sequence Intubation Success and Adverse Events: A Systematic Review and Meta-Analysis. Ann Emerg Med [Internet]. 2017;70(4):449–459.e20. Available from: http://dx.doi.org/10.1016/j.annemergmed.2017.03.026
15. Lossius HM, Røislien J, Lockey DJ. Patient safety in pre-hospital emergency tracheal intubation: A comprehensive meta-analysis of the intubation success rates of EMS providers. Crit Care. 2012;16(1):1–9.
16. Crewdson K, Lockey DJ, Røislien J, Lossius HM, Rehn M. The success of pre-hospital tracheal intubation by different pre-hospital providers: A systematic literature review and meta-analysis. Crit Care. 2017;21(1):1–10.
17. Hubble MW, Brown L, Wilfong DA, Hertelendy A, Benner RW, Richards ME. A meta-analysis of prehospital airway control techniques part I: Orotracheal and nasotracheal intubation success rates. Prehospital Emerg Care. 2010;14(3):377–401.
18. Callaway CW, Soar J, Aibiki M, Böttiger BW, Brooks SC, Deakin CD, et al. Part 4: Advanced life support: 2015 International consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations. Vol. 132, Circulation. 2015. 84-145 p.
19. Mateer JR, Olson DW, Stueven HA, Aufderheide TP. Continuous pulse oximetry during emergency endotracheal intubation. Ann Emerg Med. 1993;22(4):675–9.
20. Hubble MW, Wilfong DA, Brown LH, Hertelendy A, Benner RW. A meta-analysis of prehospital airway control techniques part ii: Alternative airway devices and cricothyrotomy success rates. Prehospital Emerg Care. 2010;14(4):515–30.
21. Gregory P, Mursell I. Manual of clinical paramedic procedures. Hoboken, NJ: Wiley-Blackwell; 2010.
22. Theodore AC. UpToDate [Internet]. Oxygenation and mechanisms of hypoxemia. 2018 [cited 2018 Jul 3]. Available from: https://www.uptodate.com/contents/oxygenation-and-mechanisms-of-hypoxemia
23. Gwinnutt C. Delivery of oxygen. In: Burtenshaw A, Benger J, Nolan J, editors. Emergency Airway Management. 2nd ed. Cambridge: Cambridge University Press; 2015. p. 3–19.
24. Walls R, Murphy M, editors. Manual of Emergency Airway Management. 4th ed. Philadelphia: Wolters Kluwer Health; 2012.

Sub-Domain 2: Out-of-Hospital Cardiac Arrest

NB: This evidence summary excludes QIs and evidence regarding dispatcher-instructed cardiopulmonary resuscitation (DI-CPR). These are included in Sub-Domain A.4. Communication/Dispatch. The QIs focus on adult medical out-of-hospital cardiac arrest.

Prevalence and/or Significance

The total incidence of OHCA cases in Australia is unknown. Five of the eight Australian State/Territory ambulance services (Ambulance Victoria, Queensland Ambulance Service, South Australia Ambulance Service, St John Ambulance Northern Territory, St John Ambulance Western Australia currently contribute data to the Aus-ROC Epistry. These five Ambulance Services provide prehospital emergency care to approximately 19.8 million persons, representing 64% of the Australian population.[1]

In 2015, the Aus-ROC Epistry recorded 15,129 OHCA cases in Australia.[1] The crude incidence was 99.4 per 100,000 population.[1] Response time for non-EMS witnessed cases varied between a median of 7.5 and 8.9 min.[1] Resuscitation was attempted in 47.1% (*n*=7,120) of all cases.[1] A shockable rhythm was present in 24.7% of cases with attempted resuscitation (range: 19.5%-36.5%).[1] Seventy-one percent of OHCA with attempted resuscitation were of a presumed cardiac aetiology (range: 50.9%-79.7%).[1] For those OHCA cases who received resuscitation, 32.9% (*n*=2,339) achieved return of ROSC in the prehospital setting and 27.4% (*n*=1,953) survived the event.[1] Only three of the five Australian ambulance services collected data on survival to hospital discharge/30 days.[1] Overall survival to hospital discharge/30 days in these ambulance services was 11.3% (range: 9.4%-12.6%).[1]

Quality Indicators and Evidence

QI-B.2.1. An ambulance arrives at an OHCA patient within X minutes of the 000-call. (X = 2, 4, 6, 8, 10, 12, 15 or 20)

Access ⇨ Guidelines[A]

- A retrospective registry study explored the effect of ambulance response time on survival after resuscitation from OHCA. The rate of hospital discharge was significantly affected by several patient- and system factors, including ambulance response time. When comparing faster and slower EMS systems, defined as those arriving on the scene within 8 minutes in

more than 75% of cases or in ≤ 75% of cases respectively, faster EMS systems had a higher discharge rate with favourable neurological outcome (CPC ≤2) (7.7 versus 5.6 persons per 100,000 population per year; OR 0.72; 95% CI 0.66 to 0.79, p<0.001).[2] (LOE3)

- A retrospective registry study examined the association of bystander CPR with survival as time to advanced treatment increases. Increasing response times negatively affected adjusted 30-day survival chances for both patients with bystander CPR and those without. In patients with versus without bystander CPR and a response time within 5 minutes, 30-day survival was 14.5% (95% CI 12.8 to 16.4) versus 6.3% (95% CI 5.1 to 7.6). In patients with versus without bystander CPR and a response time within 10 minutes, 30-day survival chances were 6.7% (95% CI 5.4 to 8.1) versus 2.2% (95% CI 1.5 to 3.1). The contrast in 30-day survival became statistically insignificant when response time was >13 minutes (bystander CPR vs no bystander CPR: 3.7% [95% CI 2.2 to 5.4] vs 1.5% [95% CI 0.6 to 2.7]), but 30-day survival was still 2.5 times higher associated with bystander CPR.[3] (LOE3)

- A retrospective registry study sought to identify upper limits of EMS response times associated with neurologically intact survival. Increased EMS response time was associated with significantly decreased adjusted odds of 1-month neurologically intact (CPC ≤2) survival (aOR for each 1-minute increase, 0.89; 95% CI 0.89 to 0.90), however, this relationship was modified by bystander interventions. The upper limits of the EMS response times associated with improved 1-month neurologically intact survival were 13 min when bystanders provided CPR and defibrillation and 11 min when bystanders provided CPR only.[4] (LOE3)

QI-B.2.2. Paramedics providing CPR utilise an audio-visual feedback and prompt device for real-time optimisation of CPR quality.

Effectiveness | ⇨ Guidelines[B]

- A systematic review and meta-analysis performed as part of an International Liaison Committee On Resuscitation (ILCOR) international consensus process investigated the effects of audio-visual feedback and prompt devices on several cardiac arrest outcome and CPR quality measures. None of the included studies demonstrated statistically significant difference in favourable neurologic outcome or survival to hospital discharge with the use of CPR feedback. The effect of CPR feedback on survival with good neurologic outcome ranged from −0.8 to 5.8%, and on survival to hospital discharge from −0.9 to 5.2. One study showed a statistically significant difference in ROSC with the use of feedback. Effect of CPR feedback on ROSC ranged from −4.4% to 17.5%.[5] (LOE3)

QI-B.2.3. **For an OHCA patient in a shockable rhythm, the first defibrillation attempt is made as soon as possible after arrival on scene.**

Effectiveness | ⇨ Guidelines[A]

- A detailed systematic review and meta-analysis performed as part of an ILCOR international consensus process investigated the effects of a prolonged period of chest compressions before defibrillation compared with a short period of chest compressions before defibrillation on several outcome measures. None of the included studies demonstrated statistically significant benefit from a short period of CPR before shock delivery in terms of ROSC (OR 1.193; 95% CI 0.871 to 1.634), survival to hospital discharge (OR 1.095; 95% CI 0.695 to 1.725), or hospital discharge with favourable neurological outcome (OR 0.95; 95% CI 0.786 to 1.15).[5] (LOE1)

QI-B.2.4. **For an adult OHCA patient, the airway is secured by a supraglottic airway (SGA) or endotracheal tube (ETT).**

Effectiveness | ⇨ Guidelines[A]

- An in-depth systematic review performed as part of an ILCOR international consensus process investigated the effects of inserting an advanced airway (SGA or ETT), compared with basic airway (bag-mask device with or with- out oropharyngeal airway) on several outcome measures. One observational study indicated a lower unadjusted rate of survival with insertion of an advanced airway (tracheal tube or LMA) compared with a bag-mask device (7.7% versus 21.9%; OR 0.30; 95% CI 0.3 to 0.3). In an analysis of 3,398 propensity-matched patients from the same study, the OR for favourable neurologic survival at hospital discharge (bag-mask device versus advanced airway) adjusted for all variables was 4.19 (95% CI 3.09 to 5.70). A second observational study showed an unadjusted rate of survival with insertion of an advanced airway (tracheal tube or LMA) compared with a bag-mask device (6.6% versus 7.0%; OR 0.94; 95% CI 0.7 to 1.3).[6] (LOE3)

QI-B.2.5. **An OHCA patient in refractory VF/VT is administered intravenous/intraosseous amiodarone or lignocaine, unless contraindicated.**

Effectiveness | ⇨ Guidelines[C]

- An in-depth systematic review performed as part of an ILCOR international consensus process investigated the effects of amiodarone, lignocaine and other antiarrhythmic drugs on several outcome measures. One RCT showed higher ROSC with administration of amiodarone (300 mg after 1 mg of adrenaline) compared with no drug (64% versus 41%; *p*=0.03; RR 1.55; 95% CI 1.31 to 1.85). However, the trial detected no difference in terms of

survival to discharge (13.4% versus 13.2%; *p*=not significant (NS); RR 1.02; 95% CI 0.65 to 1.59) nor with survival with favourable neurologic outcome at discharge (7.3% versus 6.6%; *p*=NS; RR 1.11; 95% CI 0.59 to 2.10). One observational study demonstrated higher ROSC with administration of lignocaine (50 mg, repeatable up to 200 mg) compared to no drug (45% versus 23%; *p*<0.001). Another observational study demonstrated no difference in ROSC after lignocaine or no drug (55% versus 54%; *p*=NS). Neither of the two observational studies demonstrated any benefit of lignocaine in improving survival to discharge (14% versus 8%; *p*=NS and 11% versus 2%; *p*=NS respectively).[6] (LOE1)

- An RCT comparing amiodarone (5mg/kg, followed by 2.5mg/kg if required) with lidocaine (1.5mg/kg, repeated once if required) as an adjunct to defibrillation in OHCA found that amiodarone was superior in facilitating ROSC (22.8% of versus 12.0%; *p*=0.009; OR 2.17; 95% CI 1.21 to 3.83).[7] (LOE1)

QI-B.2.6. **The receiving hospital receives notification of an OHCA/post-OHCA patient.**

Access

(No evidence identified)

QI-B.2.7. **A patient who was in OHCA survives the event, i.e. has return to spontaneous circulation (ROSC) on arrival at the receiving hospital.**

Effectiveness ⇨ Guidelines[A]

- A systematic review and meta-analysis evaluated the strength of associations between OHCA and key factors including ROSC. Out of all predictors assessed, the most powerful criterion associated with survival from OHCA was ROSC. Stratified by baseline rates, survival to hospital discharge was more likely among those who achieved return of spontaneous circulation (15.5% to 33.6%).[8] (LOE3)

QI-B.2.8. **A patient who was in OHCA survives to discharge from hospital or to 30 days from the event.**

Effectiveness ⇨ Guidelines[A]

QI-B.2.9. **A patient who was in OHCA is discharged from hospital with favourable neurological outcome; CPC ≤2 or mRS ≤3.**

Effectiveness ⇨ Guidelines[A]

(Outcome QIs)

Characteristics of the Evidence

This quality indicator evidence summary is based on a structured search of the literature and selected evidence-based healthcare databases. The evidence in this summary comes from:

- Three retrospective registry studies.[2–4]
- A systematic review and meta-analysis performed as part of an ILCOR international consensus process including two pseudo-RCTs and 10 observational studies.[5]
- A systematic review and meta-analysis performed as part of an ILCOR international consensus process including five RCTs, four observational cohort studies, three meta-analyses and one subgroup analysis of data reported in one of the RCTs.[5]
- A systematic review performed as part of an ILCOR international consensus process including two observational studies.[6]
- A systematic review performed as part of an ILCOR international consensus process including one RCT and two observational studies.[6]
- An RCT of 347 enrolled patients.[7]
- A systematic review and meta-analysis 79 cohort studies.[8]

Supporting Australian Guidelines

A. Australian Resuscitation Council (ARC). ANZCOR Guideline 6 – Compressions [Internet]. Melbourne: ARC; 2016. Available from: https://resus.org.au/guidelines/

B. Australian Resuscitation Council (ARC). ANZCOR Guideline 6 – Compressions [Internet]. Melbourne: ARC; 2016. Available from: https://resus.org.au/guidelines/

C. Australian Resuscitation Council (ARC). ANZCOR Guideline 11.5 – Medications in Adult Cardiac Arrest [Internet]. Melbourne: ARC; 2016. Available from: https://resus.org.au/guidelines/

Definitions

For the purpose of this evidence summary, the Utstein definitions will be used. Utstein-style reporting originated from an international multidisciplinary meeting held at the Utstein Abbey near Stavanger, Norway, in 1990.[9] The purpose of this inaugural meeting was establish consensus on terms and definitions used for the reporting of out-of-hospital cardiac arrest (OHCA) and resuscitation. Amongst several other aims, this standardisation was intended to facilitate quality improvement efforts.[10] The original Utstein definitions and Resuscitation Registry Template were revised and updated in 2004 and 2015.[10,11] The Australian Resuscitation Outcomes Consortium (Aus-ROC) Epistry collects data across all participating sites mostly in accordance with Utstein definitions.[12–14]

Cardiac arrest: Cardiac arrest is defined as the cessation of cardiac mechanical activities as confirmed by the absence of signs of circulation.[11] Cardiac arrest is a time-critical disease state and thus minimising the time to initiation of interventions can result in improved outcomes.

Cardiopulmonary resuscitation (CPR): An attempt to restore spontaneous circulation by performing chest compressions with or without ventilations.[11]

Neurological status ort outcome: There are numerous ways to assess neurological status. The Utstein-style templates evaluate neurological outcome after survived cardiac arrest using the Cerebral Performance Category (CPC) or modified Rankin Scale (mRS).[10] The CPC is a 5-point scale ranging from 1 (good cerebral performance) to 5 (dead). The mRS is a 7-point scale ranging from 0 (no symptoms) to 6 (dead). Survival with favourable neurological outcome is defined as a CPC 1 or 2 or mRS 0 to 3 or no change in CPC or mRS from the patient's baseline status.[10]

Out-of-Hospital Cardiac Arrest (OHCA): OHCA refers to cardiac arrest that occurs anywhere other than in the in-hospital setting.

Return of spontaneous circulation (ROSC): The reappearance of a spontaneous perfusing rhythm that results in more than an occasional gasp, brief palpated pulse, or arterial waveform.[11]

Shockable rhythm: Refers to the first monitored rhythm to be treatable with a defibrillation attempt. More specifically, shockable rhythms are ventricular fibrillation (VF) and pulseless ventricular tachycardia (VT).[11] Refractory VF/VT is defined differently in various trials but generally refers to failure to terminate VF/VT with three (3) defibrillation attempts.[6]

References

1. Beck B, Bray J, Cameron P, Smith K, Walker T, Grantham H, et al. Regional variation in the characteristics, incidence and outcomes of out-of-hospital cardiac arrest in Australia and New Zealand: Results from the Aus-ROC Epistry. Resuscitation. 2018;126:49–57.
2. Bürger A, Wnent J, Bohn A, Jantzen T, Brenner S, Lefering R, et al. The effect of ambulance response time on survival following out-of-hospital cardiac arrest. Dtsch Arztebl Int. 2018;115:541–8.
3. Rajan S, Wissenberg M, Folke F, Hansen SM, Gerds TA, Kragholm K, et al. Association of Bystander Cardiopulmonary Resuscitation and Survival According to Ambulance Response Times after Out-of-Hospital Cardiac Arrest. Circulation. 2016;134(25):2095–104.
4. Goto Y, Funada A, Goto Y. Relationship between emergency medical services response time and bystander intervention in patients with out-of-hospital cardiac arrest. J Am Heart Assoc. 2018;7(9):1–19.
5. Travers AH, Perkins GD, Berg RA, Castren M, Considine J, Escalante R, et al. Part 3: Adult Basic Life Support and Automated External Defibrillation: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation. 2015 Oct;132(suppl 1):S51–83.
6. Callaway CW, Soar J, Aibiki M, Böttiger BW, Brooks SC, Deakin CD, et al. Part 4: Advanced life support: 2015 International consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations. Vol. 132, Circulation. 2015. 84-145 p.
7. Dorian P, Cass D, Schwartz B, Cooper R, Gelaznikas R, Barr A. Amiodarone as compared to lidocaine for shock-resistant ventricular fibrillation. N Engl J Med. 2002;346(12):884–90.
8. Sasson C, Rogers MAM, Dahl J, Kellermann AL. Predictors of survival from out-of-hospital cardiac arrest a systematic review and meta-analysis. Circ Cardiovasc Qual Outcomes. 2010;3(1):63–81.
9. Cummins R, Chamberlain DA, Delooz HH, Dick WF, Eisenberg MS, Evans TR. Recommended Guidelines for Uniform Reporting of Data From Out-of-Hospital Cardiac Arrest: The Utstein Style - A Statement for Health Professionals From a Task Force of the American Heart Association, the European Resuscitation Council, the Heart and Strok. Circulation. 1991;84(2):960–75.
10. Perkins GD, Jacobs IG, Nadkarni VM, Berg RA, Bhanji F, Biarent D, et al. Cardiac Arrest and Cardiopulmonary

Resuscitation Outcome Reports: Update of the Utstein Resuscitation Registry Templates for Out-of-Hospital Cardiac Arrest. Resuscitation [Internet]. 2015;96:328–40. Available from: http://dx.doi.org/10.1016/j.resuscitation.2014.11.002

11. Jacobs I, Nadkarni V, Bahr J, Berg RA, Billi JE, Bossaert L, et al. Cardiac arrest and cardiopulmonary resuscitation outcome reports: update and simplification of the Utstein templates for resuscitation registries. A statement for healthcare professionals from a task force of the international liaison committee on resusci. Resuscitation. 2004 Dec;63(3):233–49.
12. Beck B, Bray JE, Smith K, Walker T, Grantham H, Hein C, et al. Description of the ambulance services participating in the Aus- ROC Australian and New Zealand out-of-hospital cardiac arrest Epistry. Emerg Med Australas. 2016;28(6):673–83.
13. Australian Resuscitation Outcomes Consortium (Aus-ROC). Epistry [Internet]. 2013 [cited 2018 Jun 21]. Available from: https://www.ausroc.org.au/epistry/
14. Beck B, Bray J, Smith K, Walker T, Grantham H, Hein C, et al. Establishing the aus-ROC australian and New Zealand out-of-hospital cardiac arrest epistry. BMJ Open. 2016;6(4):1–6.

Sub-Domain 3: Acute Coronary Syndrome

Prevalence and/or Significance

Acute coronary syndrome (ACS) is one of the leading causes of death globally, however, timely access to effective care of ACS can reduce and prevent cardiac arrest.[1] Whilst rates of ACS are declining in Australia, it remains a significant contributor to hospitalisations and deaths.[2] An estimated 645,000 people aged 18 and over (3% of the adult population) had coronary heart disease (CHD) in 2014–15.[2] In 2013, an estimated 65,300 people aged 25 and over had an ACS in the form of a MI or UA.[2] This equates to around 180 events per day.

Although focusing on in-hospital care, Australian research has found that not all ACS patients receive appropriate treatments, particularly for invasive management.[3] The operational challenges regarding the provision of timely percutaneous coronary intervention (PCI) to patients in regional and remote areas were also highlighted.[3] Besides recognising ACS and providing effective prehospital care, ambulance services have a key role to play in facilitating secondary access to facilities with invasive management capabilities.

Quality Indicators and Evidence

QI-B.3.1. **The ambulance service has a documented clinical care pathway that details the care it provides to patients with acute chest pain or other signs and/or symptoms suggestive of ACS and that integrates with other appropriate health services.**

Access | Effectiveness | ⇨ Guidelines[B] | ⇨ ACSQHC-CCS*

(No evidence identified)

QI-B.3.2. **A patient with acute chest pain or other signs and/or symptoms suggestive of ACS has a 12-lead electrocardiograph (ECG) acquired, interpreted and transmitted to the receiving facility within 10 minutes of arrival on scene.**

Effectiveness | ⇨ Guidelines[A,B] | ⇨ ACSQHC-CCS*

- A detailed systematic review and meta-analysis performed as part of an ILCOR international consensus process investigated the effects of prehospital 12-lead ECG with transmission (or notification) on 30-day mortality in STEMI patients who receive PCI and those who receive

fibrinolysis, or time to treatment (first medical contact-to-balloon time, first medical contact-to-needle time, door-to-balloon time, door-to-needle time). For the outcome of 30-day mortality in STEMI patients who receive PCI, the included studies demonstrated benefit of prehospital 12-lead ECG and hospital notification compared with no ECG or no notification (relative risk [RR], 0.68; 95% confidence interval [CI], 0.51–0.91). This is a 32% relative reduction in mortality. (LOE3) For the outcome of 30-day mortality in STEMI patients who receive fibrinolysis, the included studies indicated benefit of prehospital ECG and hospital notification compared with no 12-lead ECG or no notification (RR, 0.76; 95% CI, 0.71–0.82). This is a 24% relative reduction in mortality. (LOE3) For the outcome of time to treatment, the included studies showed consistent reduction in times to reperfusion with prehospital 12-lead ECG and hospital notification. Meta-analysis for this particular outcome measure was not possible due to heterogeneity.[1] (LOE3)

QI-B.3.3. **A patient with acute chest pain or other signs and/or symptoms suggestive of ACS and normoxaemia (SpO2 >93%) is <u>not</u> administered supplementary oxygen.**

➲ **Effectiveness** ⇨ Guidelines[B,C]

- A systematic review and meta-analysis compared liberal versus conservative oxygen therapy in acutely ill adults, including patient suffering MI. Compared with a conservative oxygen strategy, a liberal oxygen strategy (median baseline saturation of peripheral oxygen [SpO_2] across trials, 96% [range 94–99%, IQR 96–98]) increased mortality in-hospital (relative risk [RR] 1·21, 95% CI 1·03–1·43, I^2=0%, high quality), at 30 days (RR 1·14, 95% CI 1·01–1·29, I^2=0%, high quality), and at longest follow-up (RR 1·10, 95% CI 1·00–1·20, I^2=0%, high quality). Morbidity outcomes were similar between groups, including patient suffering MI.[4] (LOE1)

- A systematic review and meta-analysis performed as part of an ILCOR international consensus process investigated the effects of withholding oxygen on mortality, infarct size and chest pain resolution. For the outcome of mortality, the included studies showed no benefit (OR, 0.91; 95% CI, 0.25–3.34) when oxygen is withheld compared with routine supplementary oxygen administration. (LOE1) For the outcome of infarct size, trial data was too heterogenous for meta-analysis, but results indicated a small reduction in infarct size when oxygen is withheld compared with routine supplementary oxygen administration. (LOE1) For the outcome of chest pain resolution, included studies showed that there is no difference when oxygen is withheld compared with routine supplementary oxygen administration.[1] (LOE1)

QI-B.3.4. **A patient with acute chest pain or other signs and/or symptoms suggestive of ACS is administered aspirin, unless contraindicated.**

Effectiveness ⇨ Guidelines[B,C]

- A systematic review and meta-analysis performed as part of an ILCOR international consensus process investigated the effects of aspirin on a variety of outcome measures. For the outcome of infarction size, the review found no benefit to aspirin (MD, −161; 95% CI, −445.57 to 230.57). (LOE1) However, for the outcome of incidence of cardiac arrest, included studies demonstrated benefit of aspirin administration (RR, 0.87; 95% CI, 0.79–0.96). (LOE1) The included studies demonstrated benefit of aspiring in improving mortality at 5 weeks (LOE1) and in-hospital (LOE3) (RR, 0.79; 95% CI, 0.73–0.87 and RR, 0.33; 95% CI, 0.31–0.35 respectively). There was no benefit in terms of mortality at 3 month and at 28 days (RR, 0.83; 95% CI, 0.4–1.75 and RR, 0.98; 95% CI, 0.81–1.19 respectively).[5] (LOE1)

QI-B.3.5. **A patient with acute chest pain or other signs and/or symptoms suggestive of ACS has their pain score assessed before and after treatment.**

Effectiveness ⇨ Guidelines[A,B]

(No evidence identified)

QI.B.3.6. **A patient with acute chest pain or other signs and/or symptoms suggestive of ACS is administered glyceryl trinitrate, unless contraindicated.**

Effectiveness ⇨ Guidelines[B,C]

- A systematic review performed as part of an ILCOR international consensus process investigated the effects of nitrates on several outcome measures. No trials that evaluated patients specifically in the prehospital or emergency department setting were found. However, three studies demonstrated benefit in terms of infarct size reduction in patients treated in the intensive care unit (ICU) when administered within 3 hours of symptom onset. (LOE3) Two trials suggested that simultaneous treatment with nitroglycerin and fibrinolytics may interfere with reperfusion. (LOE1) One study comparing diltazem to intravenous glyceryl trinitrate in patients with NSTEMI showed a reduction in infarct size in patient treated with diltazem. (LOE1) (Note: There may be some benefit if nitroglycerin administration results in pain relief.)[6]

QI-B.3.7. **A patient with acute chest pain or other signs and/or symptoms suggestive of ACS is administered morphine, unless contraindicated.**

Effectiveness | ⇨ Guidelines[B,C]

- A systematic review performed as part of an ILCOR international consensus process investigated the effects of morphine (and other analgesic and sedative agents) on several outcome measures. One of the included studies suggested increased mortality and myocardial infarction rates associated with the use of intravenous morphine in patients presenting with high-risk NSTEMI.[6] (LOE 3).

- A retrospective observational study assessed the clinical impact of pre-hospital morphine administration in ST-elevation myocardial infarction (STEMI) patients. 4,169 patients were included in the study. 2,438 had STEMI or left bundle branch block (LBBB) of whom 453 (19%) received morphine in the prehospital setting. In-hospital complications and 1-year survival (hazard ratio 0.69; 95% CI: 0.35–1.37) were not increased in patients who received morphine prehospitally.[7] (LOE3)

QI-B.3.8. **A patient with STEMI and within 12 hours of symptom onset receives fibrinolysis if transport time is >30 minutes or is transported to a hospital capable of providing primary PCI if transport time is <30 minutes.**

Effectiveness | ⇨ Guidelines[B,D] | ⇨ ACSQHC-CCS*

- A comprehensive systematic review and meta-analysis as part of an ILCOR international consensus process investigated whether prehospital fibrinolysis (compared with in-hospital fibrinolysis) changed mortality, intracranial haemorrhage, revascularization, major bleeding, stroke and reinfarction. For the outcome of hospital mortality, three RCTs showed benefit for prehospital fibrinolysis (OR, 0.46; 95% CI, 0.23–0.93). (LOE1) For the outcome of intracranial hemorrhage, two RCTs indicated no additional harm from prehospital fibrinolysis compared with in-hospital fibrinolysis (OR, 2.14; 95% CI, 0.39–11.84). (LOE1) For the outcome of bleeding, two RCTs demonstrated no additional harm from prehospital fibrinolysis (OR, 0.96; 95% CI, 0.40–2.32). (LOE1) No high-level evidence was identified for other outcomes of revascularization, reinfarction, and ischemic stroke.[1]

- A Cochrane systematic review assessed the morbidity and mortality of prehospital versus in-hospital thrombolysis for STEMI. The three included RCTs produced inconclusive evidence whether prehospital fibrinolysis reduces all-cause mortality in individuals with STEMI compared to in-hospital fibrinolysis (risk ratio 0.73, 95% confidence interval 0.37 to 1.41). However, two of the RCTs demonstrated that prehospital thrombolysis reduced the time to drug compared with in-hospital thrombolysis. Included trails suggested that the occurrence of

adverse events (bleeding, ventricular fibrillation, stroke and allergic reactions) is similar between patients receiving fibrinolysis prehospitally and in hospital.[8] (LOE1)

- A systematic review and meta-analysis as part of an ILCOR international consensus process investigated whether direct triage and transport to a facility providing primary PCI, compared with prehospital fibrinolysis, changes mortality, intracranial haemorrhage, major bleeding. For the outcome of 30-day mortality, four RCTs showed no differential benefit to either therapy (primary PCI compared with prehospital fibrinolysis) (OR, 1.03; 95% CI, 0.72–1.46). (LOE1) For the outcome of 1-year mortality, two RCTs demonstrated no difference between primary PCI compared with prehospital fibrinolysis (OR, 0.88; 95% CI, 0.60–1.27). (LOE1) However, for the outcome of intracranial haemorrhage, four RCTs indicated less harm with primary PCI compared with prehospital fibrinolysis (OR, 0.21; 95% CI, 0.05–0.84).[1] (LOE1)

Characteristics of the Evidence

This quality indicator evidence summary is based on a structured search of the literature and selected evidence-based healthcare databases. The evidence in this summary comes from:

- A systematic review and meta-analysis performed as part of an ILCOR international consensus process including 17 observational studies.[1]
- A systematic review and meta-analysis of 25 RCTs.[4]
- A systematic review and meta-analysis performed as part of an ILCOR international consensus process including five RCTs.[1]
- A systematic review and meta-analysis performed as part of an ILCOR international consensus process including three RCTs and two observational studies.[5]
- A systematic review performed as part of an ILCOR international consensus process including one RCT, two pseudo-RCT and three observational studies.[6]
- A systematic review performed as part of an ILCOR international consensus process including one applicable observational study.[6]
- A retrospective observational study.[7]
- A systematic review and meta-analysis performed as part of an ILCOR international consensus process including three RCTs.[1]
- A Cochrane systematic review and meta-analysis of three RCTs.[8]
- A systematic review and meta-analysis performed as part of an ILCOR international consensus process including five RCTs.[1]

Supporting Australian Guidelines and ACSQHC Clinical Care Standards

A. Australian and New Zealand Committee on Resuscitation (ANZCOR). ANZCOR Guideline 14.1 – Acute Coronary Syndromes: Presentation [Internet]. Melbourne: ANZCOR; 2016. p. 1–12. Available from: https://resus.org.au/guidelines/

B. Chew DP, Scott IA, Cullen L, French JK, Briffa TG, Tideman PA, et al. National Heart Foundation of Australia & Cardiac Society of Australia and New Zealand: Australian Clinical Guidelines for the Management of Acute Coronary Syndromes 2016. Hear Lung Circ. 2016;25(10):895–951.

C. Australian and New Zealand Committee on Resuscitation (ANZCOR). ANZCOR Guideline 14.2 – Acute Coronary Syndromes: Initial Medical Therapy [Internet]. Melbourne: ANZCOR; 2016. p. 1–10. Available from: https://resus.org.au/guidelines/

D. Australian and New Zealand Committee on Resuscitation (ANZCOR). ANZCOR Guideline 14.3 – Acute Coronary Syndromes : Reperfusion Strategy [Internet]. Melbourne: ANZCOR; 2016. p. 1–10. Available from: https://resus.org.au/guidelines/

* Australian Commission on Safety and Quality in Health Care (ACSQHC). Acute Coronary Syndromes Clinical Care Standard [Internet]. Sydney: ACSQHC; 2014. p. 6–7. Available from: https://www.safetyandquality.gov.au/our-work/clinical-care-standards/

Definitions

Acute Coronary Syndrome (ACS): The term ACS refers to any group of clinical symptoms associated with acute myocardial ischemia and covers the spectrum of clinical conditions ranging from unstable angina (UA) to myocardial infarction (MI).[9] ACS occurs due to unstable atheromatous plaques or endothelial disruption with associated transient or permanent thrombotic occlusion of one or more coronary arteries leading to myocardial ischaemia and infarction.[10] Acute complete occlusion of a coronary artery results in ST-elevation on the electrocardiograph (ECG), i.e. **ST-elevation myocardial infarction (STEMI)**. Non-ST-elevation myocardial infarction (NSTEMI) is usually associated with severe but incomplete occlusion. Patients with ACS may not necessarily present with typical signs and symptoms (e.g. chest pain) but may present with vague signs and atypical complaints (e.g. fatigue).[10,11] Therefore, QIs in this section will refer to the patient with acute chest pain or other signs and/or symptoms suggestive of ACS.

Clinical care pathways: Clinical care pathways are tools used to guide evidence-based healthcare.[12] They may be defined as a complex intervention for the mutual decision-making and organisation of care processes for a well-defined group of patients during a well-defined period.[13] In STEMI the pivotal definitive treatment aim of the clinical care pathway is myocardial reperfusion therapy.

Fibrinolysis : A drug treatment used to dissolve blood clots.

Percutaneous Coronary Intervention (PCI): PCI is a procedure that involves advancing a catheter with a deflated balloon via the femoral artery or radial artery to the narrowing or occlusion in the coronary vessels where the balloon is inflated to

open the artery, allowing blood to flow.[14] A stent may be placed to maintain patency. **Primary PCI** refers to PCI being performed without the previous administration of fibrinolysis.

Reperfusion: The restoration of blood flow (and therefore oxygen supply) to the affected area of the myocardium.[14] This is performed by percutaneous coronary intervention (PCI) or fibrinolysis.

References

1. Welsford M, Nikolaou NI, Beygui F, Bossaert L, Ghaemmaghami C, Nonogi H, et al. Part 5: Acute coronary syndromes: 2015 international consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations. Circulation. 2015;132(suppl 1):S146–76.
2. Australian Institute of Health and Welfare (AIHW). Cardiovascular disease snapshot [Internet]. Vol. 16. Canberra; 2018. Available from: https://www.aihw.gov.au/reports/
3. Chew DP, French J, Briffa TG, Hammett CJ, Ellis CJ, Ranasinghe I, et al. Acute coronary syndrome care across Australia and New Zealand: The SNAPSHOT ACS study. Med J Aust. 2013;199(3):1–7.
4. Chu DK, Kim LHY, Young PJ, Zamiri N, Almenawer SA, Jaeschke R, et al. Mortality and morbidity in acutely ill adults treated with liberal versus conservative oxygen therapy (IOTA): a systematic review and meta-analysis. Lancet. 2018;391(10131):1693–705.
5. Singletary EM, Zideman DA, De Buck EDJ, Chang WT, Jensen JL, Swain JM, et al. Part 9: First Aid: 2015 international consensus on first aid science with treatment recommendations. Circulation. 2015;132(suppl 1):S269–311.
6. Bossaert L, O'Connor RE, Arntz HR, Brooks SC, Diercks D, Feitosa-Filho G, et al. Part 9: Acute coronary syndromes: 2010 International consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations. Resuscitation. 2010;122(suppl 2):S422-465.
7. Puymirat E, Lamhaut L, Bonnet N, Aissaoui N, Henry P, Cayla G, et al. Correlates of pre-hospital morphine use in ST-elevation myocardial infarction patients and its association with in-hospital outcomes and long-term mortality: The FAST-MI (French Registry of Acute ST-elevation and non-ST-elevation Myocardial Infarction) pr. Eur Heart J. 2016;37(13):1063–71.
8. Mccaul M, Lourens A, Kredo T. Pre-hospital versus in-hospital thrombolysis for ST-elevation myocardial infarction. Cochrane Database Syst Rev. 2014;(9).
9. Kumar A, Cannon C. Acute coronary syndromes: diagnosis and management, part I. Mayo Clin Proc. 2009;84(10):917–38.
10. Chew DP, Scott IA, Cullen L, French JK, Briffa TG, Tideman PA, et al. National Heart Foundation of Australia & Cardiac Society of Australia and New Zealand: Australian Clinical Guidelines for the Management of Acute Coronary Syndromes 2016. Hear Lung Circ. 2016;25(10):895–951.
11. El-Menyar A, Zubaid M, Sulaiman K, AlMahmeed W, Singh R, Alsheikh-Ali AA, et al. Atypical presentation of acute coronary syndrome: A significant independent predictor of in-hospital mortality. J Cardiol. Japanese College of Cardiology; 2011;57(2):165–71.
12. Kinsman L, Rotter T, James E, Snow P, Willis J. What is a clinical pathway? Development of a definition to inform the debate. BMC Med. 2010;8(31):1–3.
13. Vanhaecht K, De Witte K, Sermeus W. The impact of clinical pathways on the organisation of care processes. KU Leuven; 2007.
14. National Heart Foundation of Australia. Australian acute coronary syndromes capability framework [Internet]. Melbourne: National Heart Foundation of Australia; 2015. p. 26. Available from: http://heartfoundation.org.au/for-professionals/clinical-information/chronic-heart-failure

Sub-Domain 4. Stroke

Prevalence and/or Significance

In 2015, around 394,000 Australians (1.7% of the population) had experienced a stroke at some time in their lives, based on self-reported data from the Australian Bureau of Statistics (ABS) 2015 Survey of Disability, Ageing and Carers.[1] More than two-thirds (67%) of people who had a stroke were aged 65 and over.[1] Based on hospital and mortality data, there were an estimated 36,700 stroke events in Australia in 2015.[1] This equates to an approximate rate of 100 per day. The rate of stroke events fell by 23% between 2001 and 2015, from 169 to 130 events per 100,000.[1]

All stroke patients should be managed as a time-critical emergency. Besides recognising stroke and providing effective prehospital care, ambulance services have a key role to play in facilitating secondary access to facilities with appropriate diagnostics and management capabilities.

Quality Indicators and Evidence

QI-B.4.1. **A patient with suspected acute stroke is assessed using a validated stroke identification tool[†].**

Effectiveness | ⇨ Guidelines[A] | ⇨ ACSQHC-CCS*

([†] Los Angeles prehospital stroke screen (LAPSS score),[2] Cincinnati prehospital stroke scale (CPSS),[3,4] Face Arm Speech Test (FAST),[5] Melbourne Ambulance Stroke Screen (MASS score),[6] Ontario Prehospital Stroke Screening tool (OPSS)[7] or Recognition Of Stroke In the Emergency Room (ROSIER) scale[8])

- A systematic review investigated the performance characteristics of stroke identification tools according to their intended purpose when used prospectively in any clinical setting. The CPSS and the FAST generally report the highest level of sensitivity. More complex identification tools, such as the LAPSS, report higher specificity but lower sensitivity. However, due to significant heterogeneity amongst the includes studies, available data did not allow a strong recommendation to be made about the superiority of one specific stroke identification tool.[9] (LOE3)

- A systematic review and meta-analysis examined and compared operating characteristics of prehospital identification tools to predict strokes in hospital. Similarly, the analysis was confounded by significant heterogeneity amongst included studies. Overall there was

considerable variation in accuracy in the tools and up to 30% failed identification rate. Although the point estimates for LAPSS accuracy were better than CPSS, they had overlapping confidence intervals in the analysis of operating characteristics. OPSS performed similar to LAPSS whereas MASS, Med PACS, ROSIER, and FAST had less favourable overall operating characteristics.[10] (LOE3)

QI-B.4.2. **A patient with suspected acute stroke has their blood glucose level measured.**

Effectiveness ⇨ Guidelines[A]

(No evidence identified. Note: Hypoglycaemia is a well-documented stroke mimic which can be excluded easily in the prehospital setting.)

QI-B.4.3. **In a patient with suspected acute stroke, it is assessed whether or not they are on anticoagulant therapy.**

Effectiveness ⇨ Guidelines[A]

(No evidence identified. Note: Current anticoagulant therapy is an indicator of high risk.)

QI-B.4.4. **A patient with suspected acute stroke and normoxaemia (SpO2 >93%) is <u>not</u> administered supplementary oxygen.**

Effectiveness ⇨ Guidelines[A]

- A systematic review and meta-analysis investigated the effects of supplemental oxygen (normobaric oxygen) in patients with acute stroke. The authors declared that variations in supplemental oxygen administration devices, flow rates and data collection time point amongst the included RCTs resulted in significant heterogeneity. The analysis indicated benefits from supplemental oxygen in short-term prognostic indicators, as shown by decreased differences in the National Institute of Health Stroke Scale (△NIHSS) at 4 hours (-2.58; 95% CI -8.47 to 3.31; $p = 0.39$), 24 hours (-4.10; 95% CI -14.29 to 6.08; $p = 0.43$) and 7 days (-0.32; 95% CI -1.08 to 0.43; $p = 0.40$). However, NBO decreased Barthel Index scores between 3 and 7 months (-1.33; 95% CI -2.87 to 0.20; $p = 0.09$), and increased mortality rates at 3, 6 months, and 1 year (RR 1.08; 95% CI 0.92 to 1.28; $p = 0.34$). Modified Rankin Scale scores between 3 and 6 months were unchanged (0.00; 95% CI -0.15 to 0.14; $p = 0.97$).[11] (LOE1)

QI-B.4.5. **In a patient with suspected acute stroke, it is assessed when the patient was last known to be without the signs and symptoms of the current stroke or at his or her prior baseline.**

Access

QI-B.4.6. **A patient presenting with suspected stroke is transported directly to a hospital capable of performing thrombolysis and endovascular thrombectomy.**

Access ⇨ Guidelines[A] ⇨ ACSQHC-CCS*

- A Cochrane systematic review investigated the safety and effectiveness of thrombolytic therapy for acute ischaemic stroke. Thrombolytic therapy administered up to six hours after ischaemic stroke reduced mortality and poor neurological outcome (modified Rankin scale 3 to 6) at three to six months after stroke (OR 0.85; 95% CI 0.78 to 0.93). Treatment within three hours of stroke was more effective in reducing death or dependency (OR 0.66; 95% CI 0.56 to 0.79) without any increase in death (OR 0.99; 95% CI 0.82 to 1.21).[12] (LOE1)

- A pre-specified meta-analysis of individual patient data from 6,756 patients in nine randomised trials comparing thrombolysis (with alteplase) with placebo or open control demonstrated that thrombolysis increased the odds of a good stroke outcome, i.e. no significant disability at three to six months, defined by a modified Rankin Score of 0 or 1, with earlier treatment associated with bigger proportional benefit. Treatment within three hours of stroke resulted in a good outcome for 259 (32.9%) of 787 patients who received alteplase versus 176 (23.1%) of 762 who received control (OR 1.75; 95% CI 1.35 to 2.27). Treatment within three to four-and-a-half hours resulted in good outcome for 485 (35.3%) of 1,375 versus 432 (30,1%) of 1,437 (OR 1.26; 95% CI 1.05 to 1.51). A delay of more than to four-and-a-half hours resulted in good outcome for 401 (32.6%) of 1,229 versus 357 (30.6%) of 1.166 (OR 1.15; 95% CI 0.95 to 1.40).[13] (LOE1)

- A systematic review and meta-analysis aimed to characterize the period in which EVT is associated with benefit, and the extent to which treatment delay is related to functional outcomes, mortality, and symptomatic intracranial haemorrhage. The odds of good disability outcomes at 90 days (mRS scale distribution) decreased with longer time from symptom onset to intervention: cOR at 3 hours, 2.79 (95% CI 1.96 to 3.98), absolute risk difference (ARD) for lower disability scores, 39.2%; cOR at 6 hours, 1.98 (95% CI 1.30 to 3.00), ARD 30.2%; cOR at 8 hours,1.57 (95% CI 0.86 to 2.88), ARD 15.7%; retaining statistical significance through 7 hours and 18 minutes. Among those patients who achieved considerable reperfusion with EVT, each 1-hour delay to reperfusion was associated with a less favourable degree of disability (cOR 0.84; 95% CI 0.76 to 0.93; ARD -6.7%) and less

functional independence (OR 0.81; 95% CI, 0.71 to 0.92; ARD -5.2%), but no change in mortality (OR, 1.12; 95% CI 0.93 to 1.34; ARD 1.5%).[14] (LOE1)

QI-B.4.7. The receiving facility receives notification of a patient experiencing suspected stroke.

Access ⇨ Guidelines[A]

- A quasi-experimental study (pre- and post-intervention cohort design) examined the effects of implementing a multi-tiered notification system aimed at expediting management of acute stroke. Tier 1 of the multi-tiered notification system involved hospital activation of a vascular neurology resident, CT technician, radiology resident, and nurse supervisor by the ED or prehospital emergency medical services for patients presenting with acute neurologic symptoms. Sixty-two patients were analysed before and after implementation (34 vs 28, respectively). Compared to pre-intervention, the multi-tiered notification system reduced door-to-reperfusion (DTR) time by 43 minutes (mean DTR, 170 minutes vs 127 minutes; *p*=0.02). Five of the 28 patients in the post-intervention cohort (19%) had good neurologic outcomes at 90 days (mRS score = 0) compared to 0 of 34 (0%) in the pre-intervention cohort (*p*=0.89).[15] (LOE2)

- A quasi-experimental study (pre- and post-intervention cohort design) examined the effects of implementing a pre-hospital notification system aimed at expediting management of acute stroke. Amongst other components, the intervention included pre-arrival notification of emergency department (ED) staff, CT radiographers and a stroke team. In the six months following the introduction of the pre-notification system, 115 patients presented within 24 hours of onset of an ischaemic stroke. Twenty-two (19%) of these received thrombolysis compared to only five (7%) of 67 patients over the control period prior to implementation (*p*=0.03).[16] (LOE2)

Characteristics of the Evidence

This quality indicator evidence summary is based on a structured search of the literature and selected evidence-based healthcare databases. The evidence in this summary comes from:

- A systematic review including 21 observational studies using analytic or descriptive designs, or expert opinion.[9]
- A systematic review including 8 retrospective reviews of a prospectively collected database.[10]
- A systematic review and meta-analysis of 11 RCTs including 6,366 patients.[11]

- A Cochrane review of 27 trials including 10,187 patients.[12]
- A prespecified meta-analysis of nine RCTs including 6,756 patients.[13]
- A systematic review and meta-analysis of five RCTs including 1,287 patients.[14]
- A pre- and post-intervention cohort study of 62 patients.[15]
- A pre- and post-intervention cohort study of 115 patients.[16]

Supporting Australian Guidelines and ACSQHC Clinical Care Standards

A. Stroke Foundation. Clinical Guidelines for Stroke Management 2017 [Internet]. Melbourne: Stroke Foundation; 2017. Available from: https://informme.org.au/en/Guidelines/Clinical-Guidelines-for-Stroke-Management-2017

* Australian Commission on Safety and Quality in Health Care (ACSQHC). Acute Stroke Clinical Care Standard [Internet]. Sydney: ACSQHC; 2015. Available from: https://www.safetyandquality.gov.au/our-work/clinical-care-standards/

Definitions

Barthel Scale or Barthel Index: There are several stroke-specific and general neurological assessment scales are used to objectively evaluate impairment by stroke and stroke treatment outcomes. The Barthel Scale or Barthel Index is a scale used to measure performance in activities of daily living (ADL).[17] A higher number suggests greater likelihood of being able to live independently at home.

Endovascular Thrombectomy (EVT): EVT refers to removal of a blood clot under image guidance.

Modified Rankin Scale (mRS): The mRS is a more widely used scale for measuring the degree of disability after stroke or other causes of neurological disability. The mRS is a simple six-point assessment that includes reference to both limitations in activity and changes in lifestyle.[18] A mRS of zero indicates no limitations and no symptoms, whereas a mRS of 5 indicates severe disability (mRS of 6 indicates death).

National Institute of Health Stroke Scale (NIHSS): The NIHSS is composed of 11 items, each of which scores a specific ability between a zero and four.[19,20] A score of zero indicates normal function and a higher score is indicative of some level of impairment. The individual scores are summed in order to calculate a patient's total NIHSS score. The minimum score is 0 and the maximum possible score is 42.

Stroke is classically defined as neurological deficit due to acute focal injury of the central nervous system (CNS) by a vascular cause, including cerebral infarction, intracerebral haemorrhage (ICH), and subarachnoid haemorrhage (SAH).[21] Central nervous system infarction occurs over a clinical spectrum ranging from ischemic stroke, which is accompanied by overt symptoms, to silent infarction which causes no known symptoms.[21] Although less common, intracerebral haemorrhage and subarachnoid haemorrhage on non-traumatic aetiology also remain within the broad definition of stroke.[21]

Thrombolysis is a drug treatment used to dissolve blood clots.

References

1. Australian Institute of Health and Welfare (AIHW). Cardiovascular disease snapshot [Internet]. Vol. 16. Canberra; 2018. Available from: https://www.aihw.gov.au/reports/
2. Kidwell C, Starkman S, Eckstein M, Weems K, Saver J. Identifying stroke in the field. Prospective validation of the Los Angeles prehospital stroke screen (LAPSS). Stroke. 2000;31(1):71–6.
3. Kothari, R, Pancioli A, Liu T, Brott T, Broderick J. Cincinnati Prehospital Stroke Scale: reproducibility and validity. Ann Emerg Med. 1999;33(4):373–8.
4. Studnek JR, Asimos A, Dodds J, Swanson D. Assessing the validity of the cincinnati prehospital stroke scale and the medic prehospital assessment for code stroke in an urban emergency medical services agency. Prehospital Emerg Care. 2013;17(3):348–53.
5. Mohd Nor A, McAllister C, Louw SJ, Dyker AG, Davis M, Jenkinson D, et al. Agreement between ambulance paramedic- and physician-recorded neurological signs with Face Arm Speech Test (FAST) in acute stroke patients. Stroke. 2004;35(6):1355–9.
6. Bray JE, Martin J, Cooper G, Barger B, Bernard S, Bladin C. Paramedic identification of stroke: Community validation of the Melbourne ambulance stroke screen. Cerebrovasc Dis. 2005;20(1):28–33.
7. Chenkin J, Gladstone DJ, Verbeek PR, Lindsay P, Fang J, Black SE, et al. Predictive value of the ontario prehospital stroke screening tool for the identification of patients with acute stroke. Prehospital Emerg Care. 2009;13(2):153–9.
8. Nor AM, Davis J, Sen B, Shipsey D, Louw SJ, Dyker AG, et al. The Recognition of Stroke in the Emergency Room (ROSIER) scale: Development and validation of a stroke recognition instrument. Lancet Neurol. 2005;4(11):727–34.
9. Rudd M, Buck D, Ford GA, Price CI. A systematic review of stroke recognition instruments in hospital and prehospital settings. Emerg Med J. 2016;33(11):818–22.
10. Brandler ES, Sharma M, Sinert RH, Levine SR. Prehospital stroke scales in urban environments: a systematic review. Neurology. 2014 Jun;82(24):2241–9.
11. Ding J, Zhou D, Sui M, Meng R, Chandra A, Han J, et al. The effect of normobaric oxygen in patients with acute stroke: a systematic review and meta-analysis. Neurol Res. 2018;40(6):433–44.
12. Wardlaw J, Murray V, Berge E, del Zoppo G. Thrombolysis for acute ischaemic stroke. 2009;(7).
13. Emberson J, Lees KR, Lyden P, Blackwell L, Albers G, Bluhmki E, et al. Effect of treatment delay, age, and stroke severity on the effects of intravenous thrombolysis with alteplase for acute ischaemic stroke: A meta-analysis of individual patient data from randomised trials. Lancet. 2014;384(9958):1929–35.
14. Saver JL, Goyal M, Van Der Lugt A, Menon BK, Majoie CBLM, Dippel DW, et al. Time to treatment with endovascular thrombectomy and outcomes from ischemic stroke: Ameta-analysis. JAMA - J Am Med Assoc. 2016;316(12):1279–88.
15. Goldstein ED, Schnusenberg L, Mooney L, Raper CC, McDaniel S, Thorpe DA, et al. Reducing Door-to-Reperfusion Time for Mechanical Thrombectomy With a Multitiered Notification System for Acute Ischemic Stroke. Mayo Clin Proc Innov Qual Outcomes [Internet]. 2018;2(2):119–28. Available from: https://linkinghub.elsevier.com/retrieve/pii/S2542454818300304
16. O'Brien W, Crimmins D, Donaldson W, Risti R, Clarke TA, Whyte S, et al. FASTER (Face, Arm, Speech, Time, Emergency Response): Experience of Central Coast Stroke Services implementation of a pre-hospital notification system for expedient management of acute stroke. J Clin Neurosci [Internet]. 2012;19(2):241–5. Available from: http://dx.doi.org/10.1016/j.jocn.2011.06.009
17. Mahoney F, Barthel D. Functional Evaluation: The Barthel Index. Md State Med J. 1995;14:56–61.
18. Wilson JTL, Hareendran A, Grant M, Baird T, Schulz UGR, Muir KW, et al. Improving the Assessment of Outcomes in Stroke. Stroke [Internet]. 2002;33(9):2243. Available from: http://stroke.ahajournals.org/content/33/9/2243.abstract
19. National Institute of Neurological Disorders and Stroke. The National Institute of Health Stroke Scale (NIHSS) [Internet]. Know Stroke. Know the Signs. Act in Time. [cited 2019 Feb 1]. Available from: https://www.ninds.nih.gov/sites/default/files/NIH_Stroke_Scale_Booklet.pdf
20. Patrick Lyden. Using the National Institutes of Health Stroke Scale. Stroke. 2017;48:513–9.
21. Sacco RL, Kasner SE, Broderick JP, Caplan LR, Connors JJ, Culebras A, et al. An updated definition of stroke for the 21st century: A statement for healthcare professionals from the American heart association/American stroke association. Stroke. 2013;44(7):2064–89.

Sub-Domain 5: Asthma

Prevalence and/or Significance

Self-reported data from the 2014-15 Australian Bureau of Statistics (ABS) National Health Survey (NHS) shows that approximately 11% of the population (2.5 million people) have asthma.[5] Despite recommendations that every person with asthma should have an asthma action plan, only 21% of people aged 15 and over, and 57% of children aged 0–14, with asthma had one.[6] Based on data from the AIHW National Hospital Morbidity Database (NHMD), there were 39,448 hospitalisations where asthma was the principal diagnosis in 2015–16, which corresponds to a hospitalisation rate of 169 per 100,000 population.[6] In 2015, 421 Australians died due to asthma (a mortality rate of 1.5 per 100,000 population).[6]

Quality Indicators and Evidence

QI-B.5.1. **A suspected acute asthma patient has their PEF measured prior to nebulisation, unless they are unable to perform the test.**

Effectiveness | ⇨ Guidelines[A]

- A Joanna Briggs Institute (JBI) evidence summary investigated what is the best available evidence regarding peak flow measurement. The evidence summary addresses measurement of PEF as an objective technique to assess the severity of asthma exacerbations and for monitoring asthma during treatment. PEF measurement is widely accepted as an independent measure of lung function. However, the evaluation of measurement results needs to include patient characteristics, i.e. known best PEF or height-based estimated best PEF. PEF is used extensively in emergency departments for initial assessment and monitoring during treatment.[7] (LOE1)

QI-B.5.2. **A patient with acute asthma has their oxygen saturation level monitored.**

Effectiveness | ⇨ Guidelines[A]

QI-B.5.3. **A patient with acute asthma is given controlled oxygen titrated to maintain an SpO_2 level of 94-98%.**

Effectiveness | ⇨ Guidelines[A]

- A randomised controlled trial compared the effects of uncontrolled high concentration oxygen (8 L/min via face mask) with a titrated oxygen regime (to maintain SpO_2 93-95%) on $PaCO_2$ in patients presenting with severe exacerbations of asthma. High concentration oxygen therapy caused a clinically significant increase in PtCO2 evident by the proportion of patients with a rise in $PtCO_2$≥4 mm Hg at 60 min (44%) vs 19%, (RR 2.3; 95% CI 1.2 to 4.4, p<0.006). All 10 patients with a final $PtCO_2$≥45 mm Hg received high concentration oxygen therapy, and in five there was an increase in $PtCO_2$≥10 mm Hg.[8] (LOE1)

QI-B.5.4. **A patient with acute asthma is administered salbutamol via oxygen-driven nebuliser, unless contraindicated.**

➲ Effectiveness ⇨ Guidelines[A]

- A randomised controlled trial compared the effects of subcutaneously administered adrenaline, inhaled isoproterenol (a beta 2 agonist), and intravenously administered aminophylline on FEV_1. Mean improvement in FEV_1 at 1 hour was significantly greater in patients treated with isoproterenol (0.79 L) and adrenaline (0.76 L) that in those treated with aminophylline (0.23 L). Patients treated with isoproterenol also had shortest mean duration of required therapy compared to those treated with adrenaline and aminophylline (3.0 hrs, 3.5 hrs and 5.4 hrs respectively).[9] (LOE1)

- A systematic review and meta-analysis compared the effectiveness of aerosolized adrenaline compared to inhaled beta 2 agonists in the treatment of acute asthma. Although there was an improvement pulmonary function in patient treated with adrenaline (SMD 0.20; 95% CI 0.22 to 0.63, p=0.35), this was not significant. The use of more than 2 mg of adrenaline per dose was equivalent to 5 mg of salbutamol (or terbutaline) per dose, whilst 2 mg or less of adrenaline per dose was inferior to 2.5 or 5 mg of salbutamol per dose.[10] (LOE1)

- A Cochrane systematic review assessed the effectiveness of holding chambers (spacers) compared to nebulisers for the delivery of beta-agonists for acute asthma. The method of Medication administration did not significantly affect hospital admission rates. In adults, the risk ratio (RR) of admission for spacer versus nebuliser was 0.94 (95% CI 0.61 to 1.43). There were no significant differences between the two delivery methods in terms of length of stay in the emergency department, PEF and FEV_1.[11] (LOE1)

QI-B.5.5. **A patient with acute severe asthma or worse is administered salbutamol and ipratropium bromide via oxygen driven nebuliser, unless contraindicated.**

➲ Effectiveness ⇨ Guidelines[A]

- A Cochrane systematic review and meta-analysis investigated the effectiveness of combined inhaled therapy (short-acting anticholinergics and short-acting beta 2 agonists agents) compared to short-acting beta 2 agonists agents alone. Overall, patients with acute severe asthma receiving combination inhaled therapy were less likely to be hospitalised (RR 0.72; 95% CI 0.59 to 0.87). This was not true for patient suffering mild or moderate acute asthma (test for difference between subgroups *p*=0.02). Combination therapy improved FEV_1 (MD 0.25 L; 95% CI 0.02 to 0.48), PEF (MD 36.58 L/min; 95% CI 23.07 to 50.09), percent change in PEF from baseline (MD 24.88; 95% CI14.83 to 34.93) and likelihood of returning to the emergency department for additional care (RR 0.80; 95% CI 0.66 to 0.98). However, combination therapy resulted in increased adverse events (OR 2.03; 95% CI 1.28 to 3.20).[12] (LOE1)

QI-B.5.6. **A patient with acute severe asthma or worse is administered intravenous/intramuscular hydrocortisone, unless contraindicated.**

Effectiveness | ⇨ Guidelines[A]

- A Cochrane systematic review examined the benefit of systemic corticosteroids in patients with acute asthma. Early administration of corticosteroids for acute asthma significantly reduced admission rates (N = 11; pooled OR 0.40, 95%CI 0.21 to 0.78). There were no significant differences in terms of side effects between corticosteroid treatments and placebo.[13] (LOE1)

- A Cochrane systematic review investigated the benefit of corticosteroids (oral, intramuscular, or intravenous) for the treatment of patients suffering acute asthma. Compared to placebo, corticosteroids significantly reduced the need for additional care in the first week (RR 0.38; 95% CI 0.2 to 0.74). Patients receiving corticosteroids also required less beta 2 agonists (MD -3.3 activations/day; 95% CI -5.6 to -1.0). There were no significant differences in pulmonary function tests (SMD 0.045; 95% CI -0.47 to 0.56) and side effects (SMD 0.03; 95% CI -0.38 to 0.44) in the first 7 to 10 days.[14] (LOE1)

QI-B.5.7. **A patient with life-threatening asthma is be administered intramuscular adrenaline, unless contraindicated.**

Effectiveness

(No evidence identified)

QI-B.5.8. **The receiving facility receives notification of a patient with life-threatening asthma.**

Access

(No evidence identified)

QI-B.5.9. **A mild acute asthma patient who after treatment is asymptomatic with no dyspnoea and has a PEF higher than the original measurement is prehospitally discharged, unless service-defined risk criteria apply.**

Safety Effectiveness

(No evidence identified)

Characteristics of the Evidence

This quality indicator evidence summary is based on a structured search of the literature and selected evidence-based healthcare databases. The evidence in this summary comes from:

- A JBI evidence summary including a pseudo-RCT involving 409 participants, a pre-test post-test quasi-experimental study involving 51 participants, an observational study involving 68 participants, a prospective study involving 100 participants, a randomized observational analysis of 211 participants, a guidelines document, a cohort study including 36 participants, and two literature reviews.[7]
- A RCT involving 106 patients.[8]
- A RCT involving 48 patients.[9]
- A systematic review and meta-analysis of six RCT including 161 adults and 121 children and adolescents.[10]
- A Cochrane systematic review and meta-analysis of 39 trials including 729 adults and 1897 children.[11]
- A Cochrane systematic review and meta-analysis of 23 trials involving 2,724 patients.[12]
- A Cochrane systematic review and meta-analysis of 12 trials involving 863 patients.[13]
- A Cochrane systematic review and meta-analysis of six trials involving 374 patients.[14]

Supporting Australian Guidelines

A. National Asthma Council Australia. Australian Asthma Handbook [Internet]. 2017 [cited 2019 Feb 2]. Available from: http://www.asthmahandbook.org.au/

Definitions

Asthma: A chronic disease or the lower airways. Asthma can be controlled but not cured. Clinically, asthma is defined by the presence of variation in peak expiratory airflow (PEF) that is greater than that seen in healthy people and respiratory symptoms, such as wheeze, shortness of breath, cough and chest tightness, that vary over time and may be exacerbated at any point due to allergy or other factors.[1] Uncontrolled asthma is typically characterised by chronic inflammation involving many cells and cellular elements, airway hyperresponsiveness, and intermittent bronchoconstriction, congestion and/or oedema of bronchial mucosa.[2] Asthma likely represents a spectrum of conditions with different pathophysiological mechanisms,[3] and thus there may be substantial overlap with the features of COPD especially in older patients. Acute asthma exacerbation is categorised into **levels of severity** as detailed in Table B.5.1.

Table B.5.1: Levels of severity of acute asthma in adults[1,4]

Mild acute asthma	Exertional symptoms PEF>75% best of predicted No features of moderate acute asthma	
Moderate acute asthma	Increasing symptoms PEF>50-75% best or predicted No features of acute severe asthma	
Acute severe asthma	Any one of: • PEF 33-50% best or predicted • Respiratory rate ≥25/min. • Heart rate ≥110/min. • Inability to complete sentences in one breath	
Life-threatening asthma	Any one of the following in a patient with acute severe asthma	
	Clinical Signs	**Measurements**
	• Altered level of consciousness • Exhaustion • Arrhythmia • Hypotension • Cyanosis • Silent chest • Poor respiratory effort	• PEF <33% best or predicted • SpO_2 <92% • PaO_2 <8 kPa • 'normal' $PaCO_2$ (4.6-6.0 kPa)
Near-fatal asthma	Raised PaCO2 and/or requiring [mechanical] ventilation with raised inflation pressures.	

Forced Expiratory Volume (FEV): The volume that a person can forcefully expire after a full inspiration. Measurement of the volume expired in the first second (FEV_1) is a measure used in the assessment of obstructive airway disease such as asthma.

Peak expiratory flow (PEF): A person's maximum expired air flow speed. Since it measures airflow through the airways, it can be used as an indicator of the degree of airway obstruction and a measure of improvement (or deterioration) during treatment. PEF is typically measured in units of litres per minute (L/min).

References

1. National Asthma Council Australia. Australian Asthma Handbook. 2017.
2. Global Initiative for Asthma (GINA). Global strategy for asthma management and prevention [Internet]. 2012. Available from: https://ginasthma.org/
3. Anderson GP. Endotyping asthma: new insights into key pathogenic mechanisms in a complex, heterogeneous disease. Lancet. 2008;372(9643):1107–19.
4. British Thoracic Society, Scottish Intercollegiate Guidelines Network. British guideline on the management of asthma: A national clinical guideline [Internet]. London; 2016. Available from: https://www.brit-thoracic.org.uk/
5. Australian Bereau of Statistics (ABS). National Health Survey: First Results, 2014-15. ABS Cat no. 4364.0.55.001 [Internet]. Canberra; 2016. Available from: http://www.abs.gov.au/ausstats/abs@.nsf/PrimaryMainFeatures/4364.0.55.001?OpenDocument
6. Australian Institute of Health and Welfare (AIHW). Asthma snapshot [Internet]. Canberra; 2018 [cited 2018 Nov 20]. Available from: https://www.aihw.gov.au/reports/chronic-respiratory-conditions/asthma/contents/asthma
7. Li Y. Evidence Summary - Peak Flow: Measurement. Joanna Briggs Inst EBP Database, JBI@Ovid. 2018;JBI131.
8. Perrin K, Wijesinghe M, Healy B, Wadsworth K, Bowditch R, Bibby S, et al. Randomised controlled trial of high concentration versus titrated oxygen therapy in severe exacerbations of asthma. Thorax. 2011;66(11):937–41.
9. Rossing T, Fanta C, Goldstein D, Snapper J, McFadden E. Emergency Therapy of Asthma: Comparison of the Acute Effects of Parenteral and Inhaled Sympathomimetics and Infused Aminophylline. Am Rev Respir Dis. 1980;122(3):365–71.
10. J. Rodrigo G, J. Nannini L. Comparison between nebulized adrenaline and β2agonists for the treatment of acute asthma. a meta-analysis of randomized trials. Am J Emerg Med. 2006;24(2):217–22.
11. Cates C, Welsh E, Rowe B. Holding chambers (spacers) versus nebulisers for beta-agonist treatment of acute asthma. Cochraine Rev. 2013;(9).
12. Kirkland S, Vandenberghe C, Voaklander B, Nikel T, Campbell S, Rowe B. Combined inhaled beta-agonist and anticholinergic agents for emergencymanagement in adults with asthma. Cochrane Database Syst Rev. 2017;(1):1–19.
13. Rowe BH, Spooner C, Ducharme F, Bretzlaff J, Bota G. Early emergency department treatment of acute asthma with systemic corticosteroids. Cochrane Database Syst Rev [Internet]. 2001;(1). Available from: http://doi.wiley.com/10.1002/14651858.CD002178
14. Rowe B, Spooner C, Ducharme F, Bretzlaff J, Bota G. Corticosteroid for preventing relapse following acute exacerbations of asthma. Cocrahne Database Syst Rev. 2007;(3).

Sub-Domain 6: Trauma

Prevalence and/or Significance

Trauma is a major contributor to mortality, morbidity and permanent disability worldwide and in Australia. In 2014-15, injury was recorded as the cause of 12,647 deaths in Australia.[1] Falls (37.3%), intentional self-harm/suicide (23.1%) and transport accidents (10.8%) were the three leading causes of fatal injury.[1]

There were 483,678 injury cases requiring of hospitalisation in Australia in 2014–15. Most of these were due to falls (41.1%) and transport accidents (12.1%).[2] Mean length of stay (MLOS), a proxy for severity of injury, was highest in falls, thermal injury and traffic accidents (5.2, 4.6 and 3.6 days respectively).[2] About 1 in 6 injury cases (72,995, or 15%) were classified as high threat to life (HTTL),[2] defined as cases with predicted mortality risk of about 6% or higher.[3]

Prehospital management of the trauma patient forms a critical component of a developed trauma system. However, prehospital trauma care is limited, and many major trauma patients are time-critical. Decision around treatment, transport mode, rendezvous with additional resources and destination need to be made early to follow the key principle of 'the right patient, to the right hospital in the shortest time'.

Quality Indicators and Evidence

QI-B.6.1 **A patient with active external haemorrhage receives haemorrhage control by application of direct pressure, arterial tourniquet and haemostatic dressing as required.**

Effectiveness | ⇨ Guidelines[A]

- A systematic review investigated the use and effectiveness of arterial tourniquets for the management of life-threatening limb haemorrhage in the civilian setting. Effectiveness rates of arterial tourniquets ranged from 78% to 100%. The included studies reported few complications associated with the use of arterial tourniquets (<2%), even when used in elderly patients or those with comorbidities.[4] (LOE3)

- A systematic review examined the prehospital use of haemostatic dressings in controlling traumatic haemorrhage and clinically superiority of any specific haemostatic dressing. Seven different haemostatic dressings were reported with QuikClot Combat Gauze being the most

frequently applied. Cessation of bleeding was achieved in 67% to 100% of applications (median 90.5%). Adverse events (burns) were only reported in some applications of QuikClot granules. However, no adverse events were reported with QuikClot Combat Gauze use in three studies.[5] (LOE1)

QI-B.6.2. **A patient with suspected pelvic fracture has a pelvic circumferential PCCD applied.**

➲ Effectiveness

- A systematic review investigated the efficacy and safety of PCCDs. The included studies were of low quality but suggest that PCCDs are effective in reducing a pelvic ring fracture. Included studies also indicate that PCCDs may contribute to favourable physiological effects during the early phase of resuscitation. Study results are inconclusive and conflicting with regards to other outcome measures, i.e. mortality, hospital length of stay, and intensive care unit (ICU) length of stay. Almost all types of PCCDs may potentially cause pressure ulcers if used for extensive periods due to inevitable tension over bony prominences.[6] (LOE1)

QI-B.6.3. **A patient with recent (≤3 hours) traumatic injury resulting in ongoing haemorrhage and/or ATC (indicated by a validated and prehospitally applicable prediction tool) receives TXA (1g, intravenously).**

➲ Effectiveness

- A Cochrane systematic review and meta-analysis assessed the effectiveness and adverse effects of antifibrinolytic drugs in patients with acute traumatic injury. The meta-analysis, which was primarily based on data from the Clinical Randomisation of an Antifibrinolytic in Significant Haemorrhage-2 (CRASH-2) trial,[7] demonstrated that antifibrinolytic drugs reduce the risk of death from any cause by 10% (RR 0.90, 95% CI 0.85 to 0.96; p = 0.002). The review and meta-analysis suggested that antifibrinolytics have no effect on the risk of vascular occlusive events, need for surgical intervention or receipt of blood transfusion. The investigators found no evidence for a difference in the effect by type of antifibrinolytic (TXA versus aprotinin). However, considering the dominance of data from the CRASH-2 trial, results can only be confidently applied to the effects of TXA.[8] (LOE1)

QI-B.6.4. **When attending to a patient suffering neurotrauma or penetrating injury with haemodynamic instability, the ambulance departs the scene within X minutes of arriving on scene, unless unable or impractical to do so for safety or operational reasons. (X = 10, 15 or 20)**

Access ⇨ Guidelines[B]

- A systematic review examined the association between prehospital time intervals and the outcome of trauma patients. Results showed a decrease in odds of mortality for undifferentiated trauma patients when response times or transfer times are shorter. However, increased on-scene time and total prehospital time are associated with increased odds of survival for this population. This may be due to more comprehensive care provided prehospitally. Nonetheless, shorter prehospital time intervals appear beneficial for patients suffering neurotrauma or penetrating injury with hypotension.[9] (LOE3)

QI-B.6.5. **A patient is correctly triaged and transported to an appropriate hospital as per agreed trauma system protocol.**

Access ⇨ Guidelines[B]

- A systematic review and meta-analysis examined the impact of trauma system components on clinically important injury outcomes. The investigators found two trauma system components were associated with reduced odds of mortality: inclusive design (OR 0.72; 95% CI 0.65 to 0.80) and helicopter transport (OR 0.70; 95% CI 0.55 to 0.88). The provision of prehospital Advanced Trauma Life Support (ATLS) results in a significant reduction in hospital days (MD 5.7; 95% CI 4.4 to 7.0) but was not associated with significant reduction in mortality (OR 0.78; 95% CI 0.44 to 1.39). Trauma system maturity was associated with a significant reduction in mortality (OR 0.76; 95% CI 0.68 to 0.85).[10] (LOE1)

- A systematic review and meta-analysis assessed the effectiveness of the establishment of trauma systems in reducing mortality in severely injured patients. Results from the analysis of included studies demonstrated a 15% reduction in mortality after implementation of a trauma system (crude OR 0.85; 95% CI 0.778–0.998).[11] (LOE2)

- A systematic review investigated the effectiveness of prehospital trauma triage systems and assessed under-triage and over-triage for trauma patients. Mortality was lower in severely injured patients transferred to a higher-level trauma centre. The percentage of under-triage and over-triage ranged from 1% to 68% and 5% to 99%, respectively. Older age and increased geographical distance were associated with undertriage.[12] (LOE3)

QI-B.6.6. The receiving hospital receives notification of a major trauma patient as per agreed trauma system protocol.

Access ⇨ Guidelines[B]

- A systematic review investigated the effect of prehospital notification for major trauma patients on overall (<30 days) and early (<24 hours) mortality, hospital reception, and trauma team presence on arrival, time to critical interventions, and length of hospital stay. Only three studies producing limited evidence were included. One study showed a reduction in mortality (adjusted OR 0.61, 95% CI 0.39 to 0.94, 72,073 participants). There was no association between prehospital notification and other outcome measures.[13] (LOE3)

Characteristics of the Evidence

This quality indicator evidence summary is based on a structured search of the literature and selected evidence-based healthcare databases. The evidence in this summary comes from:

- A systematic review of 18 retrospective observational studies, five surveys and one analysis of online protocols involving a total of 3,028 arterial tourniquet placements.[4]
- A systematic review of one RCT involving 160 patients, 15 observational studies and one case report.[5]
- A systematic review of one RCT involving 80 patients, nine case series, three cohort studies, three retrospective studies and one laboratory study.[6]
- A Cochrane systematic review and meta-analysis of three RCTs involving a total of 20,528 patients.[8]
- A systematic review of 9 prospective and 11 retrospective observational studies.[9]
- A systematic review and meta-analysis 19 studies including one cluster RCT, three controlled before-after studies, one interrupted time series and 14 prospective or retrospective observational studies.[10]
- A systematic review of quasi-experimental and other lower study designs.[11]
- A systematic review of 33 comparable cohort and other lower study designs.[12]
- A systematic review of three observational studies involving 72,423 major trauma patients in well-established trauma systems of high-income countries.[13]

Supporting Australian Guidelines

A. Australian and New Zealand Committee on Resuscitation (ANZCOR). ANZCOR Guideline 9.1.1 – First Aid for Management of Bleeding [Internet]. Melbourne: ANZCOR; 2017. p. 7. Available from: https://resus.org.au/guidelines/

B. Royal Australasian College of Surgeons (RACS). Guidelines for a structured approach to the provision of optimal trauma care [Internet]. Melbourne: RACS; 2012. p. 35. Available from: https://www.surgeons.org/

Definitions

Acute Traumatic Coagulopathy (ATC): A complex process which interferes with normal blood clotting due to damaged tissues.[14] (also referred to as acute coagulopathy of trauma shock or trauma-induced coagulopathy)

Haemostatic dressing: A type of wound dressings which contain agents to enhance blood clotting.[5,15] These may offer additional haemorrhage control compared to standard gauze.

Ongoing haemorrhage/ATC prediction tool: A scoring system or algorithm developed for the purpose of early prediction of ongoing haemorrhage or ATC.[16–18]

Pelvic circumferential compression device (PCCD): An external device, such as a pelvic sheet or commercially available pelvic binder, designed to provide temporary stabilization of pelvic ring fractures.[6]

Tranexamic Acid (TXA): Tranexamic acid is a member of a class of drugs called antifibrinolytic agents. These agents promote blood clotting by preventing blood clots from breaking down.[8]

Trauma system: An organized, coordinated effort in a defined geographic area that delivers the full range of care to all injured patients and is integrated with the local public health system.[19]

References

1. Australian Institute of Health and Welfare (AIHW). Trends in injury deaths, Australia: 1999–00 to 2014-15 [Internet]. Canberra; 2018. Available from: https://www.aihw.gov.au/
2. Australian Institute of Health and Welfare (AIHW). Trends in hospitalised injury, Australia 1999-00 to 2014-15 [Internet]. Canberra: AIHW; 2018. Available from: https://www.aihw.gov.au/
3. Stephenson S, Langley J, Henley G, Harrison J. Diagnosis-based Injury Severity Scaling. A method using Australian and New Zealand hospital data coded to ICD-10-AM [Internet]. Vol. AIHW cat. Adelaide; 2003. Available from: http://www.nisu.flinders.edu.au/
4. Beaucreux C, Vivien B, Miles E, Ausset S, Pasquier P. Application of tourniquet in civilian trauma: Systematic review of the literature. Anaesth Crit Care Pain Med. 2018;37:597–606.
5. Boulton AJ, Lewis CT, Naumann DN, Midwinter MJ. Prehospital haemostatic dressings for trauma: A systematic review. Emerg Med J. 2018;449–57.
6. Bakhshayesh P, Boutefnouchet T, Tötterman A. Effectiveness of non invasive external pelvic compression: A systematic review of the literature. Scand J Trauma Resusc Emerg Med [Internet]. 2016;24(1):1–9. Available from: http://dx.doi.org/10.1186/s13049-016-0259-7
7. Roberts I, Shakur H, Coats T, Hunt B, Balogun E, Barnetson L, et al. The CRASH-2 trial: A randomised controlled trial

and economic evaluation of the effects of tranexamic acid on death, vascular occlusive events and transfusion requirement in bleeding trauma patients. Health Technol Assess (Rockv). 2013;17(10):1–80.

8. Ker K, Roberts I, Shakur H, Tj C. Antifibrinolytic drugs for acute traumatic injury. Cochrane Database Syst Rev. 2015;(5).
9. Harmsen AMK, Giannakopoulos GF, Moerbeek PR, Jansma EP, Bonjer HJ, Bloemers FW. The influence of prehospital time on trauma patients outcome: A systematic review. Injury [Internet]. 2015;46(4):602–9. Available from: http://dx.doi.org/10.1016/j.injury.2015.01.008
10. Moore L, Champion H, Tardif PA, Kuimi BL, O'Reilly G, Leppaniemi A, et al. Impact of Trauma System Structure on Injury Outcomes: A Systematic Review and Meta-Analysis. World J Surg. 2018;42(5):1327–39.
11. Celso B, Tepas J, Langland-Orban B, Pracht E, Papa L, Lottenberg L, et al. A systematic review and meta-analysis comparing outcome of severely injured patients treated in trauma centers following the establishment of trauma systems. J Trauma - Inj Infect Crit Care. 2006;60(2):371–8.
12. van Rein EAJ, van der Sluijs R, Houwert RM, Gunning AC, Lichtveld RA, Leenen LPH, et al. Effectiveness of prehospital trauma triage systems in selecting severely injured patients: Is comparative analysis possible? Am J Emerg Med [Internet]. 2018;36(6):1060–9. Available from: https://doi.org/10.1016/j.ajem.2018.01.055
13. Synnot A, Karlsson A, Brichko L, Chee M, Fitzgerald M, Misra MC, et al. Prehospital notification for major trauma patients requiring emergency hospital transport: A systematic review. J Evid Based Med. 2017;10(3):212–21.
14. Cap A, Hunt BJ. The pathogenesis of traumatic coagulopathy. Anaesthesia. 2015;70:96–101.
15. Granville-Chapman J, Jacobs N, Midwinter MJ. Pre-hospital haemostatic dressings: A systematic review. Injury [Internet]. 2011;42(5):447–59. Available from: http://dx.doi.org/10.1016/j.injury.2010.09.037
16. Tonglet ML. Early Prediction of Ongoing Hemorrhage in Severe Trauma: Presentation of the Existing Scoring Systems. Arch Trauma Res [Internet]. 2016;5(4):1–5. Available from: http://www.archtrauma.com/?page=article&article_id=33377
17. Peltan ID, Rowhani-Rahbar A, Vande Vusse LK, Caldwell E, Rea TD, Maier R V., et al. Development and validation of a prehospital prediction model for acute traumatic coagulopathy. Crit Care [Internet]. 2016;20(1):1–10. Available from: http://dx.doi.org/10.1186/s13054-016-1541-9
18. Mitra B, Cameron PA, Mori A, Maini A, Fitzgerald M, Paul E, et al. Early prediction of acute traumatic coagulopathy. Resuscitation [Internet]. 2011;82(9):1208–13. Available from: http://dx.doi.org/10.1016/j.resuscitation.2011.04.007
19. Gruen RL, Gabbe BJ, Stelfox HT, Cameron PA. Indicators of the quality of trauma care and the performance of trauma systems. Br J Surg. 2012 Jan;99((Suppl 1)):97–104.

Acknowledgement

The researchers would like to thank Ms Rachel McKeown for her assistance in developing this evidence summary.

Sub-Domain 7. Seizures

Prevalence and Significance

Seizures may be caused by a treatable systemic process or intrinsic dysfunction of the central nervous system. Whilst epilepsy accounts for a significant number of seizures, there are many other causes of seizures such as metabolic derangements, drug or alcohol withdrawal, and acute neurologic disorders such as stroke, encephalitis, or head injury.[1] Severe hypoglycaemia was the most frequent diabetes complication in an audit conducted by the National Association of Diabetes Centres (NADC) with 4.8% of all included adult patients (*n*=4,629) experiencing at least one episode over a 12-month period.[2] Depending on the type, uncontrolled seizures may lead to physical injury from tonic-clonic muscle activities, hypoxic cerebral insult, or worse, death. There are over 250,000 Australians living with epilepsy and it is estimated that 3% to 3.5% of Australians will experience epilepsy at some point in their lives.[3] A multi-centre study form the US suggested that seizures account for one to two percent of all emergency department visits, and approximately one-quarter of these will be a first seizure.[4] The incidence of patients with seizures seen by ambulance services in Australia is unclear.

Quality Indicators and Evidence

QI-B.7.1. A patient with a seizure has their blood glucose level measured.

Effectiveness

- A systematic review and meta-analysis investigated the incidence of severe hypoglycaemia in adults with type 2 diabetes on one or more hypoglycaemic agents. The incidence of severe hypoglycaemia (defined as hypoglycaemia requiring assistance) varies somewhat with specific medication used. For most medications, the incidence of severe hypoglycaemia was less than 1% in reviewed studies. Patient reported incidences of hypoglycaemia varied widely from 1% to 17%.[5] (LOE1)

- A randomised controlled trial involving 1,441 patients compared intensive with conventional diabetes therapy over an average of 6.5 years. Across both arms, there were a total of 3,788 episodes of severe hypoglycaemia with 1,027 (27.1%) associated with coma and/or seizure.[6] (LOE1)

- A systematic review and meta-analysis investigated the effect of severe hypoglycaemia on other outcomes in adults with type 2 diabetes on one or more hypoglycaemic

agents. Neurological events, including seizures, were reported in seven randomized trials, three cohort studies and seven other studies. The reported rates of seizures ranged from 5% to 30% in all patients with severe hypoglycaemia.[5] (LOE1)

QI-B.7.2. **A patient with an active seizure is administered a benzodiazepine by the best available route.**

➲ Effectiveness

- A Cochrane systematic review and meta-analysis compared the effectiveness and safety of different anticonvulsant drugs in patients with premonitory, early, established or refractory status epilepticus. Specifically, in the prehospital setting, the review demonstrated that intramuscular (IM) midazolam was at least as effective as and probably more effective than intravenous (IV) lorazepam in control of seizures (RR1.16; 95% CI 1.06 to 1.27) and frequency of hospitalisation (RR 0.88; 95% CI 0.79 to 0.97) or intensive care admissions (RR 0.79; 95% CI 0.65 to 0.96). However, the authors noted that the evidence stemming form randomised trials to is limited. Therefore, the authors were unable to determine if any particular anticonvulsant drug was better than another in terms of adverse effects.[7] (LOE1)

- A Cochrane systematic review and meta-analysis examined the effectiveness and safety of anticonvulsant drugs used to treat any acute tonic-clonic convulsion of any duration, including status epilepticus in children who present to a hospital or emergency medical department. The authors found insufficient evidence or no studies at all to conclusively compare buccal midazolam with rectal diazepam and intranasal (IN) and buccal midazolam. Generally, IN and buccal administration of anticonvulsant drugs was shown to lead to similar rates of seizure cessation as the IV route. IN midazolam was equivalent to IV diazepam (RR 0.98; 95% CI 0.91 to 1.06). IM midazolam also showed a similar rate of seizure cessation to IV diazepam (RR 0.97; 95% CI 0.87 to 1.09). There was no statistically significant or clinically important differences between seizure cessation with IV midazolam and diazepam (RR 1.08; 95% CI 0.97 to 1.21) or IV midazolam and lorazepam (RR 0.98; 95%CI 0.91 to 1.04). Although IV-administered anticonvulsants generally led to more rapid seizure cessation, the time taken to establish IV access usually compromised this benefit.[8] (LOE1)

- A systematic review investigates the safety and efficacy, as well as patient/caregiver satisfaction, of benzodiazepines administered through various administration routes in paediatric and adult patients with seizures. The buccal, IN and IM routes generally offered time benefits when compared with rectal and IV administrations. Time to seizure termination, seizure recurrence rates, and adverse events were generally similar among the various routes of administration. However, non-rectal routes were associated with greater patient and caregiver satisfaction.[9] (LOE1)

- A systematic review and meta-analysis compared the efficacy and safety of IV versus non-IV routes of administration for benzodiazepines to ultimately determine whether the delay caused by the establishment of IV access is justified by improved outcomes. For treatment failure, non-IV routes were generally superior to the IV route (OR 0.72; 95% CI 0.56 to 0.92). Although the interval between drug administration and seizure cessation in non-IV administered benzodiazepines was longer (MD 0.74 min; 95% CI 0.52 to 0.95), non-IV still controlled seizures faster (MD 3.41 min; 95% CI 1.69 to 5.13). Respiratory complications requiring intervention were similar between non-IV and IV benzodiazepines (RD 0.00; 95% CI –0.02 to 0.01).[10] (LOE1)

Characteristics of the Evidence

This quality indicator evidence summary is based on a structured search of the literature and selected evidence-based healthcare databases. The evidence in this summary comes from:

- A systematic review and meta-analysis including 46 RCTs involving more than 75,000 patients, eight prospective observational studies and six retrospective studies.[5]
- An RCT involving 1,441 patients.[6]
- A systematic review and meta-analysis including 14 RCTs, 16 cohort studies, 12 cross sectional studies and 11 case control or case series studies.[5]
- A Cochrane systematic review and meta-analysis including 18 RCTs or pseudo-RCTs involving 2,755 patients.[7]
- A Cochrane systematic review and meta-analysis including 18 RCTs involving 2,199 patients.[8]
- A systematic review of 75 RCTs and other study designs.[9]
- A systematic review and meta-analysis of 10 RCTs involving 1,633 patients and 1 observational study.[10]

Definitions

Benzodiazepines: A group of drugs that have similar pharmacologic effects developed and approved predominantly to treat anxiety, but some are approved for the management for other purposes such as anticonvulsant treatment.[11] Benzodiazepines commonly used in the management of active seizures include diazepam, lorazepam and midazolam.

Epilepsy: A neurological disorder characterised by a tendency to have recurrent seizures.[3] Clinically, epilepsy is defined as when any of the following exist:[12]

- At least two unprovoked (or reflex) seizures occurring more than 24 hours apart.

- One unprovoked (or reflex) seizure and a probability of further seizures similar to the general recurrence risk after two unprovoked seizures (eg, ≥60 percent) occurring over the next 10 years. This may be the case with remote structural lesions such as stroke, central nervous system infection, or certain types of traumatic brain injury.
- Diagnosis of an epilepsy syndrome.

Seizure: A sudden change in behaviour, possibly in combination with abrupt loss of consciousness and muscle stiffness and jerking or twitching, caused by electrical hyper-synchronisation of neuronal networks in the cerebral cortex.[1] A seizure may be classified as an acute symptomatic seizure when it occurs at the time of a systemic insult or in close temporal association with a documented brain insult.[13] An unprovoked seizure or remote symptomatic seizure refers to a seizure of unknown aetiology or one that occurs due to a pre-existing brain lesion or progressive nervous system disorder.[1]

References

1. Schachter S, Garcia P, Dashe J. Evaluation and management of the first seizure in adults [Internet]. UpToDate. 2018 [cited 2019 Feb 11]. Available from: https://www.uptodate.com/
2. Department of Health - National Association of Diabetes Centres. Final Report ANDIAB 2011 - Australian National Diabetes Information Audit & Benchmarking [Internet]. Canberra; 2011. Available from: http://www.health.gov.au/internet/publications/publishing.nsf/Content/pq-diabetes-pubs-andiab11-toc
3. Epilepsy Action Australia. Need to Know Facts and Statistics About Epilepsy [Internet]. 2017 [cited 2019 Feb 11]. Available from: https://www.epilepsy.org.au/about-epilepsy/facts-and-statistics/
4. Huff J, Morris D, Kothari R, Gibbs M. Emergency Department Management of Patients with Seizures: A Multicenter Study. Acad Emerg Med. 2001;8(6):622–8.
5. Bloomfield H, Greer N, Newman D, MacDonald R, Carlyle M, Fitzgerald P, et al. Evidence-based Synthesis Program Predictors and Consequences of Severe Hypoglycemia in Adults with Diabetes – A Systematic Review of the Evidence [Internet]. Minneapolis, MN; 2012. Available from: https://www.hsrd.research.va.gov/publications/esp/hypoglycemia-2012.pdf
6. The Diabetes control and Complications Trial Research Group. Hypoglycemia in the Diabetes Control and Complications Trial. Diabetes. 1997;46(2):271–86.
7. Prasad M, Krishnan PR, Sequeira R, Al-Roomi K. Anticonvulsant therapy for status epilepticus. Cochrane database Syst Rev. 2014;(9).
8. Appleton R, Martland T, Phillips B. Drug management for acute tonic-clonic convulsions including convulsive status epilepticus in children. Cochrane Database Syst Rev. 2018;(1).
9. Haut SR, Seinfeld S, Pellock J. Benzodiazepine use in seizure emergencies: A systematic review. Epilepsy Behav. Elsevier B.V.; 2016;63:109–17.
10. Alshehri A, Abulaban A, Bokhari R, Kojan S, Alsalamah M, Ferwana M, et al. Intravenous Versus Nonintravenous Benzodiazepines for the Cessation of Seizures: A Systematic Review and Meta-analysis of Randomized Controlled Trials. Acad Emerg Med. 2017;24(7):875–83.
11. Brenner G, Stevens C. Sedative-Hypnotic and Anxiolytic Drugs. In: Brenner and Stevens' Pharmacology. 5th ed. Philadelphia, PA: Elsevier; 2018. p. 205–16.
12. Fisher RS, Acevedo C, Arzimanoglou A, Bogacz A, Cross JH, Elger CE, et al. ILAE Official Report: A practical clinical definition of epilepsy. Epilepsia. 2014;55(4):475–82.
13. Beghi E, Carpio A, Forsgren L, Hesdorffer DC, Malmgren K, Sander JW, et al. Recommendation for a definition of acute symptomatic seizure. Epilepsia. 2010;51(4):671–5.

Sub-Domain 8: Hypoglycaemia

Prevalence and Significance

Based on self-reported data from the Australian Bureau of Statistics' (ABS) 2014–15 National Health Survey, an estimated 1.2 million (6%) Australian adults aged 18 years and over have diabetes and the prevalence is escalating.[5] It is assumed that for every four adults with diagnosed diabetes, there is one who is undiagnosed.[5] Males, the elderly, Indigenous Australians and people living in remote and socioeconomically disadvantaged areas are generally more affected. Type 2 diabetes is the most common form of diabetes.[5] Severe hypoglycaemia was the most frequent diabetes complication in an audit conducted by the National Association of Diabetes Centres (NADC) with 4.8% of all included adult patients (*n*=4,629) experiencing at least one episode over a 12-month period.[6] Untreated hypoglycaemia may have severe consequences.[7] The number of ambulance service responses to diabetic patients as a result of hypoglycaemia in Australia is unclear.

Quality Indicators and Evidence

QI-B.8.1. **A conscious hypoglycaemic patient is administered oral glucose, unless contraindicated.**

Effectiveness

QI-B.8.2. **An unconscious hypoglycaemic patient is administered intravenous glucose 10% or intramuscular glucagon, unless contraindicated.**

Effectiveness

QI-B.8.3. **A patient who has been administered glucose (oral or intravenous) or glucagon has their blood glucose level checked following administration.**

Effectiveness

- A systematic guideline and evidence review examined the current treatment guidelines for the management of hypoglycaemia and the evidence underpinning recommendations. The review included six guidelines from international diabetes agencies and three systematic reviews amongst other studies. The included guidelines and reviews were generally consistent in recommending 15-20 g oral glucose or sucrose, repeated after 10-15 min for treatment of the conscious hypoglycaemic adult, and 10% intravenous (IV) dextrose or 1 mg intramuscular (IM) glucagon for treatment of the unconscious hypoglycaemic adult. Specific evidence regarding the treatment of hypoglycaemia included:[8] (LOE1)

  - One systematic review and meta-analysis that compared dietary sugars with glucose tablets and found that glucose tablets were superior.[9]
  - One systematic review and meta-analysis that evaluated the effectiveness of glucagon alone and in comparison with dextrose and found that ineffectiveness of glucagon is infrequent and not different from dextrose.[10]
  - One systematic review compared IV glucose or IM glucagon and found that IV glucose is the more reliable treatment choice.[11]

- A systematic review assessed the efficacy of intravenous 10% dextrose in the management of out-of-hospital hypoglycaemia. The review found low-level evidence to suggest that the titration of 10% dextrose to conscious state in severe hypoglycaemia is as efficacious as the administration of 50% dextrose, while reducing associated risks and producing better post-treatment outcomes.[12] (LOE1)

QI-B.8.4. **A patient who has had a hypoglycaemic episode effectively corrected is prehospitally discharged, unless they are taking oral hypoglycaemic agents (OHA) or other repeat hypoglycaemic event (RHE) risk criteria* apply.**

➲ **Effectiveness**

- A systematic review assessed the extent to which post-hypoglycaemic patients with diabetes who are prescribed OHA are at risk of repeat hypoglycaemic events (RHE) after being treated in the prehospital environment, and whether they should be transported to hospital regardless of their post-treatment response. The review indicated that post-hypoglycaemic patients treated in the prehospital environment have a 2–7% risk of experiencing an RHE within 48 hours. The literature retrieved in this study recognises the potential for OHA to cause RHE. However, the extent to which this occurs in practice remained unknown.[13] (LOE1)

Characteristics of the Evidence

This quality indicator evidence summary is based on a structured search of the literature and selected evidence-based healthcare databases. The evidence in this summary comes from:

- A guideline and evidence review including six guidelines from international diabetes agencies and 20 research articles, including the following three systematic reviews.[8]
- A systematic review and meta-analysis including three RCTs and one observational study.[9]
- A systematic review and meta-analysis including five studies which were mostly observational.[10]
- A systematic review including four studies; one pseudo-RCT and three quasi-experimental studies.[11]

- A systematic review including 31 studies with at least one being an RCT.[12]
- A systematic review including 21 studies; one controlled trial, eight cohort studies, six literature reviews and three case reports.[13]

Definitions

Diabetes mellitus: A chronic disease caused by relative or absolute insulin deficiency and associated high levels of glucose in the blood.[4] In type 1 diabetes, beta-cell destruction occurs, usually leading to absolute insulin deficiency.[3] Type 2 includes the common major form of diabetes, which results from defects in insulin secretion, almost always with a major contribution from insulin resistance.[3]

Hypoglycaemia: A blood glucose level (BGL) <4 mmol/L or a BGL that is low enough to cause related signs and symptoms.[1,2] Hypoglycaemia may be considered severe when the episode renders the patient unable to self-treat due to confusion or loss of consciousness and assistance from another person is required.[2,3] Hypoglycaemia most frequently occurs due to incorrect dose or administration of anti-hyperglycaemic drugs in patients with diabetes, but can happen in any person as a result of inadequate carbohydrate intake or excessive alcohol consumption.[2]

References

1. Diabetes Australia. Hypoglycaemia. Hypoglycaemia. 2015.
2. Therapeutic Guidelines Ltd. Diabetes: Complications - Hypoglycaemia [Internet]. eTG complete. 2018 [cited 2018 Jun 20]. Available from: https://tgldcdp.tg.org.au/etgAccess
3. Australian Institute of Health and Welfare. Data Set Specification - Diabetes (clinical), National Health Data Dictionary, Version 12 [Internet]. Canberra; 2003. Available from: https://www.aihw.gov.au/reports/australias-health/data-set-specification-diabetes-clinical/contents/table-of-contents
4. Therapeutic Guidelines Ltd. Diabetes: Detection and Diagnosis [Internet]. eTG complete. 2018 [cited 2018 Jun 20]. Available from: https://tgldcdp.tg.org.au/etgAccess
5. Australian Institute of Health and Welfare. How many Australians have diabetes? Diabetes Compendium. Canberra; 2017.
6. Department of Health - National Association of Diabetes Centres. Final Report ANDIAB 2011 - Australian National Diabetes Information Audit & Benchmarking [Internet]. Canberra; 2011. Available from: http://www.health.gov.au/internet/publications/publishing.nsf/Content/pq-diabetes-pubs-andiab11-toc
7. Bloomfield H, Greer N, Newman D, MacDonald R, Carlyle M, Fitzgerald P, et al. Evidence-based Synthesis Program Predictors and Consequences of Severe Hypoglycemia in Adults with Diabetes – A Systematic Review of the Evidence [Internet]. Minneapolis, MN; 2012. Available from: https://www.hsrd.research.va.gov/publications/esp/hypoglycemia-2012.pdf
8. Villani M, de Courten B, Zoungas S. Emergency treatment of hypoglycaemia: a guideline and evidence review. Diabet Med. 2017;34(9):1205–11.
9. Carlson JN, Schunder-Tatzber S, Neilson CJ, Hood N. Dietary sugars versus glucose tablets for first-aid treatment of symptomatic hypoglycaemia in awake patients with diabetes: A systematic review and meta-analysis. Emerg Med J. 2017;34(2):100–6.
10. Boido A, Ceriani V, Pontiroli AE. Glucagon for hypoglycemic episodes in insulin-treated diabetic patients: a systematic review and meta-analysis with a comparison of glucagon with dextrose and of different glucagon formulations. Acta Diabetol. 2015;52(2):405–12.
11. Boyd R, Foëx B. Glucose or glucagon for hypoglycaemia. Emerg Med J [Internet]. British Association for Accident and

Emergency Medicine; 2000;17(4):287. Available from: http://emj.bmj.com/content/17/4/287.1

12. Nehme Z, Cudini D. A review of the efficacy of 10% dextrose as an alternative to high concentration glucose in the treatment of out-of-hospital hypoglycaemia. J Emerg Prim Heal Care. 2009;7(3).

13. Fitzpatrick D, Duncan EAS. Improving post-hypoglycaemic patient safety in the prehospital environment: A systematic review. Emerg Med J. 2009;26(7):472–8.

Sub-Domain 9: Pain Management

Prevalence and/or Significance

Pain is one of the most frequent symptoms felt by patients and thus a common reason for contacting the ambulance service.[1–3] A retrospective review of Ambulance Victoria metropolitan patient care reports found that in 2008, 108,853/315,273 (34.5%) of patients presented experiencing pain. The majority of these patients complained of pain of traumatic or medical aetiology (40.1% and 39.1%, respectively).

Chapter 11 of the Australian Productivity Commission's Report on Government Services (RoGS) provides insight into the pain management provided by State/Territory ambulance services. In the report, pain management is defined as the percentage of adult patients with severe pain (≥7/10 on a 1-10 numeric rating scale) who report pain reduction by a minimum 2 points from first to final recorded measurement.[4] 2017-18 performance amongst State/Territory ambulance services ranges from 89.0% (ACT) to 64.8% (NT).[4]

Appropriate management of pain (and associated anxiety) is an important component of comprehensive and patient-centred emergency care for patients of all ages and in any setting. However, research suggests that oligoanalgesia is still an unacceptably frequent occurrence. [3,5–13] The reasons for oligoanalgesia are complex, but include preoccupation with diagnosis and treatment of underlying medical conditions, distraction by traumatic injuries, concern about masking symptoms, fear about causing addiction to analgesics, ineffective communication and language barriers.[14]

Quality Indicators and Evidence

QI-B.9.1. **A patient has their pain intensity measured using the 0-10 verbal numerical rating scale (VNRS).**

Effectiveness

- A systematic review examined pain scales used to measure pain in adults. The visual analogue scale (VAS), the verbal rating scale (VRS) and the numerical rating scale (NRS) were compared in terms of compliance and usability and to elicit superiority. Generally, all three scales were found to be valid, reliable and appropriate for use in the emergency setting. Elderly patients and those with cognitive impairment or communication problems may find the VAS more difficult to understand. The reviewers found that overall the NRS has good

sensitivity and is able to easily generate data that can be analysed for audit purposes.[15] (LOE1)

- A systematic review investigated the use and performance of unidimensional pain scales, with specific emphasis on the NRS. The authors found significant variation in versions of the NRS and within their descriptors. However, compared with the VAS and VRS, the reviewers found that the NRS, generally, had better compliance and was the preferred instrument due to higher compliance rates, better responsiveness and ease of use.[16] (LOE1)

- A retrospective cross-sectional study aimed to determine the feasibility of prehospital pain measurement among patients 13 years of age or older using a VRS and NRS. Prehospital pain assessment using a VRS and NRS was feasible in this patient population. An 11-point scale was considered preferable for prehospital practice and could also be useful for research applications.[17] (LOE4)

- A literature review examined the characteristics required of a pain measurement tool for the assessment of acute pain in the prehospital environment. The review appraised the relative utility of a number of such instruments specifically in the prehospital context. The review included the VAS, the VNRS, forms of the VRS (adjective response scale, verbal descriptor scale), as well as several multidimensional scales and scales useful in the assessment of pain in children. The reviewers found the verbal numerical rating scale to be the most appropriate pain measure to administer in the prehospital setting for adult patients as it is practical and valid.[18] (LOE5)

QI-B.9.2. **A patient experiencing moderate (4-6/10) or severe (7-10/10) pain is administered analgesic agent(s), unless contraindicated or refused.**

Effectiveness

(No evidence identified)

Note: Pain is a common presentation in the emergency care setting and the provision of effective analgesia is widely considered a minimum expectation of ambulance services. Nevertheless, the literature indicates that oligoanalgesia remains a frequent occurrence in prehospital care. [3,5–13]

QI-B.9.3. **A patient who is administered analgesic agent(s) reports a reduction in pain to ≤ 3/10 or at least by 3 points within X minutes of administration (X = 5, 10, 15, 20 or exclude time component).**

Effectiveness

- A systematic review and meta-analysis investigated the minimum clinically important difference (MCID) in acute pain relief. Significant heterogeneity made the medians and interquartile ranges (rather than results of the meta-analyses) more appropriate descriptors of the findings. Disregarding type of scale and analytical approach (mean change or threshold analysis), the absolute MCID reported from 30 studies ranged from 8 to 40 mm (on a 100 mm scale), and the relative difference in 15 studies ranged from 13% to 85%. Amongst studies utilising a mean change analysis, 29 studies (6,517 patients) reported absolute MICD ranging from 8 to 40 mm, with a median of 17 mm (IQR 14 to 23 mm). Fourteen studies (1,617 patients) were included in analysis of relative MCID ranging from 13% to 85%, with a median of 23% (IQR 18 to 36). Amongst studies applying a threshold analysis, absolute thresholds ranged from 10 to 35 mm in six studies (2,331 patients) with a median of 10 mm, and the relative threshold ranged from 15% to 50% in four studies (534 patients). The reviewers emphasised that whilst the MCID in acute pain is important for the interpretation of results of RCTs and meta-analyses and for determining appropriate sample sizes for new trials, clinical application requires careful and contextual consideration.[19] (LOE1)

- A systematic review and meta-analysis investigated the minimum clinically important difference (MCID) in chronic pain relief. Disregarding type of scale and analytical approach (mean change or threshold analysis), the absolute MCID reported from 66 studies ranged from -1 to 82 mm (on a 100 mm scale) with a median of 20 mm (IQR 13 to 310) and the relative difference reported in 17 studies and ranged from 10% to 56% with a median of 32% (IQR 22 to 41). Amongst studies utilising a mean change analysis, 51 studies (13,561 patients) reported absolute MICD with a median of 23 mm (IQR 12 to 39 mm). Seven studies (1,465 patients) provided relative MCID with a median of 34% (IQR 22 to 45). Amongst studies applying a threshold analysis, the median absolute MCID from 43 studies (26,673 patients) was 20 mm (IQR 15 to 30) and the median relative MCID from 15 studies (9,836 patients) was 32% (IQR 15 to 41). The reviewers emphasised that whilst the MCID in chronic pain is important for the interpretation of results of RCTs and meta-analyses and for determining appropriate sample sizes for new trials, clinical application requires careful and contextual consideration.[20] (LOE1)

- A Delphi consensus process involving 56 UK military emergency medicine and anaesthetic consultants and civilian helicopter emergency physicians developed criteria for an ideal prehospital analgesic agent. Amongst other criteria, the panel agreed that the appropriate dose of the agent should achieve a reduction of pain intensity to ≤3/10 within 10 minutes of administration.[21] (LOE5)

QI-B.9.4. **A responsive patient who is administered analgesic agent(s) remains responsive to verbal stimuli, unless anaesthesia is being induced.**

Safety

- A Delphi consensus process involving 56 UK military emergency medicine and anaesthetic consultants and civilian helicopter emergency physicians developed criteria for an ideal prehospital analgesic agent. Amongst other criteria, the panel agreed that the appropriate dose of the agent should not result in a potentially dangerous decrease of the patient's level of consciousness, i.e. below being responsive to verbal stimuli.[21] (LOE5)

QI-B.9.5. **A responsive patient who is administered analgesic agent(s) does not require airway management or ventilatory support following the administration, unless anaesthesia is being induced.**

Safety

- A Delphi consensus process involving 56 UK military emergency medicine and anaesthetic consultants and civilian helicopter emergency physicians developed criteria for an ideal prehospital analgesic agent. Amongst other criteria, the panel agreed that the appropriate dose of the agent should not result in the patient losing spontaneous control of their airway or adequate ventilations.[21] (LOE5)

Characteristics of the Evidence

This quality indicator evidence summary is based on a structured search of the literature and selected evidence-based healthcare databases. The evidence in this summary comes from:

- A systematic review of 19 studies of test accuracy among consecutive patients;[15]
- A systematic review of 54 studies of test accuracy among consecutive patients;[16]
- A retrospective cross-sectional involving 1,227 patients;[17]
- A literature review.[18]
- A systematic review and meta-analysis of 37 studies of test accuracy among consecutive and non-consecutive patients.[19]
- A systematic review and meta-analysis of 66 studies of test accuracy among consecutive and non-consecutive patients.[20]
- A Delphi consensus process involving 56 experts as part of a systematic review.[21]

Definitions

Mean change analysis: The mean difference in pain scores among patients with a minimum degree of pain reduction.[22]

Minimum clinically important difference (MCID): In simple terms, MCID is patient derived score that reflects changes in a clinical intervention that are meaningful for the patient. [23]

Numeric Rating Scale (NRS): A validated scale to measure pain intensity consisting of a 11-point (0-10) scale on which 0 represents ''no pain'' and 10 indicates ''worst pain ever''. The scale can be utilised verbally, i.e. ***verbal*** **numeric rating scale (VNRS)**.

Oligoanalgesia: Inadequate treatment of acute or chronic pain.

Threshold analysis: The threshold for change in pain score which most accurately (best sensitivity and specificity) identified patients experiencing a minimum degree of pain reduction (analogous to a diagnostic test where patients' perception of change is the gold standard.[24]

Verbal Rating Scales (VRS): A validated scale to measure pain intensity consisting of adjectives/descriptors, i.e. **adjective response scale (ARS)/verbal descriptor scale (VDS)**, in which the patient is asked to indicate the severity of pain by choosing one of several scaling descriptions such as ''none'', ''slight'', ''moderate'', ''severe'' and ''agonising''.

Visual Analog Scale (VAS): A validated scale to measure pain intensity consisting of a 100 mm line anchored by ''no pain'' and ''worst pain ever'' at either end of the line. Patients indicate their pain severity on the line and the clinician measures from the ''no pain'' anchor to where the patient reports the pain intensity. This provides a pain rating score out of 100.

References

1. Jennings PA, Cameron P, Bernard S. Epidemiology of prehospital pain: An opportunity for improvement. Emerg Med J. 2011;28(6):530–1.
2. McLean SA, Maio RF, Domeier RM. The epidemiology of pain in the prehospital setting. Prehospital Emerg Care. 2002;6(4):402–5.
3. Galinski M, Ruscev M, Gonzalez G, Kavas J, Ameur L, Biens D, et al. Prevalence and management of acute pain in prehospital emergency medicine. Prehospital Emerg Care. 2010;14(3):334–9.
4. Australian Government Productivity Commission - Steering Committee for the Review of Government Service Provision. Report on Government Services - Chapter 11 (Ambulance Services) [Internet]. Canberra; 2019. Available from: https://www.pc.gov.au/research/ongoing/report-on-government-services/2019/health/ambulance-services
5. Hewes HA, Dai M, Mann NC, Baca T, Taillac P. Prehospital Pain Management: Disparity By Age and Race. Prehospital Emerg Care. 2018;22(2):189–97.
6. Castrèn M, Lindström V, Hagman Branzell J, Niemi-Murola L. Prehospital personnel's attitudes to pain management. Scand J Pain. 2015;8(1):17–22.
7. Hebsgaard S, Mannering A, Zwisler S. Assessment of acute pain in trauma-A retrospective prehospital evaluation. J Opioid Manag. 2016;12(5):347–53.
8. Siriwardena AN, Shaw D, Bouliotis G. Exploratory cross-sectional study of factors associated with pre-hospital management of pain. J Eval Clin Pract. 2010;16(6):1269–75.
9. Iqbal M, Spaight PA, Siriwardena AN. Patients' and emergency clinicians' perceptions of improving pre-hospital pain management: A qualitative study. Emerg Med J. 2013;30(3).
10. Scholten AC, Berben SAA, Westmaas AH, Van Grunsven PM, De Vaal ET, Rood PPM, et al. Pain management in trauma patients in (pre)hospital based emergency care: Current practice versus new guideline. Injury. 2015;46(5):798–806.
11. Friesgaard KD, Riddervold IS, Kirkegaard H, Christensen EF, Nikolajsen L. Acute pain in the prehospital setting: A register-based study of 41.241 patients. Scand J Trauma Resusc Emerg Med. 2018;26(1):1–10.

12. Platts-Mills TF, Hunold KM, Weaver MA, Dickey RM, Fernandez AR, Fillingim RB, et al. Pain treatment for older adults during prehospital emergency care: Variations by patient gender and pain severity. J Pain. 2013;14(9):966–74.
13. Bakkelund KE, Sundland E, Moen S, Vangberg G, Mellesmo S, Klepstad P. Undertreatment of pain in the prehospital setting: A comparison between trauma patients and patients with chest pain. Eur J Emerg Med. 2013;20(6):428–30.
14. Curtis L, Morrell T. Pain management in the emergency department. Emerg Med Pract. 2006;8(7):1–27.
15. Karcioglu O, Topacoglu H, Dikme O, Dikme O. A systematic review of the pain scales in adults: Which to use? Am J Emerg Med. 2018;36(4):707–14.
16. Hjermstad MJ, Fayers PM, Haugen DF, Caraceni A, Hanks GW, Loge JH, et al. Studies comparing numerical rating scales, verbal rating scales, and visual analogue scales for assessment of pain intensity in adults: A systematic literature review. J Pain Symptom Manage. 2011;41(6):1073–93.
17. McLean SA, Domeier RM, DeVore HK, Hill EM, Maio RF, Frederiksen SM. The Feasibility of Pain Assessment in the Prehospital Setting. Prehospital Emerg Care. 2004;8(2):155–61.
18. Jennings PA, Cameron P, Bernard S. Measuring acute pain in the prehospital setting. Emerg Med J. 2009;26(8):552–5.
19. Olsen MF, Bjerre E, Hansen MD, Hilden J, Landler NE, Tendal B, et al. Pain relief that matters to patients: Systematic review of empirical studies assessing the minimum clinically important difference in acute pain. BMC Med. 2017;15(1):1–18.
20. Olsen MF, Bjerre E, Hansen MD, Tendal B, Hilden J, Hróbjartsson A. Minimum clinically important differences in chronic pain vary considerably by baseline pain and methodological factors: systematic review of empirical studies. J Clin Epidemiol. 2018;101(2018):87–106.e2.
21. Park CL, Roberts DE, Aldington DJ, Moore RA. Prehospital analgesia: systematic review of evidence. J R Army Med Corps. 2010;156(4 Suppl 1):295–300.
22. Dworkin RH, Turk DC, McDermott MP, Peirce-Sandner S, Burke LB, Cowan P, et al. Interpreting the clinical importance of group differences in chronic pain clinical trials: IMMPACT recommendations. Pain. 2009;146(3):238–44.
23. Cook C. Clinimetrics Corner: The Minimal Clinically Important Change Score (MCID): A Necessary Pretense. J Man Mannipulative Ther. 2015;16(4):E82-3.
24. Glassman SD, Copay AG, Berven SH, Polly DW, Subach BR, Carreon LY. Defining substantial clinical benefit following lumbar spine arthrodesis. J Bone Jt Surg - Ser A. 2008;90(9):1839–47.

Sub-Domain 10: Other

Prevalence and/or Significance

- *Paracetamol Overdose*

In 2012-13 there were 10,620 hospitalised cases of poisoning by pharmaceuticals in children aged 0-24 in Australia. The largest contributor (3,935; 37%) were cases of non-opioid analgesics (for example, ibuprofen and paracetamol). Eighty four percent of these cases were due to 4-aminophenol derivatives such as paracetamol.[1] Paracetamol is also a commonly ingested agent in intentional self-harm. In 2010-11, 5,915 (29%) persons hospitalised as a result of intentional self-harm involving poisoning by exposure to drugs, medicaments and biological agents had taken paracetamol.[2]

- *Opioid Overdose*

In heroin users the risk of overdose is high, and Australia has seen an increase in heroin-related overdoses in recent years.[3] Three hundred and sixty one (20%) of the 1,808 drug-induced deaths in Australia in 2016 were due to heroin.[3] Whilst heroin use among the Australian general population is low (0.2% reporting consumption in the last 12 months), heroin is used more frequently than other drugs (49% of users using as often as weekly).[3] Besides the use of illicit opioid (heroin), the non-medical use of pharmaceutical drugs is an increasing public health concern in Australia.[4]

- *Pre-Arrival Notifications*

Notifying a receiving hospital of a patient may contribute to more efficient handover and improved access to required resources. Pre-arrival notification may play a crucial role in clinical care pathways of time-sensitive patients.

Quality Indicators and Evidence

QI-B.10.1. **A patient with suspected paracetamol overdose who presents within four hours of ingestion is administered activated charcoal, unless contraindicated.**

➲ Effectiveness

- A Cochrane systematic review investigated the benefits and harms of interventions for paracetamol overdose. Activated charcoal appeared to decrease absorption of paracetamol, but the clinical benefits were unclear. Activated charcoal seemed to have the best risk-benefit ratio among gastric lavage, ipecacuanha, or supportive treatment if given within four hours of ingestion.[5] (LOE1)

QI-B.10.2. **A patient suspected of opioid overdose who is unconscious or has depressed respiration is administered naloxone (2 mg, intramuscular/intranasal/ intravenous), unless contraindicated.**

Effectiveness

- A systematic review examined the effectiveness of naloxone when administered through different routes to patients with suspected opioid overdose in out-of-hospital settings. At the same dose (2 mg), 1 trial found similar efficacy between higher-concentration intranasal (IN) naloxone (2 mg/mL) and intramuscular (IM) naloxone, and 1 trial found that lower-concentration IN naloxone (2 mg/5 mL) was less effective than IM naloxone but was associated with decreased risk for agitation.[6]

- A systematic review investigated routes of naloxone administration for opioid reversal in the prehospital setting. The authors found no clinically significant differences between the IN, IM, intravenous (IV), and subcutaneous (SC) routes. However, the IN route may have safety benefits.[7] (LOE1)

QI-B.10.3. **The ambulance service has a policy that defines specific categories of patients for which receiving facilities are to be notified of the patient's arrival.**

Access

(No evidence identified. Note: Evidence concerning pre-arrival notifications for specific patient cohorts [e.g. trauma, acute coronary syndrome] is covered in disease-specific sub-domains.)

Characteristics of the Evidence

This quality indicator evidence summary is based on a structured search of the literature and selected evidence-based healthcare databases. The evidence in this summary comes from:

- A Cochrane systematic review of 11 RCTs involving 700 patients.[5]
- A systematic review of 7 studies, including 3 RCTs and 4 cohort studies.[6]
- A systematic review of 8 studies, including 2 RCTs involving 214 patients, and 6 studies using other designs.[7]

Definitions

Activated charcoal: Activated charcoal is an oral pharmaceutical agent that can be given to adsorb certain poisons and prevent their absorption.[8]

Naloxone: Naloxone is a competitive opioid receptor antagonists that can rapidly reverse the effects of morphine and other opioid agonists.[9]

References

1. Australian Institute of Health and Welfare (AIHW). Poisoning in children and young people 2012–13 [Internet]. Canberra; 2016. Available from: https://www.aihw.gov.au/
2. Australian Institute of Health and Welfare (AIHW). Suicide and hospitalised self-harm in Australia: trends and analysis [Internet]. Canberra; 2014. Available from: https://www.aihw.gov.au/
3. Australian Institute of Health and Welfare (AIHW). Alcohol, tobacco & other drugs in Australia [Internet]. 2018 [cited 2019 Feb 13]. Available from: https://www.aihw.gov.au/
4. Lalic S, Ilomäki J, Bell JS, Korhonen MJ, Gisev N. Prevalence and incidence of prescription opioid analgesic use in Australia. Br J Clin Pharmacol. 2018;
5. Chiew A, Gluud C, Brok J, Buckley N. Interventions for paracetamol (acetaminophen) overdose. 2018;(2).
6. Chou R, Todd Korthuis P, McCarty D, Coffin PO, Griffin JC, Davis-O'Reilly C, et al. Management of suspected opioid overdose with naloxone in out-of-hospital settings. Ann Intern Med. 2017;167(12):867–75.
7. Weaver L, Palombi L, Bastianelli KMS. Naloxone Administration for Opioid Overdose Reversal in the Prehospital Setting: Implications for Pharmacists. J Pharm Pract. 2018;31(1):91–8.
8. Brenner G, Stevens C. Toxicology and the Treatment of Poisoning. In: Brenner G, Stevens C, editors. Brenner and Stevens' Pharmacology. 5th ed. Philadelphia, PA: Elsevier; 2018. p. 47–55.
9. Brenner G, Stevens C. Opioid Analgesics and Antagonists. In: Brenner G, Stevens C, editors. Brenner and Stevens' Pharmacology. 5th ed. Philadelphia, PA: Elsevier; 2018. p. 261–71.

Appendix A

Pap R, Lockwood C, Stephenson M, Simpson P. Indicators to measure prehospital care quality: a scoping review. JBI Database Syst Rev Implement Reports. 2018;16(11):2192–223.

LIBRARY NOTE:

The article on pages 303-334 has been removed due to copyright.

It is also available online to authorised users at:
https://doi.org/10.11124/JBISRIR-2017-003742

Appendix B

Approval letter from the Human Research Ethics Committee (HREC) of the University of Adelaide

THE UNIVERSITY of ADELAIDE

RESEARCH SERVICES
OFFICE OF RESEARCH ETHICS, COMPLIANCE AND INTEGRITY
THE UNIVERSITY OF ADELAIDE

LEVEL 4, RUNDLE MALL PLAZA
50 RUNDLE MALL
ADELAIDE SA 5000 AUSTRALIA

TELEPHONE +61 8 8313 5137
FACSIMILE +61 8 8313 3700
EMAIL hrec@adelaide.edu.au

CRICOS Provider Number 00123M

25 August 2017

Associate Professor C Lockwood
Joanna Briggs Institute

Dear Associate Professor Lockwood

ETHICS APPROVAL No: **H-2017-157**

PROJECT TITLE: **The development and testing of Australian prehospital care quality indicators**

The ethics application for the above project has been reviewed by the Low Risk Human Research Ethics Review Group (Faculty of Health and Medical Sciences) and is deemed to meet the requirements of the *National Statement on Ethical Conduct in Human Research (2007)* involving no more than low risk for research participants. You are authorised to commence your research on **25 Aug 2017**.

Ethics approval is granted for three years and is subject to satisfactory annual reporting. The form titled *Annual Report on Project Status* is to be used when reporting annual progress and project completion and can be downloaded at http://www.adelaide.edu.au/research-services/oreci/human/reporting/. Prior to expiry, ethics approval may be extended for a further period.

Participants in the study are to be given a copy of the Information Sheet and the signed Consent Form to retain. It is also a condition of approval that you **immediately report** anything which might warrant review of ethical approval including:

- serious or unexpected adverse effects on participants,
- previously unforeseen events which might affect continued ethical acceptability of the project,
- proposed changes to the protocol; and
- the project is discontinued before the expected date of completion.

Please refer to the following ethics approval document for any additional conditions that may apply to this project.

Yours sincerely,

Amy Lehmann
Human Research Ethics Officer
Office of Research Ethics, Compliance and Integrity

THE UNIVERSITY of ADELAIDE

RESEARCH SERVICES
OFFICE OF RESEARCH ETHICS, COMPLIANCE AND INTEGRITY
THE UNIVERSITY OF ADELAIDE

LEVEL 4, RUNDLE MALL PLAZA
50 RUNDLE MALL
ADELAIDE SA 5000 AUSTRALIA

TELEPHONE +61 8 8313 6837
FACSIMILE +61 8 8313 3900
EMAIL hrec@adelaide.edu.au

CRICOS Provider Number 00123M

Applicant:	**Associate Professor C Lockwood**
School:	**Joanna Briggs Institute**
Project Title:	**The development and testing of Australian prehospital care quality indicators**

The University of Adelaide Human Research Ethics Committee
Low Risk Human Research Ethics Review Group (Faculty of Health and Medical Sciences)

ETHICS APPROVAL No: **H-2017-157** **App. No.: 0000022407**

APPROVED for the period: **25 Aug 2017 to 31 Aug 2020**

Thank you for your response dated 23.08.2017 to the matters raised.

It is a condition of approval that the research receives the approval(s) required by the State/Territory Ambulance Services involved in the project.

It is noted this study includes Robin Pap, PhD candidate.

Amy Lehmann
Human Research Ethics Officer
Office of Research Ethics, Compliance and Integrity

Appendix C

Outline of Methods

Appendix C: Outline of Methods

The development of the evidence summaries was guided by the Joanna Briggs Institute (JBI) approach for rapid reviews and evidence summaries.[1] Figure 1 provides a diagrammatic outline of the rapid review and evidence summary process. The searches were undertaken in the following databases:

- PubMed
- CINAHL
- The JBI Database of Systematic Reviews and Implementation Reports and
- The Cochrane Library

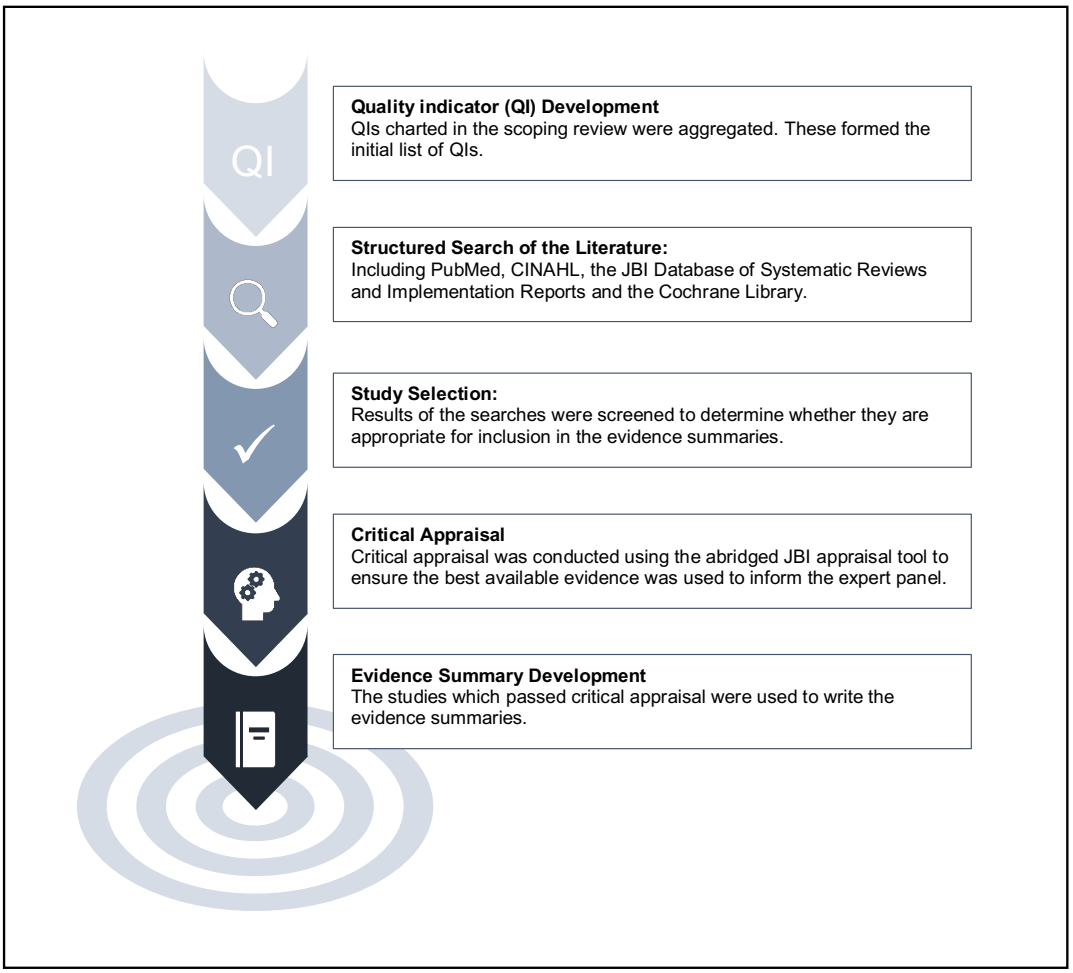


Figure 1 The rapid review and evidence summary development process

Table 1 details an example of search terms used. Generally, terms related to prehospital care were combined with sub-domain and quality indicator (QI) specific terms. Development of the terms related to prehospital care was guided by search filters created by Olaussen, et al.[2] Only English language papers were included for pragmatic reasons. Searches were not be limited by date. The search also included backtracking of references. Guidelines were excluded as detailed in section '1.3. About the Evidence Summaries'. In line with JBI's approach to evidence summaries,[1,3] the best available evidence was incorporated in each summary. This means that lower-level evidence was included only when no systematic reviews were located. Following the search, titles and abstracts were screened. If potentially eligible, the full text of the papers was read to determine whether the article should be included in the applicable evidence summary. Full-text reading involved an assessment of internal validity utilising an abridged critical appraisal tool (Table 2).[1]

Table 1 Example of search terms/filters used in PubMed

Concept	**[1] Prehospital Care**	**[2] (Sub-Domain/QI)**
Search terms	Ambulances[mh] OR Emergency Medical Technicians[mh] OR Air Ambulances[mh] OR paramedic*[tiab] OR ems[tiab] OR emt[tiab] OR prehospital[tiab] OR pre-hospital[tiab] OR first responder*[tiab] OR emergency medical technician*[tiab] OR emergency services[tiab] OR ambulance*[tiab]	*(Sub-domain and QI related search terms)*
Search Filter	[1] AND [2], English only; Systematic Reviews and Meta-Analyses/Meta-Synthesis only (Changed to '[1] AND [2], English only' if no or poor-quality Systematic Reviews and Meta-Analyses/Meta-Synthesis were identified)	

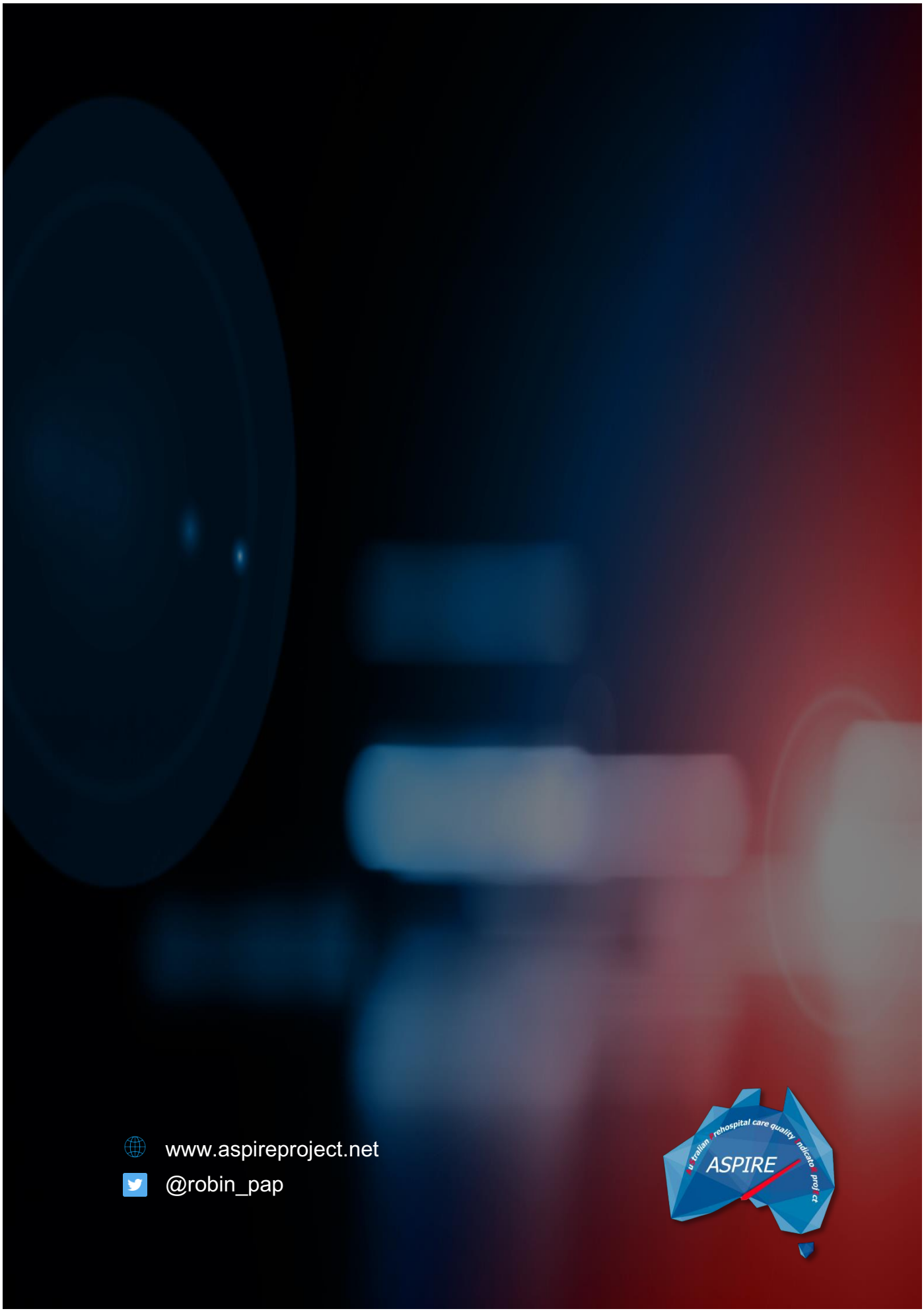
Table 2 Abridged Quality Appraisal Criteria for JBI Evidence Summaries

Type of Study/Evidence	**Quality Appraisal Criteria**
Systematic Review	• Is the review question clearly and explicitly stated? • Was the search strategy appropriate? • Were the inclusion criteria appropriate for the review question? • Were the criteria for appraising studies appropriate? • Was critical appraisal by two or more independent reviewers? • Were there methods used to minimize error in data extraction? • Were the methods used to combine studies appropriate?
Quantitative Evidence	• Was there appropriate randomization? • Was allocation concealed? • Was blinding to allocation maintained? • Was incompleteness of data addressed? • Were outcomes reported accurately?
Qualitative Evidence	• Was the research design appropriate for the research? • Was the recruitment strategy appropriate for the research? • Were data collected in a way that addressed the research issue? • Has the relationship between researcher and participants been considered? • Was the data analysis sufficiently rigorous?

The rapid reviews and evidence summaries developed for this study have several limitations. The more rapid reviews adhere to the methodological rigor of systematic reviews, the longer they will take to complete.[1,4,5] Therefore, the less time is taken to complete a rapid review the less thorough it will be. The JBI approach to evidence summaries aims for a rapid development cycle.[1] This method was considered suitable for purpose of his study considering the limited resources and time available. These restrictions also meant that there was only one researcher to screen, select, appraise and summarise the evidence and no peer review was undertaken. This introduced considerable risk of bias.

References

1. Munn Z, Lockwood C, Moola S. The Development and Use of Evidence Summaries for Point of Care Information Systems: A Streamlined Rapid Review Approach. Worldviews Evidence-Based Nurs. 2015;12(3):131–8.
2. Olaussen A, Semple W, Oteir A, Todd P, Williams B. Paramedic literature search filters: Optimised for clinicians and academics. BMC Med Inform Decis Mak. 2017;17(1):1–6.
3. Joanna Briggs Institute. The JBI Approach [Internet]. 2017 [cited 2018 May 1]. Available from: http://joannabriggs.org/jbi-approach.html
4. Ganann R, Ciliska D, Thomas H. Expediting systematic reviews: methods and implications of rapid reviews. 2010;1–10.
5. PC W, BH R. Evidence-based reviews and databases: are they worth the effort? Developing evidence summaries for emergency medicine. Acad Emerg Med [Internet]. 2007 Nov;14(11):960–4. Available from: http://proxy.library.adelaide.edu.au/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=c8h&AN=106011220&site=ehost-live&scope=site


www.aspireproject.net
@robin_pap
ASPIRE

Introduction

Welcome to the ASPIRE Expert Panel Rating Tool.

This is the rating tool which enables you to rate the clarity and validity of each of the proposed quality indicators (QIs). The rating tool is intended to be used in conjunction with the document titled 'Summarising the Evidence for the AuStralian Prehospital care quality IndocatoR projEct'. We recommend that you work through the evidence summaries and the rating process concurrently, sub-domain by sub-domain. For your convenience, the evidence summaries of the sub-domains are accessible via links in the applicable sections of this rating tool. Read the 'Prevalence and/or Significance' section of a particular sub-domain and then consider the summarised evidence as you rate the clarity and validity of each QI using the rating scales. In this way, your expert evaluation of the QIs' validity is best informed by the available evidence. You must rate all

QIs within a sub-domain before you can move on to the next sub-domain. If you think the clarity of a QI could be improved, you can state how. Towards the end of the process, you will have an opportunity to suggest up to five additional QIs. This is optional but highly encouraged.

You can leave the rating tool and then re-enter where you left off when you click on the rating tool link in the

you left off when you click on the rating tool link in the email again. However, you will need to do so on the same computer/device and same internet browser. Your responses will only be submitted once you click on 'submit' at the end.

This research project is being conducted by Mr Robin Pap (Student ID a1701299) and will form the basis for the degree of Doctor of Philosophy (Ph.D.) at the University of Adelaide under the supervision of Assoc Prof Craig Lockwood, Dr Matthew Stephenson and Dr Paul Simpson. The project has been approved by the University of Adelaide Human Research Ethics Committee (Approval Number H-2017-157 – Appendix B). It is supported through an Australian Government Research Training Program Scholarship and in part by a research grant from the Australian and New Zealand College of Paramedicine (ANZCP). If you have questions or problems associated with the practical aspects of your participation in the project or wish to raise a concern or complaint about the project, then you should consult the principle investigator. If you wish to speak with an independent person regarding a concern or complaint, the University's policy on research involving human participants, or your rights as a participant, please contact the Human Research Ethics Committee's Secretariat (telephone 08 8313 6028; email hrec@adelaide.edu.au ; mail Level 4, Rundle Mall Plaza, 50 Rundle Mall, Adelaide SA 5000). Any complaint or concern will be treated in confidence and fully investigated. You will be informed of the outcome.

Are there any risks associated with participating in this project?
There are no risks associated with participating in this study.

What are the benefits of the research project?
The findings of this research may help to better understand which quality indicators should be used to evaluate prehospital care quality.

Can I withdraw from the project?
Participaytion in this project is completely voluntary. If you agree to participate, you can withdraw from the study at any time.

What happens to my information?
Responses from this rating tool will be managed confidentially. The information participants provide by completing the rating will be stored in a password-protected electornic folder at the Univerity of Adeliade and Western Sydney University for five years. Aggregated data and resuklts of data alanlysis from this research will be included in a PhD thesis, published in scientific journals and may be presented at conferences.

Name

Please provide your full name.

We need to identify expert panel members in order to provide individualised feedback after the first round of rating (see page 16 of the evidence summaries document that was emailed to you). Your individual ratings and information you provide will be kept confidential.

Instructions

Instructions

- Please rate the clarity and validity of each QI using the scales. Please consider the full range of the scales from 1 to 9. Do not simply rate 1 or 9.
- The clarity scale asks you to rate the proposed QI in terms of the degree

to which it is clear, precise and unambiguous.

- A low rating means that the meaning of the proposed QI is unclear and totally ambiguous.
- A high rating means that the meaning of the proposed QI is clear and totally unambiguous.

- The validity scale requires you to rate the proposed QI in terms of the extent to which the statement represents high-quality prehospital care in a

  national Australian context.
  - A low rating means that the proposed QI does not represent high-quality prehospital care in a national Australian context.
  - A mid-range rating means that you are uncertain whether the proposed QI represents high-quality prehospital care in a national Australian context, or it is equivocal.
  - A high rating means that the proposed QI does represents high-quality prehospital care in a national Australian context and is therefore a good Australian prehospital care QI.
- Please consider each proposed QI independently and rate it on its own merit. Do not rate the proposed QI in relation to other ones in the sub-domain or domain, or in relation to exiting QIs or performance indicators.
- Please rate the validity of the proposed QI for the 'average' patient and not every possible clinical presentation or degree of complexity
- Please do not consider feasibility of data collection or acceptability to ambulance service staff when rating the clarity and validity of the proposed QIs. This will be assessed in phase 3 of the project.
- If you think a proposed QI should be changed, please rate it first and then suggest how it could be improved in the space provided.

A.1. General Time Intervals

Sub-Domain A.1. General Time Intervals

You can find the evidence summary here.

QI-A.1.1. In an urban setting, an ambulance arrives on scene of an emergency incident within X minutes of the service receiving the call. (X = 4, 8, 10 or 15)

Please select the time interval (X) which will make QI-A.1.1. most valid.

- ○ 4
- ○ 8
- ○ 10
- ○ 15

Please rate the clarity and validity of QI-A.1.1.

(1 = not clear/valid at all; 9 = extremely clear/valid)

	1	2	3	4	5	6	7	8	9
Clarity	○	○	○	○	○	○	○	○	○
Validity	○	○	○	○	○	○	○	○	○

If you think the *clarity* of QI-A.1.1. could be improved, please briefly state how.

QI-A.1.2. In an urban setting, an ambulance arrives

on scene of an urgent incident within X minutes of the service receiving the call. (X = 10, 15 or 20)

Please select the time interval (X) which will make QI-A.1.2. most valid.

- ○ 10
- ○ 15
- ○ 20

Please rate the clarity and validity of QI-A.1.2.

(1 = not clear/valid at all; 9 = extremely clear/valid)

	1	2	3	4	5	6	7	8	9
Clarity					○				
Validity					○				

If you think the *clarity* of QI-A.1.2. could be improved, please briefly state how.

QI-A.1.3. In an urban setting, an ambulance arrives on scene of a non-emergency incident within X minutes of the service receiving the call. (X = 15, 20 or 30)

Please select the time interval (X) which will make QI-A.1.3. most valid.

NB: To minimise the number of pages, this extract contains only the start and end of the data collection tool (pages 1-5 and 75-79). Pages 6-74 containing rating tools for QI-A.1.4. to QI-B.9.5. have been removed.

Sub-Domain B.10. Other (Clinical)

Please find the evidence summary here.

QI-B.10.1. A patient with suspected paracetamol overdose who presents within four hours of ingestion is administered activated charcoal, unless contraindicated.

Please rate the clarity and validity of QI-B.10.1.

(1 = not clear/valid at all; 9 = extremely clear/valid)

	1	2	3	4	5	6	7	8	9	
Clarity	○	○	○	○	○	○	○	○	○	
Validity	○	○	○	○	○	○	○	○	○	

If you think the *clarity* of QI-B.10.1. could be improved, please briefly explain how.

QI-B.10.2. A patient suspected of opioid overdose who is unconscious or has depressed respirations is administered naloxone (2mg, intramuscular/intranasal/intravenous), unless contraindicated.

Please rate the clarity and validity of QI-B.10.2.

(1 = not clear/valid at all; 9 = extremely clear/valid)

	1	2	3	4	5	6	7	8	9	
Clarity	○	○	○	○	○	○	○	○	○	
Validity	○	○	○	○	○	○	○	○	○	

If you think the *clarity* of QI-B.10.2. could be improved, please briefly explain how.

QI-B.10.3. The ambulance service has a policy that defines specific categories of patients for which receiving facilities are to be notified of the patient's arrival.

Please rate the clarity and validity of QI-B.10.3.

(1 = not clear/valid at all; 9 = extremely clear/valid)

	1	2	3	4	5	6	7	8	9	
Clarity	○	○	○	○	○	○	○	○	○	
Validity	○	○	○	○	○	○	○	○	○	

If you think the *clarity* of QI-B.10.3. could be improved, please briefly explain how.

Additional QIs

Additional QIs

You can suggest up to five additional QIs. Suggesting additional QIs is optional but important. You are encouraged to suggest additional QIs, especially if you feel that the proposed QIs do not sufficiently address vital aspects of prehospital care essential for quality measurement in the Australian context. The additional QIs do not need to align to the current domains or sub-domains. If you are aware of supporting evidence, please provide details/references in the spaces provided.

Additional QI-1

If you are aware of evidence supporting your suggested additional QI-1, please provide details/references.

Additional QI-2

If you are aware of evidence supporting your suggested additional QI-2, please provide

details/references.

Additional QI-3

If you are aware of evidence supporting your suggested additional QI-3, please provide details/references.

Additional QI-4

If you are aware of evidence supporting your suggested additional QI-4, please provide details/references.

Additional QI-5

If you are aware of evidence supporting your suggested additional QI-5, please provide

details/references.

End of Survey

This is the end of the first round of rating. If you are satisfied with your responses, please click the button below to submit your responses.

Thank you for participating. You will receive individualised feedback by Monday, 25 March 2019. This feedback should provide you insight into areas of agreement and more importantly disagreement amongst the expert panel ahead of the online discussion forum.

If you have any questions, please don't hesitate to contact the principle investgiator, Mr Robin Pap at robin.pap@adelaide.edu.au or mobile 0475 915 573.

Introduction

Dear XXXXXXXXXXXXXXXX

This is your rating tool to complete the **second and final round of rating** of the proposed quality indicators (QIs). In this round, you are asked to re-rate the **validity** of each proposed QI. **Each rating scale (except those of addl. QIs) is set to the position of your original (first round) validity rating.** When re-rating the QIs, you should consult the feedback tables provided to you after the first round and consider comments made by other panellists in the online discussions. This may be especially important where your rating is outside the region (1-3, 4-6 or 7-9) containing the panel's median.

For your convenience, the revised evidence summaries of the sub-domains are accessible via links in the applicable sections of this rating tool. You must rate all

QIs within a sub-domain before you can move on to the next sub-domain.

You can leave the rating tool and then re-enter where you left off when you click on the rating tool link in the email again. However, you will need to do so on the same computer/device and same internet browser. Your responses will only be submitted once you click on 'submit' at the end

Click on "submit" at the end.

This research project is being conducted by Mr Robin Pap (Student ID a1701299) and will form the basis for the degree of Doctor of Philosophy (Ph.D.) at the University of Adelaide under the supervision of Assoc Prof Craig Lockwood, Dr Matthew Stephenson and Dr Paul Simpson. The project has been approved by the University of Adelaide Human Research Ethics Committee (Approval Number H-2017-157). It is supported through an Australian Government Research Training Program Scholarship and in part by a research grant from the Australian and New Zealand College of Paramedicine (ANZCP). If you have questions or problems associated with the practical aspects of your participation in the project or wish to raise a concern or complaint about the project, then you should consult the principle investigator. If you wish to speak with an independent person regarding a concern or complaint, the University's policy on research involving human participants, or your rights as a participant, please contact the Human Research Ethics Committee's Secretariat (telephone 08 8313 6028; email hrec@adelaide.edu.au ; mail Level 4, Rundle Mall Plaza, 50 Rundle Mall, Adelaide SA 5000). Any complaint or concern will be treated in confidence and fully investigated. You will be informed of the outcome.

Are there any risks associated with participating in this project?
There are no risks associated with participating in this study.

What are the benefits of the research project?
The findings of this research may help to better understand which indicators should be used to evaluate prehospital care quality.

Can I withdraw from the project?
Participation in this project is completely voluntary. If you agree to participate, you can withdraw from the study at any time.

What happens to my information?
Responses from this rating tool will be managed confidentially. The information participants provide by completing the rating will be stored in a password-protected electornic folder at the Univerity of Adeliade and Western Sydney University for five years. Aggregated data and resukIts of data alanlysis from this research will be included in a PhD thesis, published in scientific journals and may be presented at conferences.

Name

Prepared for: XXXXXXXXXXXXXX

(This rating tool has been prepared specifically for you. **The starting position of each rating slider is set to your original validity rating.**)

Instructions

Instructions

- Please rate each QI on the scale of 1 to 9 for validity. Please consult the feedback tables provided to you from the first round and consider comments made by other panellists in the online discussions.
- If you do not want to change your rating, simply click on the slider once to confirm your original rating.
- The validity scale requires you to rate the proposed QI in terms of the extent to which the statement represents high-quality prehospital care in a national Australian context.
    - A low rating means that the proposed QI does not represent high-quality prehospital care in a national Australian context.
    - A mid-range rating means that you are uncertain whether the

proposed QI represents high-quality prehospital care in a national Australian context, or it is equivocal.

- A high rating means that the proposed QI does represents high-quality prehospital care in a national Australian context and is therefore a good Australian prehospital care QI.

- Please consider each proposed QI independently and rate it on its own merit. Do not rate the proposed QI in relation to other ones in the sub-domain or domain, or in relation to exiting QIs or performance indicators.
- Please rate the validity of the proposed QI for the 'average' patient and not every possible clinical presentation or degree of complexity
- Please do not consider feasibility of data collection or acceptability to ambulance service staff when rating the clarity and validity of the proposed QIs. This will be assessed in phase 3 of the project.
- If you think a proposed QI should be changed, please rate it first and then suggest how it could be improved in the space provided.

A.1. General Time Intervals

Sub-Domain A.1. General Time Intervals

You can find the revised evidence summary here.

QI-A.1.1. In an urban setting, an ambulance arrives on scene of an emergency incident within X minutes of the service receiving the call. (X = 4, 8, 10 or 15)

Please select the time interval (X) which will make QI-A.1.1. most valid.

- 4
- 8
- 10
- 15

Please rate the validity of QI-A.1.1.

(1 = not valid at all; 9 = extremely valid)

1 2 3 4 5 6 7 8 9

Validity

QI-A.1.2. In an urban setting, an ambulance arrives on scene of an urgent incident within X minutes of the service receiving the call. (X = 10, 15 or 20)

Please select the time interval (X) which will make QI-A.1.2. most valid.

- 10
- 15
- 20

Please rate the validity of QI-A.1.2.

(1 = not valid at all; 9 = extremely valid)

1 2 3 4 5 6 7 8 9

Validity

QI-A.1.3. In an urban setting, an ambulance arrives on scene of a non-emergency incident within X minutes of the service receiving the call. (X = 15, 20

minutes of the service receiving the call. (X = 15, 20 or 30)

Please select the time interval (X) which will make QI-A.1.3. most valid.

- ○ 15
- ○ 20
- ○ 30

Please rate the validity of QI-A.1.3.

(1 = not valid at all; 9 = extremely valid)

1 2 3 4 5 6 7 8 9

Validity

QI-A.1.4.rev. State/Territory-wide, an ambulance arrives on scene of an emergency incident within X minutes of the service receiving the call. (X = 4, 8, 10, 15, 20 or 30)

Please select the time interval (X) which will make QI-A.1.4.rev. most valid.

- ○ 4
- ○ 8
- ○ 10
- ○ 15
- ○ 20
- ○ 30

Please rate the validity of QI-A.1.4.rev.

NB: To minimise the number of pages, this extract contains only the start and end of the data collection tool (pages 1-5 and 50-54). Pages 6-49 containing rating tools for QI-A.1.5.rev. to QI-B.8.4.rev. have been removed.

B.9. Pain Management

Sub-Domain B.9. Pain Management

You can find the evidence summary here.

QI-B.9.1. A patient has their pain intensity measured using the 0-10 verbal numerical rating scale (VNRS).

Please rate the validity of QI-B.9.1.

(1 = not valid at all; 9 = extremely valid)

1 2 3 4 5 6 7 8 9

Validity

QI-B.9.2.rev. A patient experiencing mild (1-3/10), moderate (4-6/10) or severe (7-10/10) pain is administered analgesic agent(s), unless contraindicated.

Please rate the validity of QI-B.9.2.rev.

(1 = not valid at all; 9 = extremely valid)

1 2 3 4 5 6 7 8 9

Validity

QI-B.9.3. A patient who is administered analgesic agent(s) reports a reduction in pain to ≤3/10 or at least by 3 points

with X minutes of administration. (X = 5, 10, 15, 20 or exclude time component)

Please select the time interval (X) which will make QI-B.9.3. most valid.

- ○ 5
- ○ 10
- ○ 15
- ○ 20
- ○ Exclude time component

Please rate the validity of QI-B.9.3.

(1 = not valid at all; 9 = extremely valid)

1 2 3 4 5 6 7 8 9

Validity

QI-B.9.4. A responsive patient who is administered analgesic agent(s) remains responsive to verbal stimuli, unless anaesthesia is being induced.

Please rate the validity of QI-B.9.4.

(1 = not valid at all; 9 = extremely valid)

1 2 3 4 5 6 7 8 9

Validity

QI-B.9.5. A responsive patient who is administered analgesic agent(s) does not require airway

management of ventilatory support following the administration, unless anaesthesia is being induced.

Please rate the validity of QI-B.9.5.

(1 = not valid at all; 9 = extremely valid)

1 2 3 4 5 6 7 8 9

Validity

B.10. Other (Clinical)

Sub-Domain B.10. Other (Clinical)

Please find the evidence summary here.

QI-B.10.1. A patient with suspected paracetamol overdose who presents within four hours of ingestion is administered activated charcoal, unless contraindicated.

Please rate the validity of QI-B.10.1.

(1 = not valid at all; 9 = extremely valid)

1 2 3 4 5 6 7 8 9

Validity

QI-B.10.2. A patient suspected of opioid overdose who is unconscious or has depressed respirations is administered naloxone (2mg,

intramuscular/intranasal/intravenous), unless contraindicated.

Please rate the validity of QI-B.10.2.

(1 = not valid at all; 9 = extremely valid)

1 2 3 4 5 6 7 8 9

Validity

QI-B.10.3. The ambulance service has a policy that defines specific categories of patients for which receiving facilities are to be notified of the patient's arrival.

Please rate the validity of QI-B.10.3.

(1 = not valid at all; 9 = extremely valid)

1 2 3 4 5 6 7 8 9

Validity

End of Survey

This is the end of the second and final round of rating. If you are satisfied with your responses, please click the button below to submit your responses.

Thank you for participating. If you have any questions, please contact Mr Robin Pap at robin.pap@adelaide.edu.au or mobile 0475 915 573.

Block 1

The Development and Testing of Australian Prehospital Care Quality Indicators

Thank you for your interest in participating in this study. By continuing with this survey, you agree to take part in the research titled 'The Development and Testing of Australian Prehospital Care Quality Indicators' (University of Adelaide HREC Approval Number HREC-2017-157) and acknowledge the following:

1. You have had the project, so far as it affects you, fully explained to your satisfaction by reading the participant information sheet (also available here). Your consent is given freely.
2. Although you understand the purpose of the research project, it has also been explained that involvement may not be of any benefit to you.
3. You have been informed that, while information gained during the study may be published, you will not be identified and your personal results will not be divulged.
4. You understand that you are free to withdraw from the project at any time.

This study has been approved by the Human Research Ethics Committee at the University of Adelaide (approval number H-2017-157). If you have questions or problems associated with the practical aspects of your participation in the project or wish to raise a concern or complaint about the project, then you should consult the Principal Investigator. If you wish to speak with an independent person regarding a concern or complaint, the University's policy on research involving human participants, or your rights as a participant, please contact the Human Research Ethics Committee's Secretariat on:

Phone: +61 8 8313 6028

Email: hrec@adelaide.edu.au

Email: [redacted]

Post: Level 4, Rundle Mall Plaza, 50 Rundle Mall, ADELAIDE SA 5000

Any complaint or concern will be treated in confidence and fully investigated. You will be informed of the outcome.

Block 2

Important Information

About quality indicators

A quality indicator (QI) is a statement describing a measurable aspect of care or of the organisation that is linked to improved quality. A QI may refer to a ***Structure***, ***Process***, or an ***Outcome*** (see descriptions below) and may address ***Access***, ***Safety*** and/or ***Effectiveness*** as dimensions of quality.

Structures *are the characteristics of the setting in which care is provided. This comprises material resources (e.g., medical equipment), human resources (e.g., the qualifications of staff) and organisational attributes (e.g., the presence of policies and guidelines).*

Processes *are what is being done in providing service and patient care, i.e., the organisation's or individual health care provider's activities in assessing the patient, giving specific treatment and other appropriate practice in managing the patient.*

Outcomes *are the effects of care on health status of individuals or populations, such as return of spontaneous circulation (ROSC) or patient satisfaction.*

About rating acceptability

This survey enables you to rate how acceptable you find a proposed suite of prehospital care QIs.

Acceptability refers to how satisfactory or agreeable you find the QIs in terms of your professional standards and values. For each QI, ask yourself the following question:

How acceptable is it to assess the quality of my patient care or the quality of my ambulance service based on data collected using this quality indicator?

Answer this question for each QI using the 1-5 rating scale:

1 = Very unacceptable; 2 = Unacceptable; 3 = Neutral; 4 = Acceptable; 5 = Very acceptable

- Please consider each proposed QI independently and rate it on its own merit. Do not rate them in relation to other ones in this survey or in relation to existing QIs.
- Please rate the acceptability of each proposed QI for the 'average' patient and not every possible clinical presentation or degree of complexity.
- Please do not consider feasibility of data collection when rating the acceptability of the proposed QIs. Feasibility is being assessed in a different part of this study.

About the survey flow

Once you have started the survey, you can go forward and backward but you need to complete the survey in one sitting, i.e., you cannot save your progress and continue later. Before you start rating the QIs, the survey will ask you some basic demographic questions. Then there are 17 pages, each containing between one and eleven QIs. Pages 1 to 8 contain **organisational or system QIs;** Pages 9 to 17 contain **clinical QIs**. It should take you **about 30 minutes** to complete the whole survey.

If you have any questions, please don't hesitate to email Robin Pap (robin.pap@adelaide.edu.au).

Thank you.

Block 3

Demographic Information

What is your gender?

- ○ Male
- ○ Female
- ○ Other or prefer not to say

What is your age range?

- ○ 18-24 years
- ○ 25-34 years
- ○ 35-44 years
- ○ 45-54 years
- ○ 55-64 years
- ○ > 64 years

Which of the following best describes your current paramedic qualification?

- ○ Paramedic Trainee
- ○ Qualified Paramedic
- ○ ICP/MICA/CCP/ECP
- ○ I do not have a paramedic qualification

How many years full-time experience in prehospital care do you have?

- ○ <5 years
- ○ 5-9 years
- ○ 10-14 years
- ○ 15-19 years
- ○ 20-24 years
- ○ >24 years

Which of the following best describes the role you fulfil most of the time in the ambulance service you work for?

- ○ Clinician
- ○ Director, manager, or supervisor

In which Australian State/Territory do you work?

- ACT
- NSW
- NT
- QLD
- SA
- TAS
- VIC
- WA

Block 4

1. Patient Safety

For each QI, ask yourself the following question:

How acceptable is it to assess the quality of my patient care or the quality of my ambulance service based on data collected using this quality indicator?

QI-1.1 The ambulance service has a dedicated patient safety reporting system.

Structure Safety

Very unacceptable 1 2 3 4 5 Very acceptable

QI-1.2 The ambulance service has a guideline that defines the categories of patients that should be left in the care of an appropriate healthcare professional, i.e., should not be left unattended.

Structure Safety

NB: To minimise the number of pages, this extract contains only the start and end of the data collection tool (pages 1-5 and 30-35). Pages 6-29 containing rating tools for QI-1.3 to QI-13.4 have been removed. Please also note that the numbering of the QIs was adjusted for clarity in this data collection tool.

QI-13.5 A patient is correctly triaged and transported to an appropriate hospital as per agreed trauma system protocol.

Process Access

Very unacceptable — Very acceptable

1 2 3 4 5

QI-13.6 The receiving hospital receives notification of a major trauma patient as per agreed trauma system protocol.

Process Access

Very unacceptable — Very acceptable

1 2 3 4 5

Block 17

14. Seizures

For each QI, ask yourself the following question:

How acceptable is it to assess the quality of my patient care or the quality of my ambulance service based on data collected using this quality indicator?

QI-14.1 A patient with a seizure has their blood glucose level measured.

Process Effectiveness

Very unacceptable — Very acceptable

1 2 3 4 5

QI-14.2 A patient with an active seizure is administered a benzodiazepine by the best available route.

Process Effectiveness

Very unacceptable 1 2 3 4 5 Very acceptable

Block 18

15. Hypoglycaemia

For each QI, ask yourself the following question:

How acceptable is it to assess the quality of my patient care or the quality of my ambulance service based on data collected using this quality indicator?

QI-15.1 A conscious hypoglycaemic patient is administered oral glucose, unless contraindicated.

Process Effectiveness

Very unacceptable 1 2 3 4 5 Very acceptable

QI-15.2 An unconscious hypoglycaemic patient is administered intravenous glucose 10% or intramuscular glucagon, unless contraindicated.

Process Effectiveness

Very unacceptable Very acceptable

1 2 3 4 5

QI-15.3 A patient who has been administered glucose (oral or intravenous) or glucagon has their blood glucose level checked following administration.

Process Effectiveness

Very unacceptable Very acceptable

1 2 3 4 5

Block 19

16. Pain Management

For each QI, ask yourself the following question:

How acceptable is it to assess the quality of my patient care or the quality of my ambulance service based on data collected using this quality indicator?

QI-16.1 A patient has their pain intensity measured using the 0-10 VNRS*.

Process Effectiveness

*VNRS Verbal Numerical Rating Scale

Very unacceptable Very acceptable

1 2 3 4 5

QI-16.2 A patient experiencing mild (2-3/10), moderate (4-6/10) or severe (7-10/10) pain is administered analgesic agent(s), unless contraindicated or refused.

Process Effectiveness

Very unacceptable Very acceptable

1 2 3 4 5

QI-16.3 A responsive patient who is administered analgesic agent(s) remains responsive to verbal stimuli, unless anaesthesia is being induced.

Outcome Safety

Very unacceptable Very acceptable

1 2 3 4 5

QI-16.4 A responsive patient who is administered analgesic agent(s) does not require airway management or ventilatory support following the administration, unless anaesthesia is being induced.

Outcome Safety

Very unacceptable Very acceptable

1 2 3 4 5

Block 20

17. Other Clinical Quality Indicators

For each QI, ask yourself the following question:

How acceptable is it to assess the quality of my patient care or the quality of my ambulance service based on data collected using this quality indicator?

QI-17.1 The ambulance service has a policy that defines specific categories of patients for which receiving facilities are to be notified of the patient's arrival.

Structure Access

Very unacceptable — Very acceptable

1 2 3 4 5

Block 21

Optional Follow-On Interview

Are you interested and willing to participate in an interview? The aim of the interview is to find out more about your ratings in the survey and should also take approximately 30 minutes. If you are interested and willing to participate in the interview, you will need to provide your name and best contact number. This information will be kept confidential. The interview can be done a time convenient to you.

- ○ Yes
- ○ No

Block 22

Full name

Best contact number

Best time to call (e.g., weekdays morning or Saturday afternoon)

Study 3B Interview Guide

Participant No.	
Date and time of interview	___ / ___ / 20 ___ at ___:___

Opening:

1. How long have you been involved in the ambulance service and what roles have you held?

Transition:

2. What makes a quality indicator acceptable or not acceptable to you?

Key:

3. How acceptable did you find the quality indicators in general?
4. How well do you think the quality indicators align to professional standards and values?
5. Clinician: Would you agree for your clinical practice to be measured and evaluated using these quality indicators?

   Manager/Supervisor: Would you agree to measure and evaluate the clinical practice of the staff you are supervising by using these quality indicators?

Closing

6. Is there anything you would like to add?
7. Do you have any questions about the interview or the research?

Appendix Journal Metrics

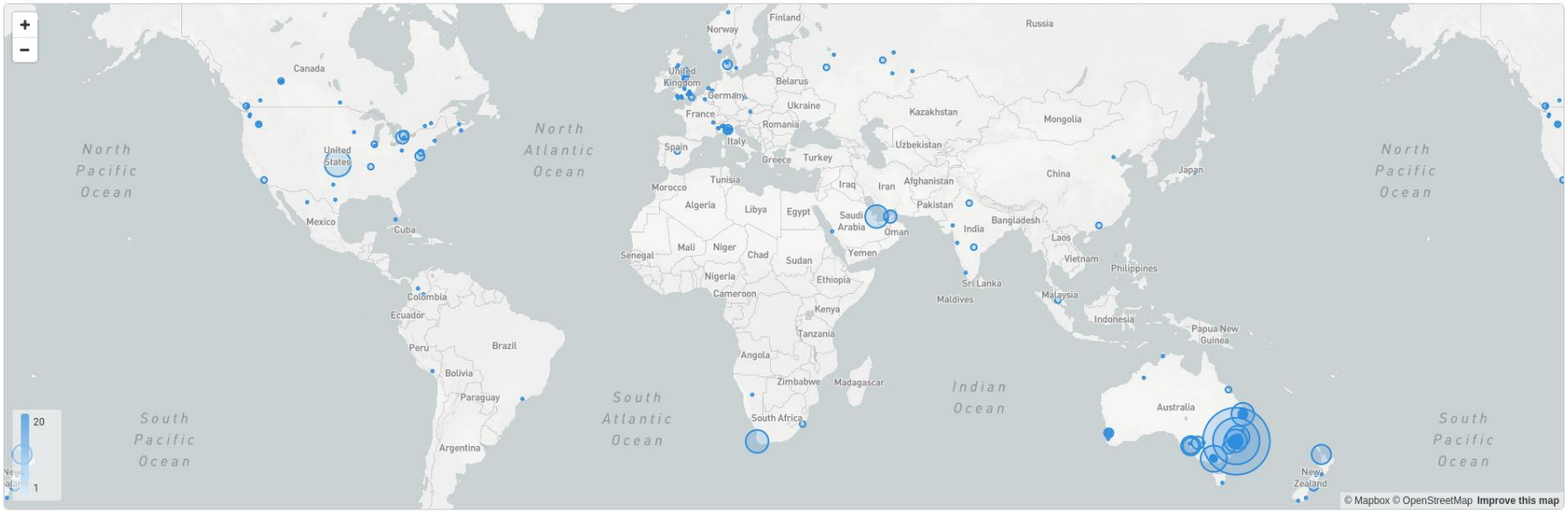
Citation	Journal Title	SJR	H-index
Pap R, Simpson P, Stephenson M, Lockwood C. Acceptability of prehospital care quality indicators for the Australian setting: an explanatory sequential mixed methods study.	(Submitted for publication)	-	-
Pap R, Lockwood C, Stephenson M, Simpson P. The development of prehospital care quality indicators for the Australian setting: a modified RAND/UCLA appropriateness method. EMJ. 2021;0:1-6	Emergency Medicine Journal	Q1	81
Pap R, McKeown R, Lockwood C, Stephenson M, Simpson P. Pelvic circumferential compression devices for prehospital management of suspected pelvic fractures: a rapid review and evidence summary for quality indicator evaluation. Scand J Trauma Resusc Emerg Med.2020;28(65)	Scandinavian Journal of Trauma, Resuscitation, and Emergency Medicine	Q1	53
Pap R, Lockwood C, Stephenson M, Simpson P. Development and testing of Australian prehospital care quality indicators: study protocol. BMJ Open. 2020;10:e038310	BMJ Open	Q1	103
Pap R, Lockwood C, Stephenson M, Simpson P. Indicators to measure prehospital care quality: a scoping review. JBI Database of Systematic Reviews and Implementation Reports. 2018;16(11): 2192-223	JBI Database of Systematic Reviews and Implementation Reports	Q2	21
Pap R, Lockwood C, Stephenson M, Simpson P. Indicators to measure prehospital care quality: a scoping review protocol. JBI Database of Systematic Reviews and Implementation Reports. 2017;15(6):1537-42.	JBI Database of Systematic Reviews and Implementation Reports	Q2	21

SJR Scimago Journal Ranking

Project website: https://www.aspireproject.net

Traffic by Location (City Map)

Select a time period is from 2016/01/01 until 2022/04/01 Select a measure is visitors



Generated by Looker on March 31, 2022 at 3:34 AM UTC