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BRIEF REPORT

Findings from three methods to identify falls in hospitals: Results from the Ambient Intelligent Geriatric Management system fall prevention trial

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Abstract

Objective: To (a) compare characteristics of patients who fall with those of patients who did not fall; and (b) characterise falls (time, injury severity and location) through three fall reporting methods (incident system reports, medical notes and clinician reports).

Methods: A substudy design within a stepped-wedge clinical trial was used: 3239 trial participants were recruited from two inpatient Geriatric Evaluation and Management Units and one general medicine ward in two Australian states. To compare the characteristics of patients who had fallen with those who had not, descriptive tests were used. To characterise falls through three reporting methods, bivariate logistic regressions were used.

Results: Patients who had fallen were more likely than patients who had not fallen to be cognitively impaired (51% vs. 29%, $p < 0.01$), admitted with falls (38% vs. 28%, $p = 0.01$) and have poor health outcomes such as prolonged length of stay (24 [16–34] vs. 12 [8–19] days [IQR], $p < 0.01$) and less likely to be discharged directly to the community (62% vs. 47%, $p < 0.01$). Most falls were captured from medical notes (93%), with clinician (71%) and incident reports (68%) missing 21%–25% of falls. The proportion of injurious falls identified through incident reports was higher than medical records or clinician reports (40% vs. 34% vs. 37%).

Conclusions: This study reaffirms the need to improve reporting falls in incident systems and at clinical handover to the team leader. Research should continue to use more than one method of identifying falls, but include data from medical records. Many falls cause injury, resulting in poor health outcomes.

KEYWORDS
accidental falls, aged, aged 80 and over, inpatients, patient safety, risk management

1 | INTRODUCTION

Falls are the second leading cause of unintentional death as a result of injury, with rates highest amongst those older than 60 years.[1] In Australian public hospitals, it has been reported that during 2015–2016, four inpatient falls cause harm per 10,000 hospitalisations, with patients who had fallen staying 18.8 days longer than those who had not fallen, potentially resulting in $38,991 in extra costs.[2]

Clinicians are required to report all falls to incident management systems.[3] This is to encourage learning from past incidents, support the resolution of incidents and identify preventative strategies.[3] Falls are hospital-acquired complications, and fall prevention is a national safety and quality imperative.[4] Under-reporting of falls in incident reports is well-documented.[5–7] An Australian fall prevention study in 2010 cautioned that the hospital incident management systems captured only three-quarters of falls (or 78% of injurious falls).[5] A key recommendation arising from that study was that in-hospital falls research should not depend purely on incident reports. An older Japanese study in 2015 similarly reported that 25% of falls recorded in the medical notes were not captured by incident reports.[8] It is unknown whether the degree of under-reporting remains as large.

Leveraging data from a wearable sensor-based fall prevention trial,[9] the aim of this brief report was to (a) compare the characteristics of patients who had fallen with those of patients who had not fallen and (b) characterise falls (time, injury severity and location) through three different methods of falls reporting (incident system reports, medical notes and clinician staff reports).

Practice Impact

As inpatient falls were under-reported in incident management systems, with a higher proportion of injurious falls reported, clinicians should be encouraged to report all falls, including non-injurious falls in incident reporting systems, to improve reliable data for system learning and research. Future studies should not rely solely on falls data sourced from incident reports.

2 | METHODS

2.1 | Design

The study protocol for the stepped-wedge pragmatic trial and results are published.[9–11] This is a secondary analysis.

2.2 | Setting and intervention

The study was conducted in three wards in two hospitals in two states in Australia. The South Australian (SA) ward was a Geriatric Evaluation and Management Unit (GEMU). In Western Australia (WA), a GEMU and general medicine ward were involved. All wards spent 25 weeks in control (first wedge), and then after a 3-week period, successive wards moved into a 25-week intervention wedge over the next 75 weeks in the following order: (1) SA GEMU; (2) WA GEMU; and (3) WA General Medicine.

2.3 | Participants

All patients aged 65 years or older were eligible for the primary trial. Those requiring palliative care and those previously enrolled in this study within the same admission were excluded. Data from 3239 trial participants, including 273 patients who had fallen, were investigated as part of this analysis.[9]

2.4 | Measurements

Patient demographic details were recorded. In the trial, fall was an 'event which results in a person coming to rest inadvertently on the ground or floor or other lower

level'.[12] Falls data were collected from three different sources: (1) electronic incident management systems, (2) case notes' review at a minimum of twice-weekly and (3) daily inquiry of the team leader and other clinicians by research staff. Injury in this study was classified as bruising, laceration, fracture, loss of consciousness or if the patient reported persistent pain.[13,14] Where fractures were recorded, radiological confirmation was required.[15] In terms of the incident reporting system, responsible officers at the hospitals produced reports for the research team.

2.5 | Program fidelity

Two weeks before the trial commenced, in-service programs occurred with ward staff to ensure that staff were familiar with the definition of a fall and with best practices. Staff were reminded on how falls should be recorded in the hospital incident reporting system as well as patient medical records.[16]

2.6 | Ethics and consent

The project had ethics and governance approval by TQEH/Lyell McEwin Hospital (LMH)/Modbury Hospital (MH) (HREC/15/TQEH/17) and Curtin University (HRE2017-0449)/SCGH (PRN 2015-110). The trial was registered with the Australian and New Zealand Clinical Trial Registry (ANZCTR): ACTRN 12617000981325. A waiver of the consent process was in place for WA, and SA participants had the opportunity to opt out.

2.7 | Statistical analysis

In this study, 'day' was defined as 0700–1959 h (13 h) whilst 'night' was 2000–0659 h (11 h). Descriptive statistics (numbers and percentages, or median and interquartile range [IQR]) described the characteristics of patients who had fallen and their falls. Patient characteristics of those who had not fallen and those who had fallen were compared using chi-squared tests, two-sample *t*-tests and median tests. Associations between patient/fall characteristics and whether a fall was recorded in an incident report were analysed using bivariate logistic regressions using generalised estimating equations (GEE) with the use of incident reports as the dependent variable. Analyses of fall characteristics included all falls, accounted for clustering of multiple falls per patient and used robust standard errors. Categorical patient/fall characteristics were entered as factors with one level specified as the reference category.

3 | RESULTS

Patients who had fallen, when compared to patients who had not fallen (Table S1), were more likely to be male (53% vs. 44%, $p=0.005$), be living in the community pre-hospitalisation (96% vs. 91%; $p=0.03$), have dementia or delirium (51% vs. 29%, $p<0.001$) and be admitted with falls (38% vs. 28%, $p=0.01$). They were more likely to have poor outcomes like non-discharge directly to the community (38% vs. 53%, $p<0.001$) and long length of stay (24 [16–34] vs. 12 [8–19] days [IQR], $p<0.001$).

The Venn diagram (Figure 1) demonstrates that there was a total of 371 falls, with 346 (93%) captured through

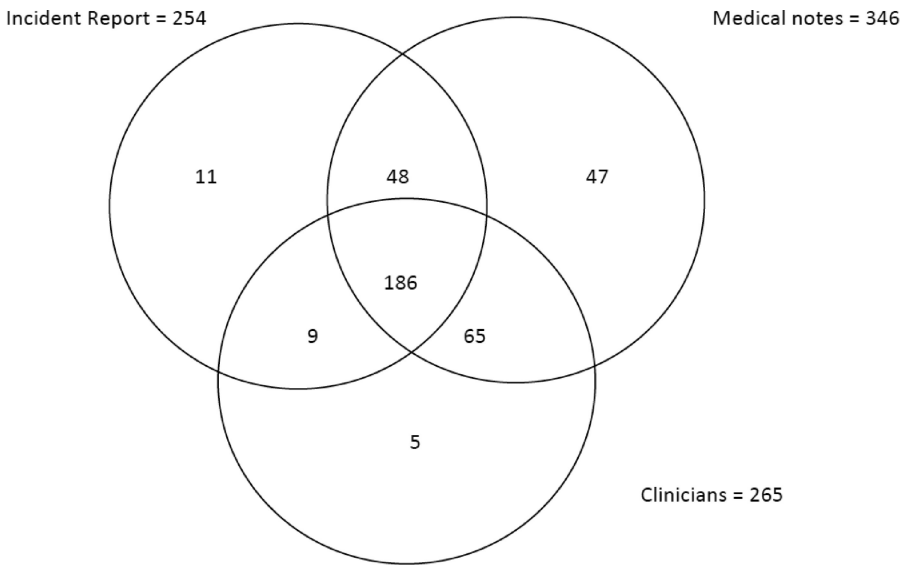

FIGURE 1 Falls events captured through medical notes, incident reports and clinicians.

TABLE 1 Characteristics of falls by reporting method.

	Total					
	Medical notes		Incident report		Clinician	
	N	%	*N*	%	*N*	%
Number of falls	346	100	254	100	265	100
Number of injurious falls	117	34	101	40	99	37
Time of fall						
Missing	45	13	35	14	33	12
Night	128	37	96	38	98	37
Day	173	50	123	48	134	51
Injury severity						
No injury	229	66	153	60	166	63
Mild	19	5	11	4	16	6
Moderate/severe	98	28	90	35	83	31
Location of fall						
Patient room	241	70	168	66	180	68
Bathroom	45	13	40	16	33	12
Toilet	33	10	28	11	30	11
Corridor	15	4	14	6	12	5
Other	12	3	4	2	10	4
Falls per patient						
Single fall	186	54	148	58	142	54
Multiple falls	160	46	106	42	123	46

medical notes, 254 (68%) through incident reports and 265 via clinician reports (71%). Of the 25 falls not documented in the medical notes, 20 had been reported to the incident reporting system, but five others were known to clinicians and were not documented or reported.

Based on medical notes (Table 1), 34% of falls were injurious, with the majority (84%) of these classified as moderate to severe. The proportion of injurious falls was 34%–40% across reporting methods, with 84%–89% of these classified as moderate to severe.

Where the time of fall was recorded ($n = 301$), almost half ($n = 128$; 42%) of falls occurred at night. Almost a quarter of falls occurred in the bathroom (13%) or toilet (10%), with the majority of falls (70%) in the patient room. Similar patterns were noted no matter which method was used to record the falls.

Falls (Table S2) were less likely to be incident reported in females (odds ratio [OR] 0.56; 95% confidence interval [CI] 0.36–0.90; $p = 0.014$) compared to men. Falls occurring in patients where the primary reason recorded for their admission was falls without fracture were less likely to be reported in the incident report (OR 0.42; 95% CI 0.24–0.73; $p = 0.002$) when compared to patients admitted for other reasons. Injurious falls were more likely to be incident reported (OR 3.02; 95% CI 1.79–5.10; $p < 0.001$) than non-injurious falls, and falls of a moderate-to-severe nature were more likely to be incident reported (OR 4.34; 95% CI 2.31–8.18; $p < 0.001$) compared to falls without injury. There were no other significant associations noted in relation to patient characteristics (age, co-morbidities of delirium or dementia, falls or fracture and polypharmacy) or time and location of falls.

4 | DISCUSSION

This study confirmed that falls continue to be under-reported to hospital incident reporting systems. Compared to previous studies where one quarter of falls were not recorded in the incident reports,[5] almost one-third of falls were missed when relying on incident reports only in this study. Of concern also was that 25 falls were not documented in the medical notes, which was similar (7% vs. 8%) to that previously reported.[5] Additionally, this research found that falls may be under-reported during clinical handovers. These were results obtained during a clinical trial where the Hawthorne effect, which is the modification of behaviour when being watched, was likely at play.[17] These issues of under-reporting and failing to document are likely higher in real-world settings.

In this study of older inpatients, patients who had fallen were more likely to have been admitted following a fall (with or without fracture) and to have cognitive impairment (dementia or delirium) as a co-morbidity. A recent study identified that factors such as age, history of falls and mental status in addition to Morse Fall Scale score, quality of gait, hospital unit type and the number of high fall risk-increasing drugs were important factors when it came to predicting inpatient falls risk.[18] In keeping with findings from other studies,[2] patients who had fallen experienced poor health outcomes when compared to patients who had not fallen, including a lower proportion discharged directly home, higher mortality and increased length of stay.

The same patterns are noted no matter which method is used to document falls. One-third of falls resulted in injuries. Similar to findings from Hitcho et al., a quarter of falls occurred in wet areas (in the toilet or shower), with the majority in the patient's room. Falls without injuries are less likely to be reported in incident reports, a finding similar to that seen in the study by Hill and colleagues.[5]

A limitation of this study was that the reference method relied on was falls recorded in the medical records. In this study, at least 26 falls were not recorded in this way (Figure 1). Whilst outside the scope of this study, it may be possible to investigate the number of falls not identified by any of the methods through analysis of the sensor data in the AmbIGeM study, an area for further exploration.

5 | CONCLUSIONS

Quality improvement initiatives ought not to rely only on incident reports as the one source of truth, and ongoing training to ensure clinicians report all falls to incident management systems is still necessary. This study reaffirms the recommendation that research studies (including quality improvement initiatives) focussed on in-hospital falls should utilise more than one method when recording falls.

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CONFLICT OF INTEREST STATEMENT

Previously, there was a patent filed (mid-2013) by A/Prof Ranasinghe and Professor Visvanathan entitled 'A system, method, software application and data signal for determining movement' but this has since lapsed. Professor Visvanathan is a member of the founding team to a start-up, HealthyVibes.ai, a technology company focussed on real-time monitoring. Professor Visvanathan is the Head of Unit of the Aged and Extended Care Services at The Queen Elizabeth Hospital in South Australia within which the GEM Unit is a service, where Dr Pazhvoor Shibu is geriatrician. Dr Kate Ingram is the Falls Lead at Sir Charles Gairdner Hospital in Western Australia.

DATA AVAILABILITY STATEMENT

Requests for data should be directed to the lead author (renuka.visvanathan@adelaide.edu.au) and include a collaboration with at least one of the Chief Investigators (R.V., K.H., or D.C.R.). Any request will be assessed for scientific rigor (by a panel consisting of R.V., K.H., D.C.R., and K.L.) and given the involvement of hospital patient data, the request must meet ethics request guidelines and be approved by the ethics committees of TQEH/Lyell McEwin Hospital (LMH)/Modbury Hospital (MH), Curtin University, and SCGH. The requestor will be responsible for preparing documentation to the standard required to meet the conditions of the various ethics committees. A data sharing agreement will likely be necessary.

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REFERENCES

1. World Health Organization. Falls. 2021. Accessed November 1, 2022. https://www.who.int/news-room/fact-sheets/detail/falls
2. Australian Commission on Safety and Quality in Health Care. Hospital-acquired complications: falls resulting in fracture or intracranial injury. Accessed March 1, 2022. https://www.safetyandquality.gov.au/sites/default/files/migrated/Falls-resulting-in-fracture-of-intracranial-injury-detailed-fact-sheet.pdf
3. Runciman WB. Lessons from the Australian patient safety foundation: setting up a national patient safety surveillance system–is this the right model? *Qual Saf Health Care*. 2002;11(3):246-251.
4. Australian Commission on Safety and Quality in Health Care. Falls prevention. Accessed March 1, 2022. https://www.safetyandquality.gov.au/our-work/comprehensive-care/related-topics/falls-prevention
5. Hill AM, Hoffmann T, Hill K, et al. Measuring falls events in acute hospitals - a comparison of three reporting methods to identify missing data in the hospital reporting system. *J Am Geriatr Soc*. 2010;58(7):1347-1352.

6. Sutton JC, Standen PJ, Wallace WA. Patient accidents in hospital: incidence, documentation and significance. *Br J Clin Pract*. 1994;48(2):63-66.
7. Shorr RI, Mion LC, Chandler AM, Rosenblatt LC, Lynch D, Kessler LA. Improving the capture of fall events in hospitals: combining a service for evaluating inpatient falls with an incident report system. *J Am Geriatr Soc*. 2008;56(4):701-704.
8. Toyabe S. Characteristics of inpatient falls not reported in an incident reporting system. *Glob J Health Sci*. 2015;8(3):17-25.
9. Visvanathan R, Ranasinghe DC, Lange K, et al. Effectiveness of the wearable sensor-based ambient intelligent geriatric management (AmbIGeM) system in preventing falls in older people in hospitals. *J Gerontol A Biol Sci Med Sci*. 2022;77(1):155-163.
10. Visvanathan R, Ranasinghe DC, Wilson A, et al. Effectiveness of an ambient intelligent geriatric management system (AmbIGeM) to prevent falls in older people in hospitals: protocol for the AmbIGeM stepped wedge pragmatic trial. *Inj Prev*. 2019;25(3):157-165.
11. Dollard J, Hill K, Wilson A, et al. Patient acceptability of a novel technological solution (ambient intelligent geriatric management system) to prevent falls in geriatric and general medicine wards: a mixed-methods study. *Gerontology*. 2022;68(9):1070-1080.
12. World Health Organization. *WHO Global Report on Falls Prevention in Older Age*. World Health Organization; 2007.
13. Haines TP, Hill AM, Hill KD, et al. Patient education to prevent falls among older hospital inpatients: a randomized controlled trial. *Arch Intern Med*. 2011;171(6):516-524.
14. Campbell AJ, Robertson MC, Gardner MM, Norton RN, Tilyard MW, Buchner DM. Randomised controlled trial of a general practice programme of home based exercise to prevent falls in elderly women. *BMJ*. 1997;315(7115):1065-1069.
15. Schwenk M, Lauenroth A, Stock C, et al. Definitions and methods of measuring and reporting on injurious falls in randomised controlled fall prevention trials: a systematic review. *BMC Med Res Methodol*. 2012;12:50.
16. Haines TP, Massey B, Varghese P, Fleming J, Gray L. Inconsistency in classification and reporting of in-hospital falls. *J Am Geriatr Soc*. 2009;57(3):517-523.
17. Rezk F, Stenmarker M, Acosta S, et al. Healthcare professionals' experiences of being observed regarding hygiene routines: the Hawthorne effect in vascular surgery. *BMC Infect Dis*. 2021;21(1):420.
18. Lindberg DS, Prosperi M, Bjarnadottir RI, et al. Identification of important factors in an inpatient fall risk prediction model to improve the quality of care using EHR and electronic administrative data: a machine-learning approach. *Int J Med Inform*. 2020;143:104272.
19. Hitcho EB, Krauss MJ, Birge S, et al. Characteristics and circumstances of falls in a hospital setting: a prospective analysis. *J Gen Intern Med*. 2004;19(7):732-739.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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