Factors influencing the provision of dental services in private general practice

Submitted by David S. Brennan

Dental School, The University of Adelaide

December 1999

Supervised by Professor A. John Spencer
Social and Preventive Dentistry, The University of Adelaide

Contents

List of Figures

List of Tables

Notes

References

Reference to published work was made in the text by listing the author(s) and date of publication in parentheses. References were listed in the Bibliography in alphabetical order of authors and date order where there were multiple references for an author. To uniquely identify each reference in the text, up to three authors were included. Where there were four or more authors, the first author was listed, followed by "et al." in the text. The complete number of authors was listed in the Bibliography.

List of abbreviations

CD	Collection District
CV	Coefficient of variation
Deff	Design effect
FTE	Full time equivalent
h^2	Communality
ICC	Intra-class correlation
LR	Logistic regression
LS of DPA	Longitudinal Study of Dentists' Practice Activity
MSA	Kaiser's measure of sampling adequacy
n/a	Not applicable
ns	Not significant
n_{ses}	Size of simple equivalent sample
OLS	Ordinary least squares
OR	Odds ratio
PR	Poisson regression
RR	Rate ratio
RSE	Relative standard error
SE	Standard error
SES	Socio-economic status
SEIFA	Socio-economic indexes for areas
Std Dev	Standard deviation

Abstract

This thesis examines factors influencing the provision of dental services in Australian private general practice to address the documented variation in service rates, and questions of appropriateness of care arising from this variation. The aims of this thesis were to examine the association of services provided with dentist, practice, and patient factors, controlling for oral health status.

A random sample of 1,212 dentists was drawn from the dental registers of each Australian State/Territory and surveyed by mailed self-complete questionnaires during 1997-98, (response rate=60.3%). Private general practitioners (n=345) provided data from a log of one typical clinical day, (n=4,115 patient visits).

In general, patient, dentist and practice factors were significant explanatory variables in models of service provision which included oral health status. This indicates that service provision is not a simple deterministic pathway involving technical considerations of oral health status being converted into a treatment plan and provision of services. Patient, dentist and practice factors play an important mediating role in determining service patterns. Among the set of explanatory variables there was no single dominant variable or subset of variables. Service provision was influenced by a large number of small effects from a wide range of factors.

The findings indicated dentist characteristics such as practice beliefs and preferences for patients had an influence on service patterns. Further understanding of the

dentist-patient relationship, the development of practice beliefs, and the dynamics of treatment planning and decision-making could be beneficial to improving service outcomes. However, other factors such as insurance status and visit type were also associated with service patterns and have the potential to be altered to achieve better service outcomes. Geographic gradients in services indicated the operation of socio-economic and other area-based barriers on service patterns. While such geographic barriers may require broad policy initiatives to address their effects on service patterns, scope exists to investigate clinical outcomes to enhance the knowledge base of treatment decision-making. Such information could form the basis for development of clinical guidelines for care which could address the appropriateness of care issues stemming from the observed variation in service provision.

Declaration

This work contains no material which has been accepted for the award of any degree or diploma 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.

I give my consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

Signed: _ 9 / 3 / 2000

David S. Brennan

Acknowledgements

This thesis was supervised by Professor A. John Spencer, Dental School, The University of Adelaide. I wish to acknowledge the role played by John Spencer in providing the opportunity and encouragement to pursue research in this field, contributing advice not just on this thesis but on a range of research issues over the period of my involvement in the AIHW Dental Statistics and Research Unit, and building and supporting an environment conducive to the pursuit of research. The general support of staff from the AIHW Dental Statistics and Research Unit and Social and Preventive Dentistry at The University of Adelaide is appreciated. In particular, I would like to thank Fearnley Szuster for assistance with obtaining dental registers and advice regarding sampling, Knute Carter for literature on Likert scales, John Spencer, Fearnley Szuster, Joan Allister, Anthony Bevan, Kaye Roberts-Thomson, Anna Puzio, Jane Chalmers, and Knute Carter for assistance with skirmishing of the questionnaire, Lyn Tucker for administrative assistance, and Lorna Lucas and Silvana Marveggio for handling phone queries. I would also like to thank the practitioners who participated in the survey.

The study was supported by a Public Health Postgraduate Research Scholarship (974949) from the National Health and Medical Research Council and a grant (000730) from the Australian Dental Research Foundation. Ethics clearance was obtained from the Australian Institute of Health and Welfare.

1. Introduction

This thesis examines factors which influence the provision of dental services in private general practice in Australia. The need for an examination of factors influencing dental service provision is based on the documentation of variation in service rates (Bailit and Clive, 1981), and the questions of appropriateness of care which arise from the observed level and variation in service rates (Bader and Shugars, 1995a; 1995b). In this chapter some background details concerning the provision of dental services in Australia are given, the problem to be investigated is described, the rationale for studying the problem is explained, and the research framework and specific objectives are outlined.

1.1 Background: oral health and dental services

Prior to outlining the problem to be investigated it is worthwhile to consider why it is important to study dental services. The importance of dental problems may tend to be underestimated due to the fact that most dental problems are not usually life-threatening. However, dental problems can create a large burden to the community due to the repetitive nature and prevalence of dental problems. In a two-week sample period dental problems were ranked as the fourth most frequent illness condition, behind headache, hypertension and colds (Spencer and Lewis, 1988a). Dental caries has been ranked as the highest diet-related disease in Australia in terms of both total costs and health care costs (Crowley et al., 1992). The burden on the community that is created by oral problems results in substantial loss of productive work time and can lead to interference with normal social functions (Spencer, 1993).

Dental services are an important component of health care. A total of $2.6 billion was spent on dental health expenditure in 1996-97, accounting for 6.1% of recurrent health services expenditure (AIHW, 1999). However, dental services may be subject to change as the effect of factors such as the widespread coverage of water fluoridation and other oral health promotion activities begin to influence oral health status. Historical trends have indicated improved oral health for children. For example, among 12-year-olds the number of permanent decayed, missing, and filled teeth declined from 4.8 in 1977 to 1.1 in 1993 (Spencer et al., 1994; Davies and Spencer, 1995). Oral health has also improved among adults in Australia, with dramatic declines in edentulism. For example, the percentage of persons aged 65 years or more who had no natural teeth declined from 66% in 1979 (ABS, 1980), to 50% in 1987-88 (Barnard, 1993), to 39% in 1996 (Brennan et al., 1997). However, this decline in edentulism has been linked to expected increases in the pool of teeth at risk of oral disease (Spencer and Lewis, 1988a).

In Australia the majority of dentists work in general practice (e.g., 84.6% in 1994) with only a small percentage in specialist and restricted practice (10.3%). Most dentists work in the private sector (e.g., 81.4% in 1994), with the major types of practice being solo practice (46.3%) and associateships (14.3%) (Szuster and Spencer, 1997). School Dental Services utilise both dentists and auxiliaries and are a major source of service provision to children. Public dental services are only available to adults who are eligible for government health cards such as the unemployed and aged pensioners. Most adult patients in Australia seek dental care through the private sector, paying either directly or through insurance schemes.

The interaction of demography and use of services produces the profile of patients visiting a dentist. Demographic changes in Australia have shown a trend towards an increased pool of middle- to older-aged adults (Spencer and Lewis, 1988a). Use of dental services has increased among adults in Australia. For example, among persons aged 65 years or more the percentage who visited in the previous 12 months increased from 21.5% in 1979 (ABS, 1980), to 40.9% in 1993 (Brennan and Stewart, 1993). Shifts in service patterns may be expected to reflect the changing oral health status of the population. In private general practice, rates of service per visit have changed between 1983-84 and 1993-94, with increases in rates of diagnostic, preventive, endodontic, crown and bridge, general/miscellaneous, and orthodontic services, and decreases in rates per visit of prosthodontic services (Brennan, 1997).

In summary, the background to dental service provision in Australia involves changes in oral health status which may be viewed in general as showing a trend towards improvement but as a consequence there will be expected increases in the pool of teeth at risk of oral disease. Demographic changes involving an increased pool of middle- to older-aged adults who are retaining teeth as edentulism declines in prevalence, parallel the changes in oral health status. Against this shifting backdrop of changes in oral health, use of services, and service-mix over time is the problem of variation in service provision at any one point in time.

1.2 Problem to be investigated

Having looked at the background to establish why it is important to study dental services, this section focuses specifically on the problem to be investigated. Numerous studies have indicated that both medical and dental services are subject to unexplained variation in rates across geographic areas and practices. For example, a study of geographic differences in medical and surgical services in the USA found large and significant differences in the use of services provided with 67 out of 123 procedures showing at least three-fold differences between sites with the highest and lowest rates of use (Chassin et al., 1986). Such variation could represent unnecessary care in high-rate areas, insufficient care in low-rate areas, or appropriate care in all areas with the differences explained by variation in health status across the areas studied (Wennberg, 1986). Variation in service utilisation rates among 227 general dental practices in the USA was found to be substantial (Bailit and Clive, 1981). Other studies from the USA have shown heterogeneity in dental service utilisation rates across small geographic areas (Gotowka and Clive, 1988), and wide variations in dentist service rates were found among a homogeneous patient population (Grembowski, Milgrom and Fiset, 1990a). In Australia, clusters of dentists were identified on the basis of their patterns of service provision across 10 areas of services (Brennan, Spencer and Szuster, 1996a).

Some attempts have been made to measure factors which are associated with variation in service rates in order to explain the phenomenon. For example, in the USA variation in dentist service rates have been associated with factors such as practice characteristics, practice beliefs of dentists and market characteristics (Grembowski, Milgrom and Fiset, 1990b; 1991). In Australia, service provision has been associated with a range of factors, including patient age, patient sex, visit type, insurance status, and geographic location (Brennan, Spencer and Szuster, 1997; 1998a; 1998b).

A framework for understanding the practice patterns of physicians, proposed by Eisenberg (1985), may provide some basis for understanding dental service patterns. Physicians' prescription of services is seen as being motivated by consideration of the physician's own personal interests and desires, the patient's own benefit, and the benefit of society. A physicians interests and desires which could influence provision of services includes desire for income, desire for a style of practice, the personal characteristics of the physician, the practice setting and standards established by clinical leadership. Factors influencing the provision of services when the physician acts on behalf of the patient include the patient's economic well-being, clinical factors, patient demand, defensive medicine, patient characteristics, and patient convenience. Factors which may operate when considering the social good include attempts to balance operating on behalf of the individual patient and collective considerations of the need to provide services equitably and efficiently.

In summary, a number of studies have established variation in rates of both medical and dental services. While there has been some research into factors associated with service rate variation there is a need for a more comprehensive approach which can incorporate a greater range of factors which have the potential to influence the provision of services, and which includes some control for any underlying differences in health status. The research problem to which this thesis is directed therefore involves the investigation of factors influencing rates of service provision.

1.3 Rationale for studying the problem

Investigation of variation in service rates ultimately leads to an interest in health outcomes (Eisenberg, 1985). This is consistent with a growing interest in evaluating programs and procedures, and evidence-based policy decisions (Legge, 1999). In documenting service rate variation and factors which are associated with such variation the emphasis in this thesis is placed more on an explanation of the process than on outcomes. However, knowledge of service patterns and their correlates provides a means of identifying practice patterns which are most likely to affect health outcomes, which can lead to further opportunities in health services research to arrive at a better understanding of how health services are provided and ways it which they can be improved (Eisenberg, 1985).

The rationale for studying the problem is based on limitations of previous analyses in terms of the number of studies and the scope of variables investigated. In particular, there has been little control for oral health status, and while a range of explanatory variables have been explored they have often been tackled in a fragmented manner. There is scope to improve upon previous attempts through the incorporation of control for oral health status and a broadening of the scope of variables included in the models of service provision. The approach of this thesis is to construct comprehensive models of service provision which include a large set of variables covering a range of constructs. This is elaborated further in the research framework outlined in the next section. The implications of studying the problem are twofold. Firstly, by studying factors which can influence service provision it will be possible to provide a better explanation for what causes service rates to vary. Secondly, this improved ability to explain service rate variation will enable better judgements to be made concerning the appropriateness of this variation, and allow policy to be developed in relation to the sources of variation and any ensuing appropriateness of care issues.

1.4 Research framework

Figure 1.1 presents a schematic outline of a range of factors which can influence the provision of services. A simple, technical view of the process proceeds in linear fashion from oral health status to visit factors to service provision, with some health outcome as the end point. This health outcome feeds back to oral health status, completing a loop. However, other factors may influence this process. Such factors include characteristics of patients (e.g., age, sex), practitioners (e.g., practice beliefs) and practices (e.g., type, size and location). The patient is linked to oral health status and visit factors, and also to a practitioner who is linked to a dental practice.

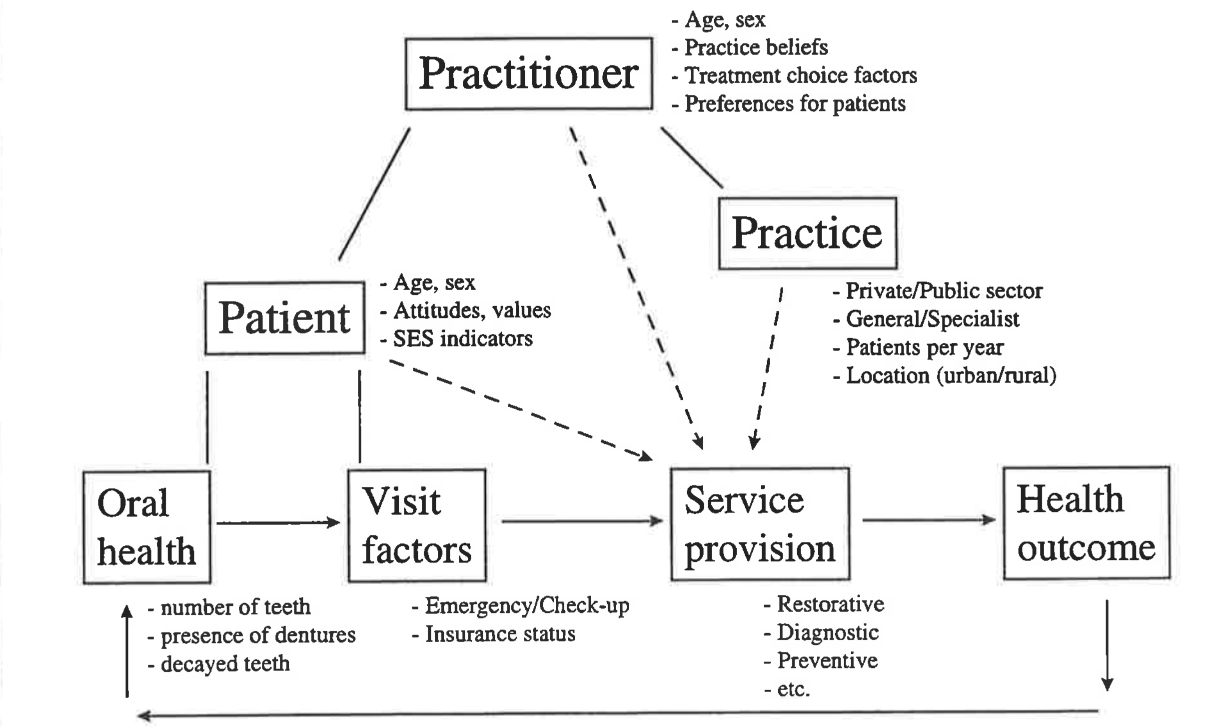


Fig. 1.1: Schematic outline of factors influencing service provision

This thesis addresses the broad research hypotheses that patient characteristics, dentist characteristics, practice factors, and oral health status are all sources of influence on, and result in variation in, the rate of dental service provision. This involves investigation of patient characteristics such as age, sex, insurance status, and visit type; dentist characteristics such as age, sex, practice beliefs, treatment choice factors and preferences for patients; practice factors such as geographic location, type of practice, and size of practice; and measures of oral health status such as number of teeth, presence of dentures and number of decayed teeth.

1.5 Specific objectives

The specific objectives of the present study are to investigate the provision of dental services by:

1. Patient characteristics (e.g., age, sex, visit type, insurance status, socio-economic status);
2. Dentist characteristics (e.g., treatment choice, practice beliefs, preferences for patients, demographics);
3. Practice factors (e.g., size, location, volume, busyness); and
4. Oral health status (e.g., number of teeth, denture wearing, decayed teeth).

This involves examination of the univariate distributions of these sets of variables, the bivariate associations of the provision of services by the set of independent variables, and the use of multivariate models of service provision by the set of independent variables.

2. Literature review

Having introduced the research problem of investigating factors influencing service provision in the previous chapter, this chapter provides a more detailed review of the literature which underlies the research problem. This involves looking at service rates in terms of describing the main areas of service, summarising previous investigations of variation in services and rate variation in relation to appropriateness of care. Then factors which influence service provision will be described in terms of patient characteristics, dentist characteristics, practice factors, and oral health status.

2.1 Service rates

Service rates comprise the set of dependent variables which are addressed in this thesis. Before considering the factors which may influence service provision it is necessary to have a closer look at what dental services are delivered, what is the usual pattern of service-mix, and what previous studies have documented about variation in rates of service provision.

2.1.1 Main areas of service

Classification of services

Dental service items provided in Australia can be consistently classified using the Schedule of Dental Services published by the Australian Dental Association (1996). The Schedule Committee of the Australian Dental Association assigns a unique three-digit identifying number to each item or clinical procedure which it regards as collectively representing Australian dental practice. The chief aim of this process is to identify clinical procedures, but there is also a close relationship with health benefit organisations. The coding system provided by the Schedule describes most items of dental treatment and is widely used in billing and insurance claims systems throughout Australia. The Schedule provides a structured classification of treatment items which is grouped into main areas of service which can comprise a number of sub-groups. For example, treatment items within the main area of diagnostic services fall into sub-groups of examinations, radiographs, and other diagnostic services. An example of the classification system is provided in Table 2.1.

Table 2.1: Example of Schedule of Dental Services

Main area	Sub-group	Item (code and description)
Diagnostic services	Examinations	011 Initial oral examination
	Radiological examination	022 Intraoral periapical or bitewing radiograph
	Other diagnostic services	048 Caries susceptibility test
Preventive services	Dental prophylaxis	111 Removal of plaque
	Topical fluoride	121 Topical application of fluoride
	Other preventive services	141 Oral hygiene instruction
Periodontics	-	222 Root planing and subgingival curettage
Oral surgery	Extractions	311 Removal of permanent tooth
	Surgical extractions	321 Surgical removal of erupted tooth
Endodontics	Pulp treatments	414 Pulpotomy - permanent tooth
	Periradicular surgery	431 Periapical curettage
Restorative services	Amalgam restorations	511 Amalgam - 1 surface - permanent tooth
	Glass ionomer, resin restorations	531 Composite resin - 1 surface - posterior tooth
Crown and bridge	Crowns	611 Resin jacket crown
	Bridges	642 Bridge pontic
Prosthodontics	New dentures and components	711 Complete maxillary denture
Orthodontics	Fixed appliances	829 Partial banding - 1 arch
General services	Emergencies	912 Sedative dressing
	Drug therapy	924 Drug prescription
Miscellaneous	-	981 Splinting and stabilisation

Some features of the Schedule which are worth noting include the classification of routine scale and clean items under the main area of preventive services rather than periodontic services. Periodontic services comprises a small set of items with no sub-groups. Oral surgery primarily consists of various types of extractions. Specialist oral and maxillo-facial surgeons supplement the items listed on the Schedule with other codes used by medical practitioners. The main areas of general services and miscellaneous services comprise a small set of items which do not easily fit under the other main areas, and are often aggregated together as general/miscellaneous services for convenience.

Treatment distributions - Australian private practice

While treatment distributions of service items provided by dentists can be derived from insurance claims these data sources may be biased to the extent that a different mix of services is provided to insured compared to uninsured patients. For example, analysis of service provision in Australia by insurance status has indicated that insured patients in private general practice had higher odds of receiving preventive, crown and bridge, and endodontic services, but lower odds of receiving oral surgery and prosthodontic services (Brennan, Spencer, and Szuster, 1997). However, a series of surveys spanning 1983-84 to 1993-94 have documented the distribution of treatment items provided in Australian private general practice which was based on a sample of patients treated in a typical day which included all patients regardless of insurance status.

In 1983-84 service-mix was dominated by restorative, diagnostic and preventive services, and a limited number of services accounted for most service provision or dentist time (Spencer and Lewis, 1989a). Both periodontics and orthodontics comprised a minor percentage of services in general practice. A similar pattern of services in terms of rank order of main areas of service was observed in Australian private general practice in 1988-89, with some changes in rates per visit such as increases in diagnostic and preventive services (Spencer, Szuster, and Brennan, 1994). The same overall pattern of treatment by main areas was observed in 1993-94, with restorative, diagnostic and preventive services dominating. However, over the period 1983-84 to 1993-94 there had been a shift involving increased percentages of patients receiving diagnostic and preventive services and decreased percentages of restorative services (Brennan, Spencer, and Szuster, 1998b). Despite decreases in percentages of patients receiving restorative services, 37.7% of patients continued to receive these services, second in rank order only to diagnostic services (46.0%) and ahead of preventive services (25.2%). All other service areas were received by under 10% of patients per visit, and in rank order from highest to lowest consisted of prosthodontic, endodontic, oral surgery, crown and bridge, general/miscellaneous, orthodontic and periodontic services.

Over the survey period the total number of services per visit increased from a mean of 1.75 in 1983-84 to 2.07 in 1993-94. However, private general practitioners showed no change in mean hours worked per year over this period, but did exhibit a decline in number of patients per hour and patient visits per year (AIHW, 1996). The decline in patient visits per year tended to counterbalance the increase in services per visit, with the result that numbers of services provided per year by practitioners remained stable.

Treatment distributions - Australian public patients

The majority of dentists in Australia work in the private sector (Szuster and Spencer, 1997). Hence, the findings presented above for private general practice should reflect the experience of dental care for most Australian adults. The public sector treats patients who are eligible for care primarily through possession of government health cards, which covers persons such as aged pensioners and the unemployed. The distribution of services provided in the public sector shows some similarities to the private sector in the rank order of main areas of service, particularly with diagnostic and restorative services dominating both service distributions (Brennan, Spencer, and Slade, 1997).

However, despite this similarity in rank order there are differences in levels of service (i.e., percentage of persons receiving services and rates of services per visit) particularly for oral surgery services, with higher levels of extractions in the public sector compared to the private sector. Such differences reflect differences in the patient populations served by each sector of the delivery system, as well as resource-related access differences with the public sector characterised by longer waiting times for care and higher percentages of emergency treatment for relief of pain.

The focus of this thesis is on service provision in private general practice. The relevance of this focus stems from the greater numbers of patients treated through the private sector and the opportunity for sources of influence other than resource constraints and institutional policies to operate on the service provision process.

Treatment distributions - international comparisons

Data on treatment distributions from the USA have shown that in 1976 the percentage of services in North Carolina was dominated by fillings (26.0%), preventive services (25.0%), and examinations/x-rays (24.0%), and when taken as the percentage of dentist's chairside time the dominance of fillings (41.7%) was more pronounced (Konrad and DeFriese, 1981). A review comparing the North Carolina study with two other national studies of the USA from 1979 showed that examination, hygiene and operative services accounted for between 72.4% and 73.9% of procedures across the studies. However when looking at dentist time distributions the focus was primarily reparative, being devoted to the treatment of caries and its sequelae (Bader and Kaplan, 1983).

Data on dental practice in the USA between 1979 and 1990 have shown that demand for dental services continued to grow over the period (Nash and Bentley, 1991). This is reflected in increases in areas such as diagnostic and preventive services (e.g., examination, prophylaxis, and fluoride treatments). However, the number of restorative procedures declined over this period, mainly due to decreased numbers of amalgam fillings. Extractions also declined, while there were increases in crowns, root canals and full maxillary dentures. Despite the decreases in restorative care, these services still comprised a major component of dental practice, accounting for approximately 30% of dentist time and 18% of dental procedures.

The pattern of treatment in the General Dental Service in England and Wales, and Scotland between 1965 and 1981 had shifted from being dominated primarily by restorations and prosthetics to one with a growing percentage of diagnosis and periodontic (including scaling) services (Elderton and Eddie, 1983a). However, restorations still comprised approximately 50% of expenditure in 1981. The proportion of overall expenditure on fillings decreased over the period, but was counterbalanced by increased expenditure on crowns, endodontics, and bridges (Elderton and Eddie, 1983b).

Treatment distributions - projections of future needs

Projections of future need for dental treatment have been motivated both by observed changes in treatment distributions over time, and by changes in other factors such as oral health status which are likely to impact on service patterns. In Canada a need-based model was developed to estimate and project the dental market for caries and periodontal diseases (Douglass and Gammon, 1985). Taking demographic and disease trends into account the model showed projected increases in the number of hours to meet the need for both operative and periodontal treatment in Canada. This trend is driven largely by the increasing number of dentate adults among older age groups, which results in an increased number of adults at risk to dental diseases. Restorative dentistry was expected to differ according to the age cohort of the patient, with more conservative restorations needed among younger patients and greater numbers of more complex restorative services needed among older adults.

In the USA epidemiological data and population estimates were used to calculate the hours of adult operative treatment need in 1972, 1990 and 2030 (Reinhardt and Douglass, 1989). It was found that in 2030 there will be 54% more hours of need than in 1972. The change in numbers of older teeth at risk was also associated with changes in requirements for restorative treatment, consistent with the Canadian findings.

Australian data has also been employed to assess the impact of change in oral health status on dental practice and services (NHMRC Expert Advisory Panel, 1993). Decreased caries experience among children and decreased tooth loss among adults were found to be shifting the burden of dental disease and needed care from children to adults. The care needed may become more complex due to the accumulation of past disease experience and its sequelae, and also previous dental treatment. Medical conditions particularly among older adults may also impact on service provision. The expected overall result is an increased need for higher level tertiary intervention services.

The short-term impact of changes in oral health on service provision has seen an increase in the volume of services, while the changes in the dominant main areas of service (i.e., restorative, diagnostic and preventive) have not been substantial. The overall increase in annual service provision during the 1980s was due to increases in higher-level, complex interventions such as endodontics and advanced restorative services (Spencer, Brennan and Szuster, 1994b). The combination of patient demand and new technologies is likely to accelerate the increase in high-level interventions resulting in a mix of services dominated by low-level and high-level intervention services in the long-term (NHMRC Expert Advisory Panel, 1993). These changes were considered to be consistent with the direction predicted by the World Health Organisation, but not to be as rapid as expected (WHO, 1990; Pilot, 1988).

Summary - main areas of service

Developed industrialised countries such as Australia, USA, and England show some common patterns of service provision, with a dominance of treatment distributions by the main areas of restorative, diagnostic and preventive services. There appears to be a trend toward decreases in restorative care, consistent with lower overall levels of caries in children and tooth loss in adults. However, despite some movement away from restorative care, these services continue to be a major component of dental treatment distributions.

2.1.2 Variation in service rates

Variation in medical services

The impetus for investigating variation in service rates was provided from documentation of medical service rates. Hence this section includes reference to both medical and dental services. While it can be argued that there are differences in the delivery of medical and dental services, there are also some similarities. Some of the differences will be considered further in Section 2.1.3, which deals with rate variation and appropriateness of care. While the conclusions drawn from studies of medical services can not necessarily be applied to dental services, such results can be instructive and lead to research questions which can be investigated using dental services.

Documentation of variation in medical services often involves comparisons between small areas with high versus low rate areas being contrasted. For example, a study of surgical rates in Manitoba found one and a half times as much surgery was performed in high rate areas compared with low rate areas (Roos and Roos, 1981).

Place of residence was concluded to be a strong influence on exposure to major surgical procedures since the surgical case mix varied little between the high and low rate areas. Hence the surgical selection process rather than the characteristics of the population within an area was attributed as a major determinant of surgery rates, with high surgical rates being associated with risk of excess deaths. However, there was acknowledgement that there was a lack of understanding of why the variation occurred.

In order to assess the contribution that population characteristics make to the observed variation in medical service rates a study was performed which looked at service rates across 56 small areas in association with variations in characteristics of the population such as self-reported health status, levels of disability, mental status, socio-economic status, and ethnic characteristics (Roos and Roos, 1982). The findings did not support a needs model, which postulates that the worse the overall health of the population within an area, the greater the need for surgical intervention. High rate areas were not associated with a population that was more disabled and in ill health.

Another study using data based on 13 large areas in the USA found that 67 out of 123 procedures exhibited at least three-fold differences in medical service rates between the highest and lowest areas (Chassin et al., 1986). However, areas did not exhibit high or low rates consistently, but were high for some and low for others. The researchers point out that while policy makers readily equate high use as inappropriate, such an assumption may be uninformed. Wennberg (1986) relates that while variation in rates may be widely documented it is difficult to distinguish between unnecessary care involving inappropriate use in areas with high rates, insufficient care involving inappropriate use in areas with low rates, and appropriate use where differences between areas are explained by differences in health status. To be able to make such distinctions requires a better scientific basis involving the definition of standards and the investigation of outcomes. Variations in medical practice may be acceptable under some circumstances (Smits, 1986). These include when uncertainties in scientific knowledge lead to acceptable alternative practice patterns, and when an innovation in diagnosis or treatment is in a phase of active dissemination.

Sources of variation in dental practice

Having reviewed some of the background to variation in medical service rates this section addresses variation in dental service rates, and begins by looking at sources of variation in dental practice. The treatment plan recommended by a dentist is the result of a process which can be shaped by a range of potential sources of influence. The process of clinical decision-making has been described as involving three phases (Bader and Shugars, 1992). The disease or condition is identified in the detection phase. A decision to intervene is made in the next phase. Then, if a decision to intervene has been made, the final phase involves selecting among alternative treatments.

Variation among dentists can arise across these three phases of clinical decision-making (Bader and Shugars, 1995b). In the detection phase, variation may arise from differences in carefulness of inspection, skill in examination techniques, and criteria used to identify conditions. In the decision to intervene phase, variation may arise from differences in dentists' perceptions regarding the course of the disease, dentists' knowledge of risk factors and perception of risk for disease. In the selection of treatment phase, variation may arise from differences in how dentists interact with patients, solicit the opinions of patients, interpret the preferences of patients, and apply their own practice beliefs in relation to treatment effectiveness.

Having outlined potential sources of variation in the service provision process, the next three sections document the extent of variation in dental services. This follows the framework adopted by Bader and Shugars (1995b) in structuring the studies into the three levels of dental practice, patient, and tooth. Practice level studies are useful for assessing rates and service distributions among practices grouped into characteristics of interest such as by geographic regions or payment mechanisms. However, such analyses tend not to control for patient factors, but instead rest on the assumption that there is an even distribution of patients across practices. Studies performed at the level of the dental patient are usually based on recommended rather than actual treatment, as the same patients are examined by multiple practitioners. Patient simulations have also been employed for both convenience and standardisation. These factors may hinder the validity of the patient level analyses to the extent that actual treatment varies from recommended treatment and simulated cases. Variation at tooth level may also be obscured when aggregated to the level of patient. This problem can be avoided through using tooth level studies based on treatment recommendations for individual teeth.

Variation in dental services - practice level

The number of studies which have documented variation in service rates and practice patterns among dental practices has been reported as being extremely small (Bader and Shugars, 1995b). Some have adopted the small area approach used in studies of medical service variation and applied it to dental practice. For example, Gotowka and Clive (1988) reported on service rates per 1,000 patients, with ratios of eight to one being observed between areas. Expenses per patient receiving services varied between one and a half to two to one between areas. Another study applied the small area approach to dental service variation by estimating simulated rates of numbers of services (Diehr and Grembowski, 1990). Despite some methodological problems inherent in the approach (e.g., the possibility of differences in patient populations between areas), the simulation study provided support for the finding of excess variability among dentists.

Other studies of variation in dental services at the practice level have adopted the use of the individual practice as the unit of analysis rather than the larger geographic regions which have formed the basis of other small area analyses. Practice profiling has been developed to collect statistical data on the frequency of delivery of services which can be used to compare between practitioners in order to identify statistical exceptions such as fraudulent billing (Rocky, 1988). The profiling method also provides a ready means to quantify variability in dental practice.

A study of dental practice profiles based on claims data from 227 dental practices for 16 service categories found that there was considerable heterogeneity among and within practices (Bailit and Clive, 1981). The substantial variation in service rates led the researchers to conclude that there was a clear need for research on patterns of dental care, including investigation of factors influencing these patterns.

A study of amalgam replacement rates based on the average percentage of two- or three-surface amalgams receiving another service at 6, 12, and 24 months in 37 general dental practices found that the variation in replacement rates among practices was substantial, but not explained by the technical quality of restorations (Bailit, et al., 1979). Once again the authors concluded there was a need for further work to elucidate the factors associated with differences among providers in practice patterns.

A study of variation in clinical practice which examined the extent of variability in diagnosis and treatment of temporomandibular disorders between two clinics found that they differed substantially in their use of tomography, varied moderately in diagnoses assigned to patients, and there was large variation in selection of treatments (Von Korff, et al., 1988). They concluded that there was a need for systematic approaches to identifying, evaluating, and modifying variation in health care practices for common presenting problems.

Another study which calculated service rates for 200 general dentists based on a homogeneous patient population found wide variations in rates for many dental services (Grembowski, Milgrom, and Fiset, 1990a). The wide variation was not explained by differences in patient characteristics, which might be expected among a homogenous group of patients, but dentist beliefs and practice characteristics were important correlates of practice profiles.

While these studies of variation in dental services at the practice level have reported on data from the USA, there is also evidence of practice variation in Australia (Brennan, Spencer, and Szuster, 1996a). A total of 202 private general practitioners provided service data in 1983 and 1988, and were used in a cluster analysis to group the dentists into practice styles. Three clusters of dentists were obtained, characterised by service rates as providing high restorative rates, low total rates, and high diagnostic and preventive rates.

In their review of variation in dental services Bader and Shugars (1995b) compared mean rates and measures of variation across three reported studies of variation in dental service provision (Bailit and Clive, 1981; Gotowka and Clive, 1988; Grembowski, Milgrom, and Fiset, 1990a). They found that the relative magnitudes of variation in service rates were roughly similar across the studies, and that the absolute magnitudes showed substantial variation among dental practices for common procedures. Provision of examinations and prophylaxes showed the least amount of variation among practices which was attributed to the use of routine schedules rather than a reliance on clinical symptoms.

While there are few studies which have included comprehensive attempts to evaluate factors which are associated with variation in dental service rates, the variance in service rates explained by the models is generally small (Grembowski. Milgrom, and Fiset, 1991). Alternatively, studies have found independent variables such as dentist and practice variables were not significant (Bailit et al., 1979). This has led to suggestions that some of the variation in service rates could emanate from idiosyncratic decisions of individual dentists (Bader and Shugars, 1995b).

Variation in dental services - patient level

Studies of variation in dental services at the patient level involve comparison of recommended treatment for the same patients who had been examined by a number of dentists. The measures used to compare the treatment recommendations vary between studies (Bader and Shugars, 1995b), and include: cost, numbers of surfaces decayed and planned for treatment, and replacement decisions for dentures.

A study of the cost of recommended dental treatment for two patient actors examined by fee-for-service and capitation dentists found that fee-for-service dentists, while not recommending much more treatment, tended to recommend more expensive types of treatment (Hazelkorn, 1985). Another study of costs of recommended treatment found wide variation, and concluded that the nature of care that is planned is very dependent on the individual dentist involved, with the majority of restorations during a single course of care being the result of idiosyncratic decision-making (Elderton and Nuttall, 1983). A simulation of treatment planning which compared best possible care with care limited to a particular insurance plan found that dentists were able to elect alternative treatments when faced with financial constraints, but that there was substantial unexplained variation in their treatment planning for any given patient (Conrad, Milgrom, and Kiyak, 1984).

A study of variation in caries recording and restorative treatment planning among university teachers found large variation in caries recording between examiners and this variation was carried over into the subsequent treatment plan, with great variation in the plans for reparative care (Rytomaa, Jarvinen, and Jarvinen, 1979). A study of the relationship between epidemiological coronal caries assessments and practitioners' treatment recommendations found that for a tooth assessed as carious by epidemiologic examination a mean of approximately 90% of examining practitioners recommended treatment while among teeth classified as sound by epidemiological criteria the mean proportion of dentists who recommended treatment was 11% (Bader, Shugars, and Rozier, 1993).

Few studies are available which examine treatment recommendations which do not involve single tooth restorative services (Bader and Shugars, 1995b). Substantial differences in recommended treatment involving bridge, partial denture and endodontic services were reported (Hazelkorn, 1985), while another study investigated differences in complete denture assessment (Cabot, 1990). Although there was good agreement on the need for new dentures, there was disagreement over judgements concerning vertical dimensions which could have led to failures in subsequent re-makes. Finally, a simulation study of treatment planning for periodontal services prepared by 346 dentists for 7 prototypic patients based on written histories, clinical and radiographic full-mouth examination results, radiographs and models found that the number of recommended periodontal services was related to the number of restorative units and inversely related to the number of extractions and prosthodontic devices (Milgrom et al., 1981). Subgingival curettage was the treatment of choice for most practitioners, with this being the primary response to a wide range of presenting problems. It was concluded that the variability in response to various periodontal conditions indicated a need to critically examine the process by which dentists reduce clinical data into an integrated diagnosis and treatment plan.

Variation in dental services - tooth level

Compared to the body of research available at the practice and patient levels, there is a more extensive collection of studies at the tooth level, which has been attributed to the simpler study designs afforded by the simulation approach (Bader and Shugars, 1995b). A number of studies have been performed based on extracted teeth and radiographs. There is a consistent trend across these studies which indicates substantial variation in diagnoses of caries and recommended treatment (Bader and Shugars, 1995b). A study of radiographic diagnoses and treatment decisions on approximal caries found that diagnostic quality differed widely between dentists and there was great inter-observer variation with respect to caries diagnosis and planned restorative treatment based on radiographic interpretation (Espelid, 1986). Another study of inter-rater agreement in interpreting radiographs showed that there was substantial agreement on the presence or absence of caries, but only fair agreement on the specific depth of caries (Langlais, et al., 1987). They concluded that treatment decisions based solely on interpretation of radiographs may not be in the best interests of the patient, but may be more credible when based on additional information such as patient history and clinical information. Inter- and intra-observer variations have been found to be lowest when lesions were diagnosed as being in the outermost parts of the teeth, with cut-off points gradually moving toward a stricter diagnostic threshold as deeper parts of the tooth were examined (Espelid and Tveit, 1986). Variation in radiographic caries diagnosis and treatment decisions has been found to be large despite standardised conditions, and has been attributed to differences on diagnostic criteria and viewing ability (Mileman, Purdell-Lewis, and Van der Weele, 1982).

A study which examined diagnostic and treatment planning decisions on a selection of extracted teeth set in realistic contact with each other found that the greatest discrepancy between practitioners resulted from visual inspection but was reduced when the diagnosis was made radiographically (Noar and Smith, 1990). However, early lesions were more reliably diagnosed visually and later lesions more reliably diagnosed radiographically. Another study based on teeth mounted in blocks and radiographed involved dentists examining the teeth radiographically, visually and by probing to assess their need for restoration replacement (Tveit and Espelid, 1992). Great variation was found in replacement decisions which was attributed to a wide variety of treatment philosophies among dentists. Another study collected both restorative treatment decisions based on radiographs and restorative treatment thresholds based on a list of descriptions of lesions where dentists were asked to indicate at which point would a filling be required (Kay, Nuttall, and Knill-Jones, 1992). It was found that their reported restorative thresholds had little or no relationship to what they actually planned on the basis of radiographic examination, and it was concluded that the inherent attitudes of dentists have a stronger influence on treatment planning than their ability to correctly detect pathology.

While there are a number of studies based on simulations there is a limited amount of information based on dentists' examinations of patients (Bader and Shugars, 1995b). In one study it was found that a large number of tooth surfaces planned for treatment were the result of decisions made by a few dentists (Elderton and Nuttall, 1983). Only two tooth surfaces out of the 2,435 examined were planned for filling by the unanimous agreement of all the 15 dentists in the study, and only 41.4% of the restorative treatment decisions were the result of agreement between a majority of the dentists. The authors concluded that a great deal of restorative treatment is the result of 'grey area' decision-making. A similar lack of agreement in judgement of need for treatment has been observed in other studies (e.g., Rytomaa, Jarvinen, and Jarvinen, 1979). Another study examined the extent of agreement among dentists to recommend treatment for 1,187 teeth in 43 patients (Bader and Shugars, 1993). Overall inter-dentist reliability in recommending treatment for individual teeth was moderate. Among restored teeth, the reliability of dentists' recommended treatment was considered to be little better than poor. It was concluded that much of the variation in dentists' practice profiles is due to basic differences in decisions on treatment recommendations for individual teeth with specific conditions.

Some studies are available which deal with clinical conditions other than restorative treatment for caries. A study of dentists' management of periapical lesions in endodontically treated teeth using simulated cases based on clinical history and radiographs involved dentists selecting one of five treatment alternatives indicated that the cut-off point for selection varied among examiners, with substantial inter-examiner disagreement (Kvist et al., 1994). A study of inter-rater agreement on subgingival calculus detection following scaling indicated that reliability for all paired clinical ratings was low, with there being a high probability of indicating that calculus was absent, regardless of extent, suggesting a need to define acceptable performance criteria (Pippin and Feil, 1992).

A number of studies have investigated variation associated with treatment of third molars. Using simulated cases based on radiographs, general dental practitioners were asked to evaluate the need for extraction of asymptomatic mandibular third molars (Knutsson et al., 1992a). The number of molars that were recommended for extraction ranged from 0 to 26 among the observers, and there was no molar where the decision to extract was unanimous. The authors concluded that there was great variation among general dental practitioners regarding their evaluation of the need for removal of asymptomatic mandibular third molars. Another study compared the judgement of both oral surgeons and general dental practitioners regarding the need to extract asymptomatic mandibular third molars (Knutsson et al., 1992b). The number of third molars recommended for extraction by the group of oral surgeons ranged from 3 to 21 of the 36 teeth examined in the simulation study. The mean intra-observer agreement within the two groups was comparable, with both general dental practitioners and oral surgeons displaying great variation in their judgement on the need for removal of third molars. A study of general practitioners and dental students regarding their decisions on diagnoses, treatment, and referrals of third molar cases based on radiographs and written information found that overall good diagnostic abilities were shown by both groups, but there was a moderate level of disagreement over diagnoses of pericoronitis, partial eruption, and retention (Berge, 1993). Finally, a study of treatment thresholds for third molar problems demonstrated wide variations between treatment plans made by individual clinicians (Brickley, Kay, and Shepherd, 1995).

Summary - variation in service rates

Studies of variation in dental service rates are rare at the practice level, and are also limited at the patient level, but are more common at the tooth level. The general picture which emerges from these studies is that variation among dentists in service rates, diagnostic decisions, and recommended treatment is widespread. In their review of variation in provision of dental services Bader and Shugars (1995b, page 70) summarise as follows: "Although the study of variation in dental practice is limited in breadth, depth, and detail, whenever the decisions of dentists are compared - regardless of whether the comparison is made for specific teeth, for individual patients, or for service provision rates across patients - substantial differences among dentists are found." These differences have been attributed to variation in detection of conditions, decisions to treat, and selection of treatment, and related to differences on dentists' beliefs or knowledge regarding diagnostic criteria, course of disease, operation of risk factors, and effectiveness of treatment (Bader and Shugars, 1995b). The central impact of this variation concerns the extent to which the appropriateness of care is compromised as a result of variability in services recommended and provided. The topic of appropriateness of care is dealt with in the next section.

2.1.3 Rate variation and appropriateness of care

Appropriateness of care is a concept which spans considerations of the accuracy of risk assessment and diagnosis, and treatment outcomes such as the effectiveness and cost-effectiveness of alternative treatments (Bader, 1992a). While the appropriateness of the treatment provided is an integral component of the quality of dental care, it is acknowledged that there are few objective rules to guide a process which is often simply thought to represent professional judgement (Kress, 1980). It has been pointed out that dentists are not unique in displaying a lack of agreement over matters which the public considers to be well-standardised, thoroughly researched, and uniformly implemented, as some of the impetus for examining variation in services arose from similar findings regarding medical service rates (Maryniuk, 1990).

Differences in medical and dental practice

However, it has also been acknowledged that dental and medical practice differ (Bader and Shugars, 1995b). The role of dental training may encourage the desirability of replacing restorations and instil attitudes of distrust regarding the quality of restorations placed by others, which may be exacerbated by the lack of set standards and minimal to no direct peer interactions in dental practices (Maryniuk, 1990). Dental practice is often decentralised in the private sector, with practices operating independently and structured as small businesses (Bader and Shugars, 1995b). This may limit the opportunity for dentists to directly compare clinical observations and practice. Treatment planning in dentistry has been described as being more of an art than a technology, suffering from both a lack of emphasis in dental curricula and the fragmented organisation of clinical dentistry into a number of specialty areas which may hinder an integrated approach (Kress, 1990).

Another aspect of dentistry which differs from medical care involves the focus of general dental practice being predominantly on the prevention and treatment of a limited number of conditions, primarily consisting of caries and periodontal disease, and their sequelae (Bader and Shugars, 1995b). As a result, dentists tend not to perform a true differential diagnosis, but instead routinely apply criteria for the presence or absence of two diseases and their sequelae. Many diagnoses and recommendations for treatment therefore occur in the absence of symptoms, and may involve consideration of multiple sites, and hence multiple clinical decisions which may involve interactions. With dental diseases being few in number and high in frequency the dental approach to case management is considered to be more oriented to treatment than to diagnosis (Kress, 1980).

Another contrast between dental and medical care has been raised with respect to the reaction of these respective professions to the findings of variation in services. Medicine has been seen to be embracing a multifaceted course of inquiry spanning investigations of under- and over-utilisation of treatment, examination of the effectiveness of many treatments, and the development of clinical decision-making methods (Bader and Shugars, 1995b). This has been contrasted with the view among dentists that variation in clinical decisions has not generally been regarded as a problem. This lack of concern has been linked to two historical bases, which are the technical orientation of dentistry and the provision of much of dental care through dental markets. An orientation toward technical perfection emphasises the technical quality of a service rather than the resolution of the problem from the viewpoint of the patient, while the operation of market forces on provision of dental services encourages the role of pricing both in selection of dental treatment and in the judgement of the value of a particular treatment in terms of effectiveness.

Given that dentistry has some emphases which differ from medical care, which may need to be considered when applying the findings from one area to another, an important issue which remains to be discussed concerns the interpretation of the observed variation in the provision of dental services. This is pursued in the following section.

Interpreting variation in relation to appropriateness

Of primary importance when looking at variation in provision of dental services is the notion that if services vary between practitioners then it is unlikely that each of the various rates or selections of treatments is equally effective. If this is the case, then the appropriateness of some of the care provided may be questionable, or as Bader and Shugars (1995b, page 63) put it "...it is an explicit assumption .... that variation in treatment decisions (i.e., differences in treatment recommended and provided by dentists for patients in similar and/or identical circumstances), does raise important questions that need to be addressed". The need to address the issues of appropriateness of dental care has been linked to the lack of sound, objective studies of accuracy of risk assessment and diagnosis and treatment outcomes, and the need for dentistry to provide research which is of relevance to those who make policy decisions (Bader, 1992a).

Within dentistry a number of levels of analysis have been applied to investigate the research problem of variation among dentists. While there are numerous reports of variation at the level of the dental practice it is not possible to make definitive judgements regarding what is an acceptable amount of variation, or in other words to answer the question, "which rate is right?" (Wennberg, 1986). Further information, particularly on outcomes, is required to answer such questions. At the patient level, while it is still difficult to say which service rate is most appropriate, the control for patient characteristics in the study design points to other factors such as the skills, knowledge, and beliefs of dentists as potential sources of variation in rates, with the assumption being that the remaining variations observed along the service rate continuum are unlikely to be equally appropriate (Bader and Shugars, 1995b).

Finally, even with the more controlled experimental designs afforded by studies performed at the level of the individual tooth, there is "an unmistakable pattern of lack of agreement among dentists on a variety of individual clinical diagnostic and treatment decisions" (Bader and Shugars, 1995b, page 69). This lack of agreement over treatment recommended for the same teeth examined under similar conditions highlights the problem of appropriateness of care issues in dentistry.

Appropriateness of care issues to be addressed

One issue associated with appropriateness of care concerns addressing the lack of data. Bader (1992a) notes that there are many examples of common treatment practices which are not supported by research findings. For example, many preventive treatments are routinely provided to individuals considered to be more prone to risk, but risk assessment is only beginning to be adequately developed in dentistry. Accuracy of diagnosis may also be questionable, while the evaluation of the effectiveness of alternative dental treatments is rare. Outcomes in general need to be more thoroughly researched, while the broadening of the scope of outcomes to consider aspects of care from the perspective of the patient is also required. However, it is noted that "for the established and more commonly performed dental treatments and diagnostic procedures and skills, data needed for use in evaluations of appropriateness of care are not available" and "these treatments and these skills represent the bulk of dental treatment" (Bader, 1992a, page 502). While there is a need for a greater research effort to address these issues, a problem associated with the lack of data pertaining to appropriateness of care issues consists of the lack of priority assigned to the research required to provide a better understanding of these matters (Bader, 1992a). This may stem from the need to conduct such research in dental practices using quasi-experimental designs, in order to address the question of "what actually happens?" (Bader, 1992b).

While there is a lack of data on outcomes as well as a lack of acceptance of the importance of research of these issues, an unresolved question concerns the nature of the variation in services. A range of potential sources of influence could shape the provision of services. Knowledge of these factors is necessary in order to arrive at a better understanding of the process of service provision, and be in a position to develop policy responses which can address the issues associated with variation in services provided and appropriateness of care.

2.2 Influences on service provision

Having described service rates, reviewed variation in service rates and discussed rate variation in relation to the issue of appropriateness of care in the previous section, this section focuses on sources of influence on service provision. This involves consideration of patient characteristics, dentist characteristics, practice factors, and oral health status.

2.2.1 Patient characteristics

Patient characteristics are fundamental sources of influence on the process of service provision. While oral health status may be considered foremost amongst the potential range of characteristics possessed by a patient which would be likely to influence the dental service they receive, the technical nature of measuring this characteristic warrants separate consideration (see section 2.2.4). In this section the patient characteristics of age, sex, visit type, insurance status, and socio-economic status are discussed in relation to variation in service provision.

Age and sex

A study of dental practice profiles in the USA found that patient age had a major effect on service rates, but patient sex had a negligible influence (Bailit and Clive, 1981). In Australia, the pattern of service-mix has been linked to both patient age and sex distributions (Spencer and Lewis, 1989a). Population-level data from Australia for dentate persons who had visited in the previous year showed that extractions were provided at a higher rate among adolescent and young adult age groups, fillings were highest among middle aged adults, and scale and clean services were highest among young to middle aged adults (Carter et al., 1994). In private general practice, all 10 main areas of service showed significant variation by age of patient (Brennan, Spencer, and Szuster, 1998b). The patterns of association by age included diagnostic and preventive services being provided at higher percentages in younger compared to older age groups, orthodontic services being highest among adolescents, restorative services being provided at higher percentages in middle aged groups, and prosthodontic services being higher across older age groups.

While rates of total, combined restorative services have remained relatively stable during the 1980s and 1990s there have been shifts in their distribution among age groups of patients (Spencer, Szuster, and Brennan, 1994). For example, restorative rates increased significantly between 1983-84 and 1988-89 for patients aged 45-64 and 65+ years, but decreased for patients aged 5-11 and 12-17 years. Within the main area of restorative services there were also shifts in component services over time between patient age groups (Spencer, Brennan, and Szuster, 1994a). For example, trends between 1983-84 and 1988-89 for younger patients included decreased numbers of amalgams, three-surface glass ionomers, and one- and two-surface resin composites, but increased numbers of one-surface glass ionomers and fissure sealants. Older patients showed increased numbers of crowns, one- and three-surface amalgams, glass ionomers, and three-surface resin composites.

These Australian findings relate to patients treated by private general practitioners. While this represents the majority of practitioners in Australia, patients treated through the public sector represent a different patient population by virtue of their eligibility status (e.g., aged pensioners, unemployed persons). Australian findings for adult public patients have shown that extractions are associated with age of patient, being higher among those aged under 30 years (Brennan, Spencer, and Slade, 1997). An examination of services received by adult public patients showed significant variation by age in 9 out of 10 main areas of service (Brennan and Spencer, 1999). The patterns showed parallels with those observed in the private sector (e.g., higher rates of diagnostic and preventive services among younger patients, and increasing rates of prosthodontic services across older age groups of patients).

While there were significant differences in service provision by sex of patient in four out of the 10 main areas of service in private general practice, these differences were not as pronounced as those observed for age of patient (Brennan, Spencer, and Szuster, 1998b). The service pattern by sex of patient included higher percentages of female patients receiving diagnostic and general/miscellaneous services, but higher percentages of male patients received oral surgery and endodontic services.

Visit type

Reason for visit, classified as emergency, check-up, and other visits for dental problems not involving relief of pain, has been associated with provision of services in Australian private general practice (Brennan, Spencer, and Szuster, 1997). Check-up visits were associated with higher odds for provision of diagnostic, and preventive services, but lower odds for extraction, restorative, and endodontic services compared to emergency visits. Crown and bridge, and prosthodontic services were higher for other visits involving dental problems without relief of pain compared to emergency visits. Among adult public patients in Australia, emergency visits were associated with higher rates of extraction and temporary services, but lower rates of restorative, prosthodontic, periodontic, preventive, and endodontic services (Brennan and Spencer, 1999). Population-level data for Australia on dentate persons who had visited within the previous year showed that persons who visited for a problem received very different treatment compared to those who visited for a check-up (Carter, et al., 1994). Overall, persons visiting for a problem had more visits, fewer scale and cleans, and a greater proportion of both fillings and extractions.

Insurance status

There have been a number of studies which have demonstrated an association between the use of services and insurance coverage (Locker and Leake, 1993; Grembowski, Conrad, and Milgrom, 1985; Kovar, Jack, and Bloom, 1988; Manning, et al., 1985). In addition to demand, some reports have indicated that insurance coverage is also associated with better oral health (Bailit, et al., 1985), and possibly with the mix of services (Mueller and Monheit, 1988). Data from the 1987-88 National

Oral Health Survey of Australia has indicated age-specific associations of dental insurance in relation to services provided and oral health status (Sivaneswaran, Allister, and Barnard, 1994; 1995). A multivariate analysis of service provision by insurance status in Australian private general practice found that insured patients were more likely to receive preventive, crown and bridge, and endodontic services, but less likely to receive extractions (Brennan, Spencer, and Szuster, 1997).

Another factor, related to economic incentives, which can influence service rates concerns type of dental plan. In a comparison of a dual-choice dental plan, it was found that fee-for-service patients received more visits and services than capitation patients, and it was concluded that over-treatment occurred for the fee-for-service patients and under-treatment for the capitation patients (Atchison and Schoen, 1990). In a study where the same patients were examined by a number of dentists it was found that a prepayment system was less expensive in terms of the cost of recommended treatment compared to fee-for-service dentists (Hazelkorn, 1985). A simulation study of treatment planning found that there was an effect of increased comprehensiveness of insurance coverage on the level and mix of services, while intermediate ranges of insurance coverage led to changes in the mix of services, but not overall cost (Conrad, Milgrom, and Kiyak, 1984).

Socio-economic characteristics

A study of variation in service rates found that the wide variation observed in rates of dental services was not explained by differences in patient characteristics (Grembowski, Milgrom, and Fiset, 1990a). Family incomes were similar and the majority of families had at least one adult with a college degree. These results were from a study which purposively sampled from a homogenous patient population, therefore there was limited scope for these patient characteristics to be related to service rates. Instead the observed variation pointed to other sources of influence, when these patient characteristics were controlled.

A study of amalgam replacement rates found that patient income was among a number of factors, including patient visit rate and technical quality of restorations which were not associated with replacement rates (Bailit et al., 1979). Another study of dental practice profiles found that socio-economic status had a negligible influence on service rates (Bailit and Clive, 1981), but this may reflect a dampening effect of insurance coverage on socio-economic differences among the study population.

Population-level survey data for dentate adults in Australia who had visited for a check-up in the previous year showed little variation in mean numbers of services received by income or health card status (Carter et al., 1994). However, those persons who had visited for a problem exhibited wide variations. The mean number of extractions showed a consistent increase from the highest income group to the lowest income group, and a slight decrease in fillings. Variation by card holder status was also evident, with those eligible for a health card (e.g., age pensioners, unemployed persons) who visited for a problem having more extractions and slightly less fillings than those not eligible for a health card.

2.2.2 Dentist characteristics

Age and sex

A range of aspects of dental practice have been linked to differences associated with sex of dentist. For example, patterns of participation and practice by female dentists have been described (McEwen and Seward, 1988a; Price, 1990), and practice patterns of male and female dentists compared (Spencer and Lewis, 1988b). The average output of services was found to be lower for female compared to male dentists (Ashford and Cole, 1981), and had been linked to child rearing and part-time work patterns (Boyle, 1986; Seward and McEwen, 1987; McEwen and Seward, 1988b; Pack et al., 1987; Brennan, Spencer, and Szuster, 1992). However, the differences in service provision, while statistically significant, have been reported to be small in terms of effect size at the patient level (Kent, Carter, and Spencer, 1998). The distribution of the ten main areas of service is similar in terms of rank order between male and female dentists (Brennan, 1997).

A study of caries recording and restorative treatment plans could not find any trends related to the sex, age or years of experience of the examiner (Rytomaa, Jarvinen, and Jarvinen, 1979). However, younger dentists have been found to be less likely to have restorative treatment criteria in the enamel (Mileman and Espelid, 1988). A study of treatment recommendations based on simulated cases found that dentists in the 60+ years category were more likely to recommend treatment for smaller interproximal lesions, and more likely to recommend composite resin than younger dentists, while dentists in the 40-49 year age group were the most likely to recommend stainless steel crowns (Hanes, Myers, and Dushku, 1992).

Age of dentist was associated with service provision in the USA, with an increase in the numbers of extractions, but a decrease in the numbers of fillings, examinations and cleanings as dentist age increased (Konrad and DeFriese, 1981). A study of practice profiles of younger and older dentists found that younger dentists provided more operative, endodontic and periodontic treatment, while older dentists provided more removable prosthodontic care (Martens, et al., 1987). Some of this service variation in relation to age was attributed to an association of age of patients with age of dentists. In a study of the appropriateness of restorative dental treatment it was found that an adult's probability of overtreatment was higher if their dentist was younger (Grembowski et al., 1997a).

In Australia, the pattern of service provision has been shown to be associated with age of dentist, but generally the patterns lack clear and consistent trends (Brennan, 1997). Endodontic services were one exception, showing a consistent pattern of higher rates among younger dentists. Other service areas such as restorative and diagnostic tend to show lower rates amongst the oldest dentists, while preventive services tend to be provided at higher rates by dentists among the middle age groups.

Dentist-patient relationship

Research of the dentist-patient dyad can reflect perceptions of either or both the patient and dentist. Studies concentrating on patient perceptions include an extensive literature on patient satisfaction which has been linked to the rise of consumerism in health care (Williams and Calnan, 1991). Such studies are useful in understanding patient behaviour, and evaluating providers, services and facilities

(Davies and Ware, 1981). Dentist perceptions may be important for a number of reasons. Dentistry may be perceived as stressful by both dentist and patient, with one source of stress arising from the dentist-patient relationship itself (O'Shea, Corah, and Ayer, 1983). Dentist perceptions of patients may be related to the quality of care received (Weinstein, et al., 1978). Incongruities between dentist and patient perceptions of the importance and value of dental care may act as a barrier to treatment (Frazier, et al., 1977). Patients may choose dentists with styles consistent with their own desires (Maryniuk, 1990), with differences in the way dentists interact with their patients providing a potential source of variation in services (Bader and Shugars, 1995b).

A study of dentist perceptions of good patients in the USA highlighted the importance of dental sophistication, interpersonal responsiveness, and compliance (O'Shea, Corah, and Ayer, 1983). These dimensions were related to the perceptions of treatability, likability, and manageability of patients. Another study found that dentists evaluated their patients using the three dimensions of compliance, tractability, and interpersonal responsiveness (Rouse and Hamilton, 1991). A Finnish study of the dentist-patient relationship grouped the findings into motivation and compliance, allows disruptive behaviour, and punctual and active (Lahti, et al., 1992). Comparisons of ideal and actual behaviour based on these factors indicated that the most important characteristics of the ideal patient (e.g., appreciation, compliance, trust) were difficult for the dentist to judge, providing a possible source of dissatisfaction with work (Lahti, et al., 1995).

The dentist-patient relationship may play a role in the probability of receiving inappropriate restorative care (Grembowski et al., 1997a). It was found that adults who were satisfied with their previous dental care were less likely to receive inappropriate replacement restorations. In a study of dentists' estimates and attitudes regarding the longevity of restorations, patients were thought to be responsible for 47% of restoration failures, with older dentists more likely to attribute failure to the patient than younger practitioners (Maryniuk and Kaplan, 1986). The behavioural nature of successful treatment was underlined by a study which showed that patients with positive attributes, such as providing few obstacles to treatment, received better quality of care (Milgrom, Ratener, and Weinstein, 1983).

Clinical decision-making has been described as a social process, involving the dentist and patient, and sometimes family members and insurers (Grembowski, Milgrom, and Fiset, 1988). Within this process dentists respond to technical and patient factors, but technical factors tend to dominate. An unanticipated strong, opposite relationship between dentists' preventive and patient orientation, was interpreted as involving those dentists who were preventively oriented having strongly held views on how dentistry should be practised. This would result in their being less likely to allow patient concerns to interfere with their style of practice. While a minority of dentists ranked the patient factors of cost and patient preference as important in treatment choice decisions, at least one of these factors was significant in statistical models of service rates (Grembowski, Milgrom, and Fiset, 1991). Dentists who ranked cost as important performed more, lower cost crown build-ups, while dentists who ranked patient preference as important performed fewer, high cost crowns and more, cheaper extractions. The negative correlations observed between patient preference and selected technical factors suggested that dentists who ranked patient preference as important tended to place less emphasis on technical factors.

Treatment philosophy

The changing pattern of treatment in the GDS between 1965 and 1981 led to calls for a fundamental shift in philosophy from what was primarily a restorative service to primarily a preventive service (Elderton and Eddie, 1983a; 1983b). The need to re-evaluate the prevailing restorative treatment philosophy was linked to avoiding repetitive replacement cycles (Elderton, 1988). In view of the changing pattern of caries there has also been a suggestion that the present surgical emphasis in the management of caries be limited to a minimum, and an assessment of susceptibility and risk of caries should be an integral part of treatment planning, and a precursor to any restorative treatment (Elderton and Dowell, 1989).

A study of the reasons for restoration replacement found significant variation in the way in which dentists with similar backgrounds and practice environments replace restorations (Drake, Maryniuk, and Bentley, 1990). It was concluded that many clinical decisions were not completely influenced by clinical findings, but were also shaped by individual practice philosophies of dentists.

It has been reported that since the stated treatment thresholds of dentists had little influence on their recommended restorative treatment plans, the inherent attitudes of dentists has a stronger influence on treatment planning than their ability to correctly detect pathology (Kay, Nuttall, and Knill-Jones, 1992). The observation that the stated restorative treatment thresholds of dentists had little influence on their treatment plans based on radiographic examination has been explained through treatment philosophy. While dentists may share a similar threshold and interpretation of the radiographic evidence some might adopt a more interventionist approach due to a belief that restorations offer a rapid and sure means of restoring the health of a tooth (Kay, Nuttall, and Knill-Jones, 1992).

In a study of variation in radiographic interpretation and restorative treatment decisions it was found that the majority of dentists would restore lesions confined to enamel, while others would wait until the lesions had reached the dentin (Espelid, et al., 1985). The criteria for restoration based on radiographic appearance was correlated with the dentists' opinions about cavity formation. A study of replacement decisions for amalgams concluded that the greatest contribution to variation in treatment decisions was the wide variety of treatment philosophies among dentists, especially where crevices or marginal defects are concerned (Tveit and Espelid, 1992).

A study of decisions on restorative treatment and recall intervals based on bitewing radiographs found that the most likely explanation of the variation observed between practitioners was their differing beliefs about disease processes and benefits of alternative treatments (Mileman and Espelid, 1988). A study of decisions to take bitewing radiographs found little variation was explained by presenting dental status, proportion of restorative decisions based on radiographs alone, importance attached to diagnostic use of floss, practice location and equipment (Mileman et al., 1988), suggesting idiosyncratic use of radiographs and a weak tendency to adopt different diagnostic sets of procedures, with some dentists relying on radiographs and others on more diverse clinical signs and techniques.

An investigation of endodontic re-treatment decisions found that for cases and examiners it was possible to identify one cut-off point along the continuum of lesion size, but there was disagreement among examiners (Kvist, et al., 1994). This disagreement was related to conflict over facts and/or values, with the main components of the choice of cut-off considered to be value-dependent.

A study of factors influencing variation in dentist service rates found that, in general, practice beliefs explained only a little of the variation in rates, with information sharing being associated with fewer diagnostic services, and preventive orientation associated with fewer preventive services (Grembowski, Milgrom, and Fiset, 1990b). Another study of practice beliefs found that a belief in patient influence was associated with fewer extractions, preventive orientation was associated with more crowns, but fewer crown build-ups and root canals, while a belief in information sharing was associated with a lower rate for bridge crowns (Grembowski, et al., 1991). A study of the appropriateness of restorative dental treatment found that the probability of receiving a restoration in a decayed tooth was lower if the dentist had beliefs which supported information sharing, which was attributed to reflect a more conservative, less invasive form of practice where dentists inform patients by sharing information when making treatment decisions (Grembowski, et al., 1997).

2.2.3 Practice factors

Geographic location

Geographic variations in the use of physician services under Medicare in the USA have shown considerably less use of services by rural patients than by urban patients (Miller, Holahan, and Welch, 1995). In Australian general medical practice, differences by geographical location were consistent with a lower availability of specialists and wider range of duties for general practitioners in country compared to metropolitan areas (Britt, et al., 1993) Distance has been proposed as a significant environmental factor influencing health in Australia, through the association of remoteness with distributional inequity in health services (Brownlea and Taylor, 1984). Both currently and historically, an imbalance in availability of general health services has been noted between urban and rural locations in Australia, with rural areas characterised by fewer facilities and a shortage of health personnel (Humphreys, 1988).

In the UK, regional variations in dental care have been associated with supply of services. In regions with fewer dentists per capita, there was more emphasis on extraction as opposed to conservation of teeth (Ashford, 1978). In Australia, the availability of dentists is considerably lower outside of major urban areas (Szuster, 1993). Population-level data for Australia showed that urban dwellers had a higher mean number of scale and clean services in the previous year than rural or remote dwellers, while persons residing in remote locations had more extractions and fewer fillings than persons from urban or rural locations (Stewart, Carter, and Brennan, 1998). An analysis of the provision of public dental services in urban, rural, and remote locations in Australia found that dental care provided at non-urban locations was more likely to include restorative, oral surgery, and prosthodontic services, but less likely to include preventive services (Brennan, Spencer, and Slade, 1996). A study of services provided by private general practitioners in Australia found that controlling for age of patient, insurance status and visit type, patients at capital city locations received higher rates of diagnostic, preventive, periodontic, and crown and bridge services, but lower rates of prosthodontic services compared to non-capital locations (Brennan, Spencer, and Szuster, 1998a).

Type of practice

Practice characteristics and environmental characteristics have been found to influence the treatment which patients receive (Grembowski, Milgrom, and Fiset, 1990b). Larger practices were associated with more preventive and periodontic services, fewer services per patient were associated with increasing age of the practice, and busier practices provided more restorative services. Fluoridation was associated with lower rates of diagnostic, preventive and periodontic services. Markets with high fees provided more total, diagnostic, preventive and periodontic services. In a study of the appropriateness of restorative care, it was found that the probability of over-treatment was higher for adult patients treated by dentists from a busy practice, who advertised, charged higher fees, had less continuing education, or had a solo practice (Grembowski et al., 1997a). A study of the quality of restorative dentistry found that waiting time for treatment was negatively associated with quality (Milgrom, Ratener, and Weinstein, 1983).

2.2.4 Oral health status

Both Wennberg (1986) and Smits (1986) recognised that variation in medical service rates could simply reflect differences in underlying health status and not inappropriate care. However, there is some evidence which suggests that variation in medical service rates are not the result of differing health status (Roos and Roos, 1982). Studies of variation in dental service rates at the practice level have tended to rely on the implicit assumption that patient characteristics are evenly distributed across practices, but this assumption for clinical conditions is unlikely to be true as caries and periodontal disease have been documented as displaying regional variation (Bader and Shugars, 1995b).

In dentistry, there have been attempts to control for health status by employing homogeneous patient populations (Grembowski, Milgrom and Fiset, 1990a; 1991) or using diagnosis of main condition (Brennan, Spencer, Szuster, 1999). These attempts at control for oral health status represent an indirect form of control which rests on assumptions (e.g., that homogeneity of some patient characteristics is reflected in health status, and that similar diagnostic conditions provides adequate control for health status).

Other analyses have included health status in simulations of treatment planning (e.g., role playing using actors as patients, Hazelkorn 1985; interpretation of radiographs, Espelid, 1986), or have studied oral health status as an outcome of the service provision process (Manning et al., 1985; Vehkalahati and Helminen, 1994). A simulation study of periodontal treatment planning found that oral hygiene and major medications were the variables which best discriminated between treatment plans, with the number of recommended periodontic services related to numbers of restorations, extractions, and prostheses (Milgrom, et al., 1981). In a tooth-level analysis of recommendations for restorative treatment it was found that the presence of a previous restoration seemed to magnify the differences between dentists in their treatment decisions (Bader and Shugars, 1993). A study of replacement decisions for amalgam fillings found that the variation in replacement decisions was smaller for large compared to small lesions, with the greatest variation between dentists occurring for fillings with crevices (Tveit and Espelid, 1992). A study of restorative treatment decisions based on radiographs found that the number of dentists who agreed on a restoration was strongly correlated with lesion severity (Espelid, 1986).

A study of factors influencing the appropriateness of restorative dental treatment found that clinical and perceived oral health status were important explanatory variables (Grembowski, et al., 1997a). Probability of over-treatment was higher for adults who had more fillings at baseline, while an adult's probability of under-treatment was higher if they had less decayed or more missing surfaces at baseline. Another study looking at the quality of restorative care found that patients with better oral health received better care (Milgrom, Ratener, and Weinstein, 1983). However, in general, there is a paucity of studies which have been able to assess actual service rate variation with any control for presenting oral health status.

Given the central role that oral health status should play in planning and provision of dental services, the lack of control for health status represents a major weakness in studies of variation in dental service rates. For example, while only being an indirect and somewhat coarse measure of oral health status, there are clear and consistent associations between diagnosis of main conditions and patterns of service provision in Australian private general practice (Brennan, Spencer, and Szuster, 1999). The need to control for oral health status has been recognised, with Grembowski, Milgrom and Fiset (1991) calling for studies which include measures of oral health status in order to address the issue of the extent to which unexplained variation in rates in models of service provision reflects differences in oral health.

2.2.5 Summary: influences on service provision

Age of patient is related to services and is likely to reflect age-related disease experience and the cumulative effect of previous treatment. Dentist age may be associated with age distributions of patients, and hence reflect the age-specific service pattern of patients. Age of dentist may also reflect other factors such as training and clinical experience. Insurance and visit type were both associated with service provision. Socio-economic factors such as income were associated with service provision in population-level data where there was sufficient variation to enable such associations to be detected. Dentist factors have been associated with service variation, with lack of agreement on diagnostic and treatment decisions often attributed to likely differences in treatment philosophies and practice beliefs. Practice characteristics have also been associated with service patterns, with consistent trends evident for comparisons between locations such as urban and rural areas. Not surprisingly, oral health shows an association with service patterns in those studies in which it has been included.

Overall, while there are a number of studies which have examined some of the factors which influence the provision of dental services, there are few studies which have been able to span a wide range of these factors to provide a comprehensive model. The advantage of such an approach is the ability to simultaneously assess the importance of a range of factors as explanatory variables in the service provision process while also controlling for potential confounding of the remaining factors in the model.

3. Methods

This chapter outlines the mode of data collection employed, collection instrument and data items collected, method of sampling, analytical approach, and aspects of power and sample size.

3.1 Mode of data collection

Data were collected by a mailed self-complete questionnaire, which was sent to sampled dentists. The data collection methodology was based on the Total Design Method as outlined by Dillman (1978), and updated by Salant and Dillman (1994). The approach consisted of a primary approach letter which was mailed to sampled dentists to introduce them to the study. A letter of support for the study from the President of the Australian Dental Association was included with the primary approach letter. One week later the sampled dentists were mailed the survey questionnaire, together with a cover letter and a reply-paid envelope in which to return the completed questionnaire. One week following the questionnaire mailing they were mailed a brief reminder letter which included an expression of thanks to those who had already returned their questionnaires. At intervals of approximately four weeks a replacement questionnaire with cover letter and reply-paid envelope was mailed to those dentists who had not yet responded. Up to three follow-up approaches were conducted. Examples of these letters are included in Appendix A.

This approach to data collection and the collection instrument was tested in a pilot study of 30 dentists from New South Wales in July 1997. As the pilot study achieved an acceptable response rate with no methodological problems identified, this approach was adopted for the main data collection which then followed in September 1997. Some modification of the collection instrument was made before the main data collection. This is outlined below.

3.2 Collection instrument and data items

The collection instrument comprised an eight page self-complete questionnaire which was mailed to sampled dentists. An example of the instrument and instruction sheet which was included with the questionnaire is presented in Appendix B.

Data items were collected on:

- dentist characteristics,
- practice variables (i.e., size, location, volume and busyness of a practice),
- practice beliefs,
- factors influencing choice of alternative treatments,
- dentist's preferences for patient characteristics,
- characteristics of patients treated during the one day service log, and
- services provided during a typical day.

Data on dentist characteristics included year of graduation, year of birth, and sex. A filter question was used to retain dentists who were general practitioners, working in private practice, and currently treating patients in Australia.

Practice variables included main type of private practice, postcode of practice, time worked, numbers of patients treated, waiting time for appointments and auxiliaries working with the sampled dentist. These variables had been used previously in the

Longitudinal Study of Dentists' Practice Activity (e.g., Brennan, Spencer, and Szuster 1996b).

Items on practice beliefs were collected using a 5-point Likert scale ranging from 1 = strongly agree to 5 = strongly disagree. Eight items were included drawn from published work on service rate variation by Grembowski, Milgrom, and Fiset (1988; 1991)

Factors influencing choice of alternative treatments were based on published research of Grembowski, Milgrom, and Fiset (1988) which consisted of the choice between the treatment pair scenarios of crown *vs* amalgam, root canal *vs* extraction, bridge *vs* denture, prophylaxis *vs* scaling, with the addition of two different treatment pairs. These were visual exam *vs* x-ray, and preventive intervention *vs* restoration. Dentists were instructed to list up to five responses which they considered important in choosing the first alternative treatment of each pair presented. This question was asked as an open-ended question with five boxes available on the questionnaire. This was modified from the pilot study where a range of options were supplied and dentists asked to rank the five most important factors. Feedback from the pilot study indicated that dentists were confused by the concept of ranking alternatives, but were able to complete the open-ended question approach.

Dentist's preferences for patient characteristics were collected on 37 items using a 5-point Likert scale. These items included the 27 items reported by Rouse and

Hamilton (1991), with the addition of 10 items covering aspects of cost, affordability, dental knowledge and attitudes.

Services provided during a typical day were collected from a one-day log of services which included the item of service and dentist time per item. Service items were recorded using the three-digit coding scheme from the Australian Dental Association's (1992) *Schedule of Dental Services*. The use of service logs has been used previously in the Longitudinal Study of Dentists' Practice Activity (e.g., Spencer and Lewis, 1989a; Spencer, Brennan, and Szuster 1994a, 1994b).

Characteristics of patients treated during the one day service log were recorded at the time of service provision by the responding dentists. These items included age, sex, insurance status, reason for visit, residential postcode, time since last visit, and oral health status. Some of these items (e.g., age, sex, insurance status) have been used previously in the Longitudinal Study of Dentists' Practice Activity (Spencer, Szuster, and Brennan, 1994a; Brennan, Spencer, and Szuster, 1997; 1998a; 1998b). An evaluation of each individual patient was also recorded using a five-point Likert scale using items derived from published research on patient dental values (Weinstein et al., 1979). These items were recorded for up to 18 patients from the service log, this number was increased from 12 to 18 after the pilot study which indicated that 12 may not be sufficient to cover a one day period.

3.3 Sampling

Dentists were sampled at random from the dental registers of each Australian State/Territory. Specialists were excluded where they could be identified from the registers, as were dentists with overseas addresses. Dentists with inter-state addresses were included if they were not also registered in another State/Territory. After excluding specialists and overseas registered dentists from the sampling frame, a sampling rate was calculated to obtain a sample of 1202 dentists, as outlined in Table 3.1 below.

Table 3.1: Sampling details by State/Territory

State/Territory	Number of registered dentists	Exclusions		In-scope frame (registered - exclusions)	Target sample (in-scope frame x 0.135)
		Overseas	Specialist		
New South Wales	3899	197	357	3345	452
Victoria	2357	91	226	2040	275
Queensland	1743	68	159	1516	205
South Australia	768	11	(a)	757	102
Western Australia	890	6	87	797	108
Tasmania	152	3	1	148	20
Australian Capital Territory	208	0	(b)	208	28
Northern Territory	97	5	(b)	92	12
Total	10114	381	830	8903	1202

(a) listed on separate specialist register

(b) specialists not identified on the register

The rationale for this sample size is outlined in Section 3.5 below. The sampling rate was calculated as follows, using the target sample size and the total in-scope frame:

Sampling rate = Target sample / In-scope frame = 1200 / 8903 = 0. 135

For each State/Territory a separate sample was drawn based on the in-scope frame and the overall sampling rate. With rounding this resulted in a total sample of 1202 dentists. The sample reflects the national distribution, with the majority of sampled dentists coming from New South Wales, Victoria, and Queensland.

3.4 Statistical approach

This section looks at the statistical approach adopted for the thesis by reviewing the dependent and independent variables to be used in the analyses, data reduction techniques used to process the independent variables prior to statistical modelling, and finally an outline of the approach to the statistical models.

3.4.1 Dependent and independent variables

The range of data items collected was outlined in the Section 3.2 (Collection instrument and data items). Services collected in the log of a typical clinical day comprise the set of dependent variables which form the basis of the analysis. These service items were collected at the level of individual service items, using the three-digit coding scheme of the Australian Dental Association (1992). Using this coding scheme service items can be aggregated into one of 10 main areas of service as outlined in Table 3.2.

Table 3.2: Dependent variables

Main area of service	ADA codes
Diagnostic	Items 011 - 099
Preventive	Items 111 - 199
Periodontic	Items 211 - 299
Oral surgery	Items 311 - 399
Endodontic	Items 411 - 499
Restorative	Items 511 - 599
Crown and bridge	Items 611 - 699
Prosthodontic	Items 711 - 799
Orthodontic	Items 811 - 899
General/miscellaneous	Items 911 - 979 / 981 - 999

The independent variables used in the analysis can be grouped into categories of dentist and practice characteristics, practice beliefs of dentists, factors influencing treatment choices made by dentists, dentist preferences for patients, patient, visit, and oral health variables, patient evaluation items, and area-based indicators of socio-economic status. This is outlined in Table 3.3.

Table 3.3: Independent variables

Group	Item
Dentist	Age, Sex, Time since graduation
Practice	Practice type, Geographic location, Number of other dentists, Patients per year, Appointment time, Number of staff
Practice beliefs	Battery of 8 items on a 5-point Likert scale
Factors influencing treatment choice	Five ranked opened-ended responses to 6 treatment choices
Dentist preferences for patients	Battery of 37 items on a 5-point Likert scale
Patient	Age, Sex
Visit	Visit type, Insurance, Geographic location, New patient status
Oral health	Dentate status, Dentures, Number of teeth, Decayed teeth
Patient evaluation items	Battery of 5 items on a 5-point Likert scale
Area-based indicators of socio-economic status	Census based index of disadvantage

Dentist and practice characteristics consist of age and sex of dentist, practice type (solo, non-solo), geographic location (capital city, non-capital), years since graduation, and a range of variables relating to their main private practice. These practice variables include percent of time worked at the practice, number of other dentists at the practice, patients per hour treated, hours per year worked, patients per year treated, appointment time, and numbers of chair-side assistants, hygienists, managers, secretaries and other staff.

Practice beliefs of dentists and their preferences for patients were collected using 5-point Likert scales ranging from strongly agree to strongly disagree. Eight practice belief items and 37 dentist preference items were collected. Factors influencing treatment choice were collected from ranked open-ended responses to six treatment choice scenarios.

Patient, visit and oral health variables comprised a set of items collected by dentists during the one-day log of services provided in a typical clinical day. Patient and visit items included age and sex of patient, visit type (emergency, non-emergency), insurance status, patient status (new or previous patient for that dentist), and geographic location of patient (capital city, non-capital) based on their residential postcode. Oral health variables included dentate status (dentate, edentulous), denture status (present, absent), number of teeth, and number of decayed teeth at the start of their current visit.

Patient evaluation items were recorded by dentists for the patients they treated in their log of services provided in a typical clinical day. Responses were recorded on a 5-point Likert scale ranging from strongly agree to strongly disagree for a battery of five items.

Area-based indicators of socio-economic status were matched to the residential postcode of patients treated by dentists during their log of a typical clinical day. The indicator used consisted of the Index of Relative Socio-economic Disadvantage, which is based on data from the 1996 Census of Australia.

3.4.2 Data reduction

Batteries of items were used to collect data on practice beliefs of dentists, dentist preferences for patients, and dentist evaluations of patients. To investigate the inter-relationships of these items and produce a set of independent variables which was both conceptually coherent and parsimonious the items in each battery were subjected to a process of scale development. Scales development is presented in Section 4.5 (Scale development). Briefly, this involves the use of Factor analysis to identify sets of items within each battery which are related and can be used to form scales and sub-scales (Kim and Mueller, 1978; Streiner and Norman, 1995). The scales and sub-scales derived from this process of data reduction will then be used as independent variables in further analysis which deals with factors influencing the provision of services.

A similar data reduction approach will be used to produce a limited number of independent variables from the open-ended treatment choice scenarios. This involves grouping the responses and then using the counts across the treatment scenarios as input into a cluster analysis in order to identify and classify groups of dentists on the basis of their treatment choice responses. Discriminant function analysis will be used as a measure of secondary validity to assess the accuracy of the classification derived from the cluster analysis (Johnson and Wichern, 1988; Romesburg, 1984; SAS, 1988).

In the statistical modelling process the median value of continuous variables will be used as a cut-off point for the coding of dichotomous indicator variables. This was preferred as it provides an objective, empirically based means of coding indicator variables. This avoids arbitrary divisions which may be viewed as capricious post hoc changes. It also results in large numbers in both the reference and indicator variable, and in the case of scale scores helps to avoid potentially small cell sizes which may result from skewed distributions.

To avoid potential problems of multi-collinearity derived variables will be used rather than the component variables on which they were based. For example, patients per year is calculated by multiplying hours per year by patients per hour, with the derived variable, patients per year, being included in further analysis. Similarly, multiple measures such as numbers of non-dentist staff will be combined in an overall count of non-dentist staff rather than use each type of staff member separately.

3.4.3 Statistical models

The general approach to the construction of statistical models follows a sequence of investigating the distributions of both dependent and independent variables. Then the analysis will proceed through statistical testing of bivariate associations of the dependent variables (main areas of service) by the set of independent variables (i.e., dentist, practice, practice belief, treatment choice factors, dentist preferences, patient, visit, oral health, patient evaluation items, and area-based socio-economic status). No adjustment of P-values will be made in the bivariate analysis, but to avoid potential problems associated with multiple comparisons all results, both significant and non-significant, will be presented (Rothman, 1986). Then multivariate models of service provision by the independent variables will follow the bivariate analyses.

Previous analysis of service rates has shown that these variables are typically skewed in their distribution (e.g., Bailit and Clive, 1981; Grembowski, Milgrom and Fiset, 1990a). Poisson models provide a statistical approach which is conducive to applications involving skewed rates. The Poisson distribution is the second most frequently used discrete distribution after the binomial distribution, and is used extensively in applications involving the formulation of probability models for a wide range of situations dealing with counts of rare events (Sahai and Khurshid, 1996). The use of the Poisson distribution for modelling health count data is justified on the basis of the Poisson approximation to the binomial distribution, with the application of the Poisson model indicated when the probability of the health outcome is small in relation to the observation period (Sahai and Khurshid, 1996). A number of phenomena have been observed to fit a Poisson distribution, including such diverse events as deaths by horse kicks, numbers of radioactive decay particles, arrival of patients at a doctor's waiting room, typographical errors, numbers of persons over 100 years old, occurrences of suicides and telephone calls arriving at a switchboard (Selvin, 1996).

The Poisson regression model is considered as a special case of the generalised linear model, with the method of estimation generally based on the maximum likelihood principle. The only real conceptual difference between Poisson regression and standard multiple regression is the assumption of a Poisson rather than a normal distribution, but they both have the same analytic goal of fitting a regression equation with the mean as a function of a set of independent variables (Sahai and Khurshid, 1996). An advantage of the Poisson model is that the regression coefficients not only indicate the direction and magnitude of association between the dependent and independent variable controlling for the other independent variables as is also the case in a standard linear regression model, but in Poisson regression they can be used to derive rate ratios which can be readily interpreted to describe the association. The distribution of the service rates in this thesis will be assessed for their suitability for Poisson modelling.

When the individual liability to an event varies the Poisson model may give a poor fit, and negative binomial models may perform better. For example, Smeeton (1986) found that the distribution of mental illness in general practice had a poor fit to a Poisson model, but a negative binomial model fitted the data very well. In general, recurrent events are considered to be best measured as an event rate, defined as the number of events divided by the observation period, with the Poisson distribution performing more poorly than the negative binomial distribution as the events are more likely to recur in some individuals than in others (Glynn and Buring, 1996). In relation to dental service rates, data are unlikely to be normally distributed because of the long tails and high number of observations clustered at zero. However, the Poisson distribution, which assumes procedures occur independently, may not hold for dental procedures. A negative binomial distribution assumes each person uses procedures with a Poisson distribution, but that each person has a different Poisson parameter (Diehr and Grembowski, 1990). Comparison of fit between Poisson and negative binomial models has been performed using dental service rates from Australian private general practice (Brennan, 1997). Overall, it was found that Poisson models were preferred over negative binomial models for more complex models which had greater numbers of parameters. Since complex multivariate models are the main analytic goal of this thesis, Poisson regression models will be pursued in preference to negative binomial models.

Other approaches have combined linear models in conjunction with Poisson and Logistic models. For example, to model the number of visits over a 12 month period the Poisson model was the preferred option as the data were skewed and in the form of counts for a fixed period of time (Korten et al, 1998). However, multiple linear regression was also used for comparison purposes, as this analytic approach had the advantage of widespread use and ease of interpretation of coefficients. While the Poisson model was taken on statistical grounds as the preferred model for analysis of the volume of services in the population examined by Korten et al. (1998) they found that neither model was preferred over the other in terms of goodness of fit, model diagnostics, outlying observations, and patterns of associations detected. Logistic regression was also used to compare attenders from non-attenders, assuming that different factors may influence initial contact from repeated use of services.

The Poisson model has been widely used for the purposes of making statistical inferences about rates, and particularly in health statistics to model the number of deaths over time (Breslow and Day, 1987). However, in some situations (e.g., where there are a large number of comparison groups) the use of standard regression analysis or their logarithms may be considered a more prudent approach (Breslow and Day, 1987). When the number of deaths is small in comparison to the total cohort size the Poisson model should provide a good approximation to the exact distribution of the rate (Breslow and Day, 1987). While Poisson models will be pursued as the method of choice in this analysis, comparisons with Ordinary Least

Squares and Logistic regression models will also be made, and the stability of the results examined.

3.5 Power and sample size

Sample size estimates were calculated using information available from the Longitudinal Study of Dentists' Practice Activity. These data were used as they provided the most recent national level estimates of service rates in Australian private general practice, as well as being comparable in terms of mode of data collection and likely response. Service rates are the key dependent variables, comprising 10 main areas of service. Numbers of services are divided by the number of patient visits for each dental practitioner to obtain a measure of services per visit, hence the number of visits is the relevant consideration for sample size and statistical power. To estimate the required sample size a series of two-group comparisons were performed using data from the 1993 Longitudinal Study of Dentists' Practice Activity (Brennan, 1997) and *StatCalc* software (Epi-Info) with alpha = 0.05 and power = 0.80 for a range of hypothetical differences measured as rate ratios. Table 3.4 presents the rate per visit for each service area from 1993, and the number of required visits per group for a difference or hypothetical rate ratio.

Based on a similar methodological approach to sampling and data collection as the Longitudinal Study of Dentists' Practice Activity, between 4855 and 8758 patient visits would be expected from a sample of approximately 1200 practitioners (Brennan, 1997). No specific response rate was hypothesised, as the number of patient visits collected was the prime consideration and this could vary according to the number of completed logs and numbers of patient visits per completed log.

Taking the lowest end of the range of patient visits from the Longitudinal Study of Dentists' Practice Activity, (i.e., 4855 patient visits), as a conservative estimate of the projected response would result in a rounded cell size of 2428 patient visits in each of the two groups being compared. This would exceed the calculated required cell sizes, and hence be sufficient to detect differences or rate ratios of: 1.25 in four of the 10 areas of service, rate ratios of 1.50 in eight of the ten areas of service, and rate ratios of 1.75 or greater in all 10 areas of service. This would enable the detection of sensitive differences among those service areas which were provided at the highest rates (e.g., restorative, diagnostic, and preventive services) as well as having adequate power to detect differences likely to be of public health significance (i.e., rate ratios of 1.75+) in all 10 areas of service.

Table 3.4: Required sample sizes for comparisons of service rates based on a range of hypothetical rate ratios

Service areas	Rate per visit	Hypothetical rate ratios			
	1993-94	1.25	1.50	1.75	2.0
		n	n	n	n
Restorative	0.62	149	33	<14	<14
Diagnostic	0.59	173	40	15	<15
Preventive	0.33	561	150	70	41
Endodontic	0.11	2322	650	319	195
Prosthodontic	0.10	2586	725	356	219
Extraction	0.09	2909	817	401	247
Crown & bridge	0.07	3831	1078	532	328
General/Misc.	0.04	6943	1962	971	601
Periodontic	0.02	14356	4023	1996	1239
Orthodontic	0.02	14356	4023	1996	1239

4. Results

This chapter presents details of the response to the data collection, age and sex distributions of responding dentists and sampled patients, descriptive data on distributions and measures of central tendency, and scale development. Inferential statistics are then presented on the associations of services with the set of independent variables spanning dentist, practice, patient and oral health.

4.1 Response

4.1.1 Response by State/Territory

A total of 676 dentists responded to the survey, resulting in a response rate of 60.3%, as presented in Table 4.1. The invalid sample, such as dentists who were excluded from the sample when it was discovered they were working overseas, and dentists who could not be contacted at their registered addresses, were subtracted from the sample to leave the valid sample. The numbers received from the valid sample were used to calculate response rates.

Response rates varied from 57.4% in New South Wales and 57.9% in Victoria, up to 84.6% in Tasmania. The response rates among the remaining States ranged between 61.6% in Queensland and 69.2% in the Australian Capital Territory. In general, response rates were slightly lower in the larger States, but these States contributed the highest numbers of responses to the total.

Table 4.1: Response by State/Territory

State/Territory	Sample	Excluded	Incorrect address	Total invalid	Valid sample	Responded	Percent response
New South Wales	452	3	19	22	430	247	57.4
Victoria	275	7	7	14	261	151	57.9
Queensland	205	2	18	20	185	114	61.6
South Australia	102	1	3	4	98	61	62.2
Western Australia	108	0	8	8	100	69	69.0
Tasmania	20	0	7	7	13	11	84.6
Australian Capital Territory	28	0	2	2	26	18	69.2
Northern Territory	12	1	3	4	8	5	62.5
Total	1202	14	67	81	1121	676	60.3

4.1.2 Response by stage of mailing

Figure 4.1 shows the cumulative response to the survey by stage of mailing over the survey period. The initial questionnaire was mailed out after the primary approach letter (PAL), with a response of 19.0% at the time of the reminder mailing. At five weeks into the survey period a response of 41.1% had been reached, when the first follow-up mailing with replacement questionnaire was sent to dentists who had not yet responded. However, the final response of 60.3% was not achieved until 23 weeks into the survey period. This partly reflects a delay in mailing around weeks 13 and 14 associated with public holidays, but it also highlights the difficulty of achieving high responses in mailed surveys of professionals, even with multiple follow-up mailings.

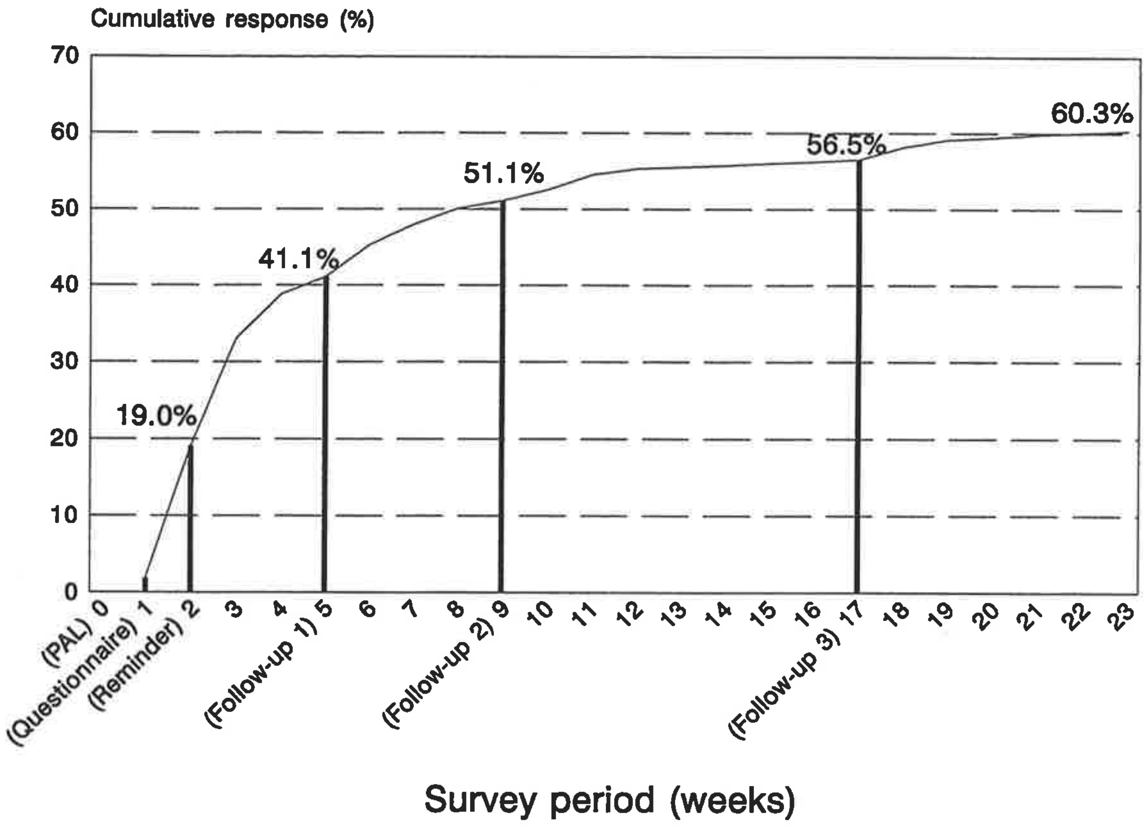


Fig. 4.1: Response by stage of mailing

4.1.3 Response by area of practice and sector

Figure 4.2 shows the numbers of respondents by area of practice and sector. Of the 676 respondents a total of 552 were entered for analysis, with the remainder being excluded for reasons such as ill health or retirement. Of the 552 entered responses, 451 were in general practice. Of the 451 general practitioners, 418 were in the private sector. A total of 407 of the private general practitioners were currently treating patients. Those dentists who were not in general practice, not in the private sector, and not treating patients were sequenced out. Of the 407 private general practitioners currently treating patients, a total of 345 provided service provision data in a log of a typical clinical day, while 62 failed to provide service data (e.g., for reasons such as not having enough time to complete the log).

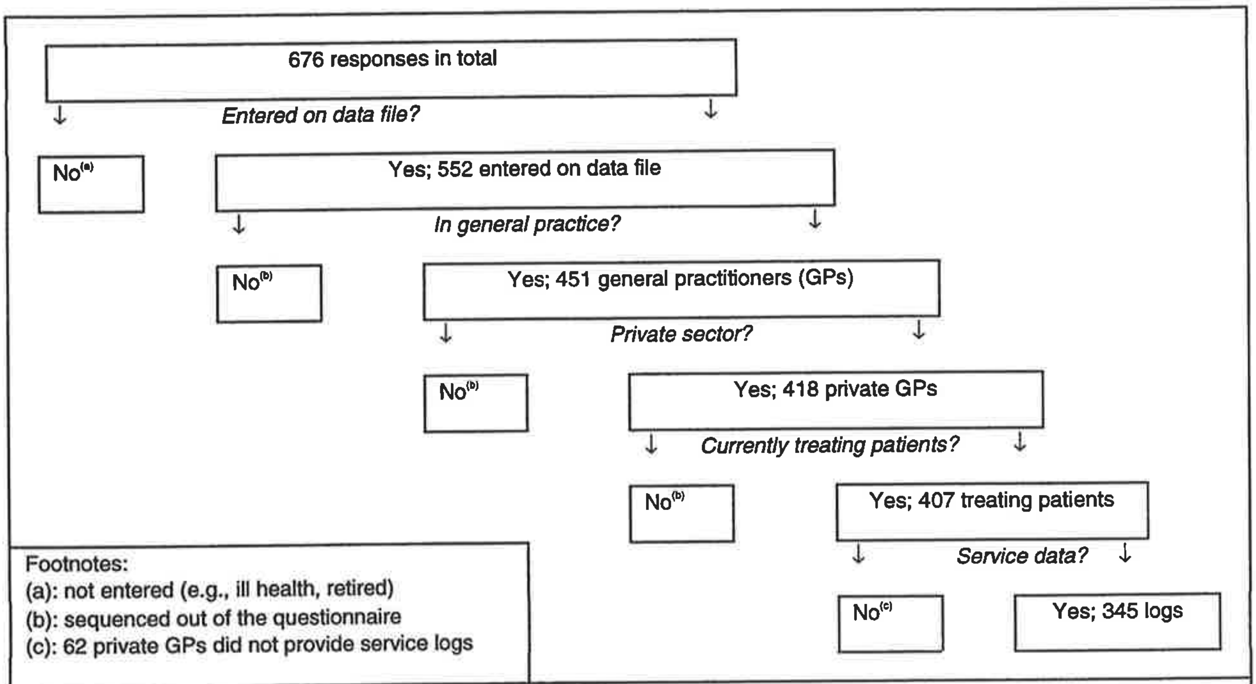


Fig 4.2: Numbers of respondents by area of practice and sector

4.2 Comparison of respondents by service log status

The previous section indicated that 345 dentists who were private general practitioners and currently treating patients provided service provision data from a log of a typical clinical day. In this section, the characteristics of these dentists are compared with the 62 dentists who did not provide service logs to investigate potential bias arising from the failure to provide service provision information.

Table 4.2: Sex, age, practice type and location by service log status

	Service log status		
	Service data	No service data	P (chi-square)
	%	%	
Sex of dentist			
Male	80.0	83.9	0.48
Female	20.0	16.1	
Age of dentist			
20-29 years	13.9	8.3	0.50
30-39 years	27.8	26.7	
40-49 years	29.3	33.3	
50-59 years	18.3	15.0	
60+ years	10.7	16.7	
Practice type			
Solo	51.3	48.3	0.19
Partnership	10.4	18.3	
Associateship	17.7	11.7	
Assistant	17.7	21.7	
Other	2.9	0.0	
Geographic location			
Capital city	84.1	91.5	0.14
Non-capital	15.9	8.5	

Table 4.2 shows there were no significant differences by service log status for sex, age, practice type or location, with the majority of dentists being males, aged 30-39 and 40-49 years, working in solo practices, and located in capital cities.

Table 4.3 indicates that there were no significant differences by service log status by dentist age and years since graduation. Practice characteristics such as percent of time worked and numbers of dentists in the main practice did not vary significantly. Practice activity measures such as patients per hour, hours per year, patients per year and appointment time also did not vary significantly, although the P value for hours per year was marginal. Numbers of support staff measured as full-time equivalents did not vary significantly, with low numbers for each type except for assistants.

Table 4.3: Dentist and practice characteristics by service log status

	Service log status				
	Service data		No Service data		P (t-test)
	Mean	SE	Mean	SE	
Dentist age (years)	43.4	0.6	45.0	1.6	0.32
Years since graduation	19.3	0.6	21.3	1.6	0.22
Percent of time worked [a]	90.6	1.1	84.1	4.1	0.13
Number of other dentists [a]	1.46	0.12	1.59	0.18	0.56
Patients per hour [a]	1.55	0.03	1.59	009	0.60
Hours per year [a]	1788	32	1635	89	0.08
Patients per year [a]	2781	70	2607	196	0.36
Appointment time (days) [a]	7.1	0.5	8.1	1.3	0.48
Assistants (FTE) [a]	1.71	0.10	1.69	0.21	0.96
Hygienists (FTE) [a]	0.08	0.02	0.05	0.02	0.26
Managers (FTE) [a]	0.23	0.02	0.22	0.06	0.83
Secretaries (FTE) [a]	0.62	0.04	0.79	0.14	0.14
Other staff (FTE) [a]	0.06	0.02	0.12	0.10	0.55

(a): in main private practice

(FTE): full-time equivalents based on 38 hours per week

While the relatively small numbers of dentists not providing service logs may work against finding statistically significant results in this comparison with dentists who did provide service data, the trends on the basis of the point estimates indicate there was little difference between the two groups. This suggests the findings for those dentists who supplied service data are not biased compared to those who did not.

4.3 Age and sex distributions: private general practice

This section of the *Results* presents the age and sex distributions of dentists and patients. The remainder of the results are restricted to these dentists, who were treating patients in private general practice, and to the patients treated by these dentists.

4.3.1 Dentist age and sex distribution

Table 4.4 shows that the 345 responding private general practitioners consisted of 276 males (80.0%) and 69 females (20.0%). Overall, the majority of dentists were in the age groups 30-39 (27.8%) and 40-49 (29.3%) years. Male dentists had an older age distribution than females, with higher percentages in the age groups 40-49 years (30.8% *vs* 23.2%), 50-59 years (20.3% *vs* 10.1%), and 60+ years (13.4% *vs* 0.0%).

Table 4.4: Age and sex distribution of responding private general practitioners who provided service provision data and comparative population data on private practitioners

	Responding practitioners						Dentist population data*		
	Sex of dentist						Sex of dentist		
Dentist age	Male		Female		All		Male	Female	All
(years)	n	%	n	%	n	%	%	%	%
20-29	29	10.5	19	27.5	48	13.9	9.4	25.1	12.3
30-39	69	25.0	27	39.1	96	27.8	28.0	42.6	30.7
40-49	85	30.8	16	23.2	101	29.3	29.8	22.0	28.4
50-59	56	20.3	7	10.1	63	18.3	17.6	7.1	15.7
60+	37	13.4	0	0.0	37	10.7	15.1	3.2	12.9
Total	276		69		345				

*From Szuster and Spencer (1997) Dental practitioner statistics, Australia, 1994.

Compared to the age distribution of the dentist population, the responding practitioners had a similar pattern by age. Both distributions were dominated by the 30-39 and 40-49 years age groups, with male dentists having an older distribution compared to female dentists.

4.3.2 Patient age and sex distribution

Table 4.5 shows the age and sex distribution of patients treated by the responding private general practitioners during their log of a typical clinical day. Data were collected from a total of 4115 patients, comprising 1832 males and 2214 females of the 4046 patients with no missing data for age. Overall, there were small percentages of younger patients (aged less than 25 years) and older patients (aged 65+ years). The highest percentages of patients were aged 25-44 years (34.5%) and 45-64 years (30.6%). The age distributions were similar for male and female patients, exhibiting the same pattern by age as for both males and females combined.

Table 4.5: Age and sex distribution of patients treated by responding private general practitioners

	Sex of patient					
	Male		Female		All	
Patient age (years)	n	%	n	%	n	%
<5	24	1.3	13	0.6	37	0.9
5 - 11	151	8.2	142	6.4	293	7.2
12 - 17	131	7.2	171	7.7	302	7.5
18 - 24	122	6.7	178	8.0	300	7.4
25 - 44	606	33.1	788	35.6	1394	34.5
45 - 64	566	30.9	671	30.3	1237	30.6
65+	232	12.7	251	11.3	483	11.9
Known	1832		2214		4046	
Unknown	-		-		69	
Total	-		-		4115	

The obtained sample yield of 4115 patients, based on the calculations of expected sample yield (see Section 3.5 Power and sample size in *Methods*), would be sufficient to detect rate ratios of 1.25 in three service areas, 1.50 in eight service areas, and 1.75 in all 10 service areas.

4.4 Distributions of dependent and independent variables

This section includes descriptive statistics of the distributions of the dependent and independent variables which form the basis of further analysis of service patterns.

4.4.1 Service rates

Table 4.6 presents the distribution of services per visit by main area of service. The distributions reflect both the volume of service provided in different service areas, and the degree of variation in service provision between practitioners. Mean rates of service show that diagnostic, preventive and restorative services dominate the distribution, while periodontic and orthodontic services are provided at low rates in private general practice. This is also reflected in the percentage of patients with greater than zero services per visit. In general, services provided at higher rates had lower skewness values and coefficients of variation. For example, diagnostic services were provided at a rate of 0.650 services per visit and had a skewness of 2.05 and coefficient of variation of 121, compared with orthodontic services which had a rate per visit of 0.021, skewness of 6.86 and coefficient of variation of 684. Therefore, service rates are skewed to a varying extent across different main areas.

Table 4.6: Distribution of services per visit by main area of service

	Mean	Variance	Std Dev	S.E.	Skew	% > 0	CV
Diagnostic	0.650	0.624	0.790	0.012	2.05	50.4	121.46
Preventive	0.379	0.489	0.699	0.011	2.03	27.2	184.67
Periodontic	0.019	0.023	0.152	0.002	9.90	1.7	816.87
Extraction	0.086	0.153	0.391	0.006	10.61	6.8	452.87
Endodontic	0.112	0.210	0.458	0.007	5.28	7.4	408.62
Restorative	0.566	0.986	0.993	0.016	2.84	35.4	175.48
Crown/bridge	0.077	0.133	0.364	0.006	6.50	5.7	471.20
Prosthodontic	0.098	0.285	0.534	0.008	10.41	6.3	545.36
Orthodontic	0.021	0.021	0.146	0.002	6.86	2.1	684.95
General/misc.	0.042	0.050	0.223	0.003	6.17	3.8	530.34
Total services	2.051	1.586	1.259	0.020	2.21	100.0	61.41

Skewed rates may be suitable for Poisson analysis. The mean of a Poisson distribution can be represented by the rate parameter (lambda) and the standard deviation as the square root of lambda (Colton, 1974). Under the assumption of a Poisson distribution the mean equals the variance (i.e., both are represented by the same parameter, lambda). The sample variance divided by the sample mean should be approximately equal to 1.0 for data derived from a random sample from a Poisson distribution (Selvin, 1996). For the data presented here, the orthodontic and diagnostic services are closest to a Poisson distribution, with values of 1.00 and 0.96, while general/miscellaneous, periodontic, preventive and total services per visit are also close to 1.0, with values of 1.19, 1.21, 1.29 and 0.77 respectively. Extraction, endodontic, restorative and crown and bridge had values of the variance divided by the mean which ranged between 1.73 and 1.88, while prosthodontic services with a value of 2.91, varied most from the Poisson assumption. While Poisson regression will be used as the main analytic approach, Ordinary Least Squares and Logistic regression will also be used to assess the stability of results.

4.4.2 Dentist and practice characteristics

Some dentists and practice characteristics were presented in the comparison of practitioners who provided service log data with those who did not (see Section 4.2). These characteristics included both categorical variables (e.g., dentist age, sex, type of practice, and geographic location) and continuous variables. This section further profiles the main continuous variables in terms of their distributions with the aim of using the categorical variables as indicator variables in further analysis. To assist in reducing the data items into a parsimonious set the components used to estimate the number of patient visits per year (i.e., hours per year, patients per hour) are not presented, and the numbers of non-dentist staff (e.g., assistants, receptionists) have been combined into a single count.

Table 4.7: Dentist and patient characteristics: distributions of continuous variables

	Median	% > median
Time since graduation (years)	17.5	50.0
Number of other dentists [(a)]	1	31.9
Patient visits per year [(a)]	2664	50.0
Appointment time (days) [(a)]	4	47.4
Number of non-dentist staff (FTE) [(a)]	2.11	48.0

(a): in main private practice

(FTE): full-time equivalents based on 38 hours per week

The median values provide a convenient cut-off for creating indicator variables. The percentage greater than the median was close to 50% for each variable except the number of other dentists in the main private practice of the responding dentists, indicating the median value spanned a large range which extended beyond the mid-point. However, all variables have sufficient cell numbers above the median to provide adequate numbers for analysis.

4.4.3 Practice beliefs

The distribution of the practice belief items is presented in Table 4.8. These items were derived from published work by Grembowski, Milgrom and Fiset (1988; 1991). Responses were scored from 1 (strongly agree) to 5 (strongly disagree) for each particular item. The direction of responses was reversed for item 6 during subsequent scale development (see Section 4.5 Scale development). Most items were skewed to one end of the distribution, with items 1, 4, 5, 7 and 8 skewed towards 1 (strongly agree) while items 2 and 6 were skewed towards 5 (strongly disagree). Item 3 was not strongly skewed. Only two items (2 and 3) had a percentage greater than 20% for the mid-point response (i.e., 3).

Table 4.8: Distribution of practice belief items

		(a)Distribution of responses (%)							
Item	Description of item	1	2	3	4	5	Skew	Mean	S.E.
1	Plaque control programs are a prerequisite for dental treatment	52.5	26.4	13.8	6.2	1.2	1.16	1.77	0.05
2	The primary focus of dentistry should be directed at controlling active disease rather than developing better preventive advice	4.1	5.6	31.1	36.4	22.9	-0.60	3.68	0.06
3	If a patient disagrees with the dentist's recommended treatment, the dentist should try to convince the patient to accept it	6.7	23.4	33.0	25.4	11.4	-0.01	3.11	0.06
4	Dentists should usually inform patients about the cost of their treatment before the treatment begins	65.6	27.4	5.0	0.6	1.5	2.23	1.45	0.04
5	With the dentist's advice the patient should choose the service	47.1	31.2	17.9	2.1	1.8	1.10	1.80	0.05
6*	If a patient does not accept the dentist's recommended treatment, the patient is dismissed from the practice	2.1	1.5	11.5	31.3	53.7	-1.54	4.33	0.05
7	Dentists should present all treatment options to patients	69.7	23.3	4.1	1.5	1.5	2.41	1.42	0.04
8	Excluding diagnostic & preventive services, all patients should usually know how much their dental treatment will cost them, out-of-pocket, before treatment begins	49.6	34.3	11.7	2.1	2.3	1.46	1.73	0.05

(a) responses were scored from 1 (strongly agree) to 5 (strongly disagree)
*direction reversed in subsequent scale development

4.4.4 Influences on treatment choice

Dentists provided up to five responses which they judged to be important in selecting one of two alternative treatment pair scenarios. This was based on the findings of Grembowski, Milgrom and Fiset (1988), who used the treatment pair scenarios of crown *vs* amalgam, root canal *vs* extraction, bridge *vs* denture, and prophylaxis *vs* scaling, with the addition of two treatment pairs concerning examination *vs* radiograph, and preventive *vs* restorative intervention. The original ordering of responses in presented in Appendix C. Table 4.9 presents the responses ordered into groups.

In total, there were 97 responses to the six treatment pair scenarios. This was more than that obtained by Grembowski, Milgrom and Fiset (1988), who reported responses corresponding to the first 32 responses listed in Appendix C. However, they used four rather than six scenarios, and collected up to three responses per scenario rather than five. Their 32 responses cover 14 of the 21 groups of responses, with no responses in the groups relating to Bite, Diagnosis, Visit history, Treatment history, Prognosis, Fluoride and Choice.

Of the 21 groups of responses, it is also possible to further aggregate these categories into higher conceptual groupings. For example, the categories of Caries, Mouth status, Tooth status, Root status, Denture status, Perio status, and Bite could all be grouped together as an "Oral health" category. The categories of Patient, Experience, and Convenience all relate to "Patient factors", while the categories of Dentist and Choice could be aggregated as "Dentist factors".

Table 4.9: Responses to choice of alternative treatment pairs grouped into categories

Group	Items
Background:	01. Age of patient; 03. Medical history/general health; 33. Dental fear/anxiety; 38. Pregnancy; 63. Diet/lifestyle; 79. Gagging; 88. Occupation/sport; 91. Family history
Caries:	02. Caries rate/risk; 54. Interproximal caries, restorations; 55. Recurrent caries; 84. Arrested caries
Mouth status:	04. Number of missing teeth; 24. Oral hygiene status; 51. Rest of dentition/proximal teeth; 74. Overall status of mouth/extent of other treatment needed
Tooth status:	05. Alignment/tooth anatomy; 06. Extent of tooth damage; 12. Duration/type of infection; 44. Suitability for restoration/ pre-existing filling/ fracture; 45. Role in occlusion/ function/ avoiding dentures; 50. Size of lesion/ amount of healthy tooth/ vitality; 52.Which tooth/tooth position; 67. Number of proximal contacts
Root status:	09. Root caries/condition; 10. Pulp status/sensitivity; 11. Anatomy/difficulty of canals; 58. Duration of root canal; 64. Root filled/ treated; 75. Future/past need for root canal treatment; 80. Root sensitivity
Denture status:	13. Existing partial denture; 14. Abutment contours/tipping; 15. Length of edentulous span; 16. Abutment strength/condition; 17. Soft tissue contours/damage; 47. Abutment length; 77. Whether abutment for partial denture; 83. Too heavy for temporary bridge
Perio status:	18. Extent of calculus; 19. Periodontal status/pocket depth; 20. Tooth mobility; 21. Gingival status/bleeding
Bite:	43. Heavy bite; 46. Bite/occlusal force/abrasion problems/retained food particles
Diagnosis:	39. Colour change/staining; 40. X-ray evidence; 41. Probe/penetration/sticking; 49. Visible caries/clinical appearance; 70. Density of enamel/presence of fillings; 73. Ability to view/accuracy of diagnosis; 81. No need for panoramic of other teeth; 94. Salivary flow; 95. Vitality test
Visit history:	35. My records/availability of x-ray/legal record; 37. Time since last x-ray/check-up/visit; 61. Dental treatment history; 62. Time since last perio treatment/exam; 97. Public or private patient
Treatment history:	42. Previous endo treatment; 48. Number of fillings, crowns, implants/age of fillings; 96. Fissure seals present
Treatment constraints:	22. Preparation for other procedures/need for other treatment; 29. Cost to patient/affordability; 34. Aesthetics; 66. Time/urgency; 71. Potential problems/difficulty with alternatives; 82. Access to equipment (e.g., micro-abrasive); 87. Access/ease of treatment
Pain:	30. Pain control/comfort; 32. Need for anaesthesia; 36. Toothache; 60. Symptoms/pain
Prognosis:	53. Tooth prognosis/serviceability in the long term; 56. Longevity of restoration; 59. Probability of root canal success; 68. Longer lasting; 72. Nerve prognosis; 85. Need for strength
Plans:	07. Future plans for tooth/treatment plan; 57. Future plans (partial or bridge)
Fluoride:	69. Fluoride applications; 86. Fluoride history
Patient:	23. Patient preference/approval/acceptance of potential difficulties; 25. Patients ability to tolerate procedure/ co-operate; 65. Patient motivation/ dental IQ/ recall compliance
Experience:	26. Patient previous experience with similar procedures; 31. Patients ability to tolerate prosthesis/type of partial
Convenience:	27. Convenience to patient; 28. Number of appointments
Dentist:	08. Ability of dentist/philosophy of dentist; 76. Need for specialist; 78. Practice profit/ time-money ratio/ convenience to dentist; 89. Radiation to dentist
Choice:	90. None/always do the latter alternative; 92. None/always do first alternative; 93. Do neither alternative/both

Table 4.10 presents the percentage of responses influencing choice of a visual examination only versus a radiograph as a diagnostic aid for a posterior tooth.

Percentages are presented for the first to the fifth most important responses, and for the sum of percentages across each row. Overall, the sum of percentages indicate that there were three main groups of responses across the five listed, these were background, caries, and visit history. There were also four secondary groups of responses ranked below the first three, these were treatment constraints, patient, mouth status and diagnosis. Among the three top-ranked groups of responses, caries tended to dominate as the first most important response, while visit history had the highest percentage of the second response, and background accounted for a large percentage of the third to fifth responses.

Table 4.10: Percentage of responses influencing treatment choice: examination versus radiograph

Group	1st response	2nd response	3rd response	4th response	5th response	Sum of %s
Background	9.5	15.8	22.5	17.9	19.6	85.3
Caries	43.9	17.6	11.8	5.7	3.6	82.6
Mouth status	5.5	10.2	7.6	7.1	4.5	34.9
Tooth status	2.1	3.4	0.7	1.9	0.9	9.0
Root status	0.3	4.0	2.8	6.6	7.1	20.8
Denture status	-	-	-	-	0.9	0.9
Perio status	0.6	2.5	6.2	2.8	3.6	15.7
Bite	-	-	0.3	-	-	0.3
Diagnosis	10.1	5.0	5.9	9.4	3.6	34.0
Visit history	15.2	22.6	12.8	10.8	6.3	67.7
Treatment history	0.9	4.3	4.2	1.9	3.6	14.9
Treatment constraints	1.2	5.9	9.0	14.2	16.1	46.4
Pain	4.3	4.0	2.8	6.6	5.4	23.1
Prognosis	-	-	0.3	-	-	0.3
Plans	0.3	0.6	0.3	0.9	-	2.1
Fluoride	0.3	-	0.3	-	1.8	2.4
Patient	3.7	3.1	8.7	8.5	17.9	41.9
Experience	-	-	-	-	-	-
Convenience	0.9	0.9	3.8	4.2	2.7	12.5
Dentist	0.3	-	-	1.4	2.7	4.4
Choice	0.9	-	-	-	-	0.9

Table 4.11 presents the percentage of responses influencing choice of a preventive intervention versus a restoration for an initial carious lesion in an occlusal surface of a posterior tooth. Overall, across the five responses there were two groups which dominated, these were patient and background responses. Caries, mouth status, and treatment constraints formed a set of second-ranked groups of responses, with pain and visit history comprising a set of third-ranked responses. While patient responses were the highest ranked group overall, background and caries responses had high percentages among the first to third responses, with responses in the patient group having high percentages among the fourth and fifth responses.

Table 4.11: Percentage of responses influencing treatment choice: prevention versus restoration

Group	1st response	2nd response	3rd response	4th response	5th response	Sum of %s
Background	32.9	24.1	20.1	10.3	5.8	93.2
Caries	25.5	14.2	9.7	7.5	1.2	58.1
Mouth status	7.4	19.8	14.3	10.9	7.0	59.4
Tooth status	8.0	3.3	5.0	2.9	1.2	20.4
Root status	-	-	-	-	-	-
Denture status	-	-	-	-	-	-
Perio status	-	0.3	-	0.6	-	0.9
Bite	-	0.3	-	0.6	-	0.9
Diagnosis	4.3	4.6	3.9	4.0	7.0	23.8
Visit history	5.2	4.0	8.9	8.0	8.1	34.2
Treatment history	-	0.3	1.5	1.7	-	3.5
Treatment constraints	1.8	5.9	10.8	16.7	19.8	55.0
Pain	7.1	8.9	6.9	7.5	8.1	38.5
Prognosis	0.3	-	0.8	0.6	1.2	2.7
Plans	-	0.3	-	0.6	2.3	3.2
Fluoride	-	-	1.9	0.6	1.2	3.7
Patient	4.6	13.2	15.4	27.0	36.0	96.2
Experience	-	-	-	-	-	-
Convenience	-	0.3	-	-	-	0.3
Dentist	0.3	0.3	0.8	0.6	1.2	3.2
Choice	2.5	-	-	-	-	2.5

Table 4.12 presents the percentage of responses influencing choice of a crown versus an amalgam or composite build-up on a posterior tooth. The overall percentages across the five responses were dominated by two groups, these were treatment constraints and tooth status. A set of second-ranked groups of responses with much lower percentages than the first set were comprised of the groups of patient, plans, prognosis and mouth status responses. Among the first-ranked set of responses, tooth status comprised a higher percentage of the first response, but treatment constraints had higher percentages among the third to fifth responses.

Table 4.12: Percentage of responses influencing treatment choice: crown versus amalgam or composite

Group	1st response	2nd response	3rd response	4th response	5th response	Sum of %s
Background	1.8	3.5	3.5	2.6	0.8	12.2
Caries	2.1	2.2	2.4	1.3	3.2	11.2
Mouth status	4.2	7.2	7.3	5.6	8.0	32.3
Tooth status	57.3	26.1	15.3	17.7	17.6	134.0
Root status	2.1	3.5	4.2	2.2	1.6	13.6
Denture status	-	-	1.4	1.3	-	2.7
Perio status	0.3	2.5	4.9	5.6	1.6	14.9
Bite	2.1	4.7	4.2	2.2	4.0	17.2
Diagnosis	-	-	-	-	-	-
Visit history	1.2	1.6	1.7	0.9	2.4	7.8
Treatment history	0.3	0.9	-	-		1.2
Treatment constraints	17.3	28.0	30.6	28.1	37.6	141.6
Pain	-	0.6	-	-	-	0.6
Prognosis	3.9	6.0	7.3	6.5	6.4	30.1
Plans	2.4	7.2	9.4	13.0	6.4	38.4
Fluoride	-	-	-	-	-	-
Patient	3.3	5.7	6.6	13.0	10.4	39.0
Experience	-	-	-	-	-	-
Convenience	0.3	-	-	-	-	0.3
Dentist	-	0.3	1.4	-	-	1.7
Choice	1.2	-	-	-	-	1.2

Table 4.13 presents the percentage of responses influencing choice of root canal therapy versus an extraction of a posterior tooth. Overall across the five responses, treatment constraints comprised the highest ranked group of responses, with tooth status ranked second, and the set of patient, root status, mouth status and caries comprising a third-ranked set of response groups. While responses in the treatment constraints group were highest overall they tended to comprise a higher percentage of the third to fifth responses, with the tooth status group comprising the highest percentage among the first response.

Table 4.13: Percentage of responses influencing treatment choice: root canal therapy versus extraction

Group	1st response	2nd response	3rd response	4th response	5th response	Sum of %s
Background	1.2	2.2	1.7	5.7	3.3	14.1
Caries	11.2	6.9	4.7	4.9	6.0	33.7
Mouth status	10.6	10.3	11.0	6.5	4.0	42.4
Tooth status	32.8	19.0	13.0	14.2	11.9	90.9
Root status	3.6	8.1	13.7	13.0	11.9	50.3
Denture status	-	0.6	-	0.8	2.6	4.0
Perio status	1.5	6.2	7.4	1.6	3.3	20.0
Bite	0.3	0.3	-	0.4	-	1.0
Diagnosis	-	-	-	-	-	-
Visit history	1.2	0.3	-	0.8	0.7	3.0
Treatment history	-	-	-	-	0.7	0.7
Treatment constraints	10.9	19.9	20.4	27.6	28.5	107.3
Pain	-	2.2	1.3	0.8	-	4.3
Prognosis	8.5	6.9	5.7	4.5	2.0	27.6
Plans	0.6	2.2	2.3	2.0	2.6	9.7
Fluoride	-	-	-	-	-	-
Patient	16.1	10.9	11.7	9.3	10.6	58.6
Experience	-	-	-	-	-	-
Convenience	-	0.6	3.0	4.1	5.3	13.0
Dentist	0.9	3.4	4.0	3.7	6.6	18.6
Choice	0.3	-	-	-	-	0.3

Table 4.14 presents the percentage of responses influencing choice of a fixed bridge versus a removable partial denture for a missing anterior tooth. Overall across the five responses, denture status was ranked the highest group, treatment constraints were ranked second, and the set of mouth status, periodontal status and patient responses comprised a third-ranked set of groups. Denture status tended to dominate as a high percentage of all five responses, although treatment constraints also comprised a high percentage of the fourth and fifth responses.

Table 4.14: Percentage of responses influencing treatment choice: fixed bridge versus partial denture

Group	1st response	2nd response	3rd response	4th response	5th response	Sum of %s
Background	2.4	2.2	3.6	1.6	2.4	12.2
Caries	0.6	3.4	2.3	2.4	0.6	9.3
Mouth status	11.2	9.9	12.1	11.6	7.1	51.9
Tooth status	2.1	5.2	2.9	5.6	4.7	20.5
Root status	-	0.9	0.3	-	0.6	1.8
Denture status	22.2	33.6	33.3	37.5	25.4	152.0
Perio status	25.2	15.7	14.4	2.8	3.6	61.7
Bite	0.3	0.6	1.0	2.4	1.8	6.1
Diagnosis	-	-	-	0.4	-	0.4
Visit history	0.6	0.6	0.7	0.8	-	2.7
Treatment history	-	-	0.7	-	-	0.7
Treatment constraints	17.3	16.4	19.3	23.5	34.3	110.8
Pain	0.6	-	1.0	0.4	0.6	2.6
Prognosis	2.7	3.1	-	0.8	0.6	7.2
Plans	0.3	0.3	0.3	0.8	0.6	2.3
Fluoride	-	-	-	-	-	-
Patient	11.2	5.9	6.9	9.2	15.4	48.6
Experience	1.5	0.9	0.3	0.4	1.8	4.9
Convenience	-	0.9	0.3	-	-	1.2
Dentist	0.3	0.3	0.7	-	0.6	1.9
Choice	1.2	-	-	-	-	1.2

Table 4.15 presents the percentage of responses influencing choice of prophylaxis (mechanical cleaning) versus subgingival curettage or periodontal scaling. Periodontal status was the highest ranked group across the five responses, with the second-ranked group of mouth status having a much lower percentage across the five responses, and patient and tooth status response groups were lower again, comprising a set of third-ranked groups of responses. Periodontal status tended to dominate as the highest percentage among each of the five responses.

Table 4.15: Percentage of responses influencing treatment choice: prophylaxis versus curettage or scaling

Group	1st response	2nd response	3rd response	4th response	5th response	Sum of %s
Background	2.5	4.1	4.2	6.0	12.5	29.3
Caries	-	0.3	-	-	-	0.3
Mouth status	9.6	18.3	21.3	18.0	5.6	72.8
Tooth status	2.5	5.4	7.1	12.0	18.1	45.1
Root status	-	0.7	-	0.7	-	1.4
Denture status	-	-	-	-	-	-
Perio status	76.4	54.9	41.3	33.3	34.7	240.6
Bite	-	-	-	-	-	-
Diagnosis	0.6	0.7	0.8	0.7	1.4	4.2
Visit history	1.6	1.0	2.1	4.0	4.2	12.9
Treatment history	-	-	-	-	-	-
Treatment constraints	1.2	0.7	2.9	3.3	6.9	15.0
Pain	1.2	2.7	1.7	3.3	1.4	10.3
Prognosis	0.3	0.7	0.8	4.7	1.4	7.9
Plans	-	0.3	-	-	-	0.3
Fluoride	-	-	-	-	-	-
Patient	2.5	10.2	15.4	12.0	11.1	51.2
Experience	-	-	0.4	0.7	-	1.1
Convenience	-	-	-	-	1.4	1.4
Dentist	0.6	-	2.1	1.3	1.4	5.4
Choice	0.9	-	-	-	-	0.9

Table 4.16 presents the percentage of responses influencing treatment choice across the five responses combined for each of the six alternative treatment pair scenarios, and also for the responses combined across each of the six scenarios. Within each of the scenarios, there tended to be a limited set of response groups which accounted for a large proportion of the cumulative percentage.

Pair 1 (the examination versus radiograph scenario) was dominated by responses in the background (16.4%), caries (19.9%) and visit history (15.0%) groups, which together accounted for just over 50% of the responses. For pair 2 (preventive versus restorative care) background (22.2%), patient factors (15.1%) and caries (14.4%) accounted for 51.7% of the total. For pair 3 (crown versus amalgam) tooth status (29.3%) and treatment constraints (26.8%) accounted for 56.1% of the total. For pair 4 (root canal therapy versus extraction) treatment constraints (20.2%), tooth status (19.4%) and patient factors (12.0%) accounted for 51.6% of the total. For pair 5 (bridge versus denture) denture status (30.5%) and treatment constraints (20.7%) accounted for 51.2% of the total. For pair 6 (prophylaxis versus scaling) periodontal status accounted for 53.9% of the total. Similarly, across all six scenarios the response groups of mouth status (10.1%), tooth status (11.3%), periodontal status (12.1%) and treatment constraints (15.0%) accounted for 48.5% of the total responses.

Table 4.16: Percentage of responses influencing treatment alternatives

Group	Pair 1: Exam vs xray	Pair 2: Preventive vs restorative	Pair 3: Crown vs amalgam	Pair 4: Root canal vs extraction	Pair 5: Bridge vs denture	Pair 6: Prophy vs scaling	All (pairs 1-6)
Background	16.4	22.2	2.6	2.6	2.5	4.5	8.2
Caries	19.9	14.4	2.2	7.0	2.0	0.1	7.5
Mouth status	7.4	12.7	6.3	9.1	10.7	15.5	10.1
Tooth status	2.0	4.8	29.3	19.4	4.0	6.7	11.3
Root status	3.5	0.0	2.9	9.6	0.4	0.3	2.9
Denture status	0.1	0.0	0.5	0.6	30.5	0.0	5.8
Perio status	3.0	0.2	2.9	4.2	13.9	53.9	12.1
Bite	0.1	0.2	3.4	0.2	1.1	0.0	0.9
Diagnosis	7.1	4.5	0.0	0.0	0.1	0.7	2.0
Visit history	15.0	6.4	1.5	0.6	0.6	2.0	4.3
Treatment history	2.9	0.7	0.3	0.1	0.2	0.0	0.7
Treatment constraints	7.7	8.5	26.8	20.2	20.7	2.1	15.0
Pain	4.4	7.7	0.2	1.0	0.5	2.0	2.5
Prognosis	0.1	0.4	5.9	6.0	1.6	1.2	2.6
Plans	0.5	0.4	7.4	1.9	0.4	0.1	1.8
Fluoride	0.3	0.6	0.0	0.0	0.0	0.0	0.2
Patient	6.7	15.1	7.0	12.0	9.1	9.4	9.8
Experience	0.0	0.0	0.0	0.0	0.9	0.2	0.2
Convenience	2.3	0.1	0.1	2.2	0.3	0.1	0.9
Dentist	0.6	0.5	0.4	3.3	0.4	0.9	1.0
Choice	0.2	0.7	0.3	0.1	0.3	0.3	0.3

Table 4.17 presents individual responses for items with distributions of greater than 10% in any of the five responses influencing choice of treatment in the six treatment pair scenarios. The shading indicates there was a high response for that item (i.e., greater than 10%) for that treatment pair scenario. There were 19 items with loadings over 10% for at least one of the five responses influencing the choice of treatment within that pair. Most response items loaded heavily on only one scenario, with the exceptions being six of the first seven items. The "cost" item loaded on five of the six

scenarios, the "caries" item loaded on three scenarios, and the "patient preference" item loaded on four scenarios. This resulted in their accounting for a high percentage of the total across all five responses of the combined six scenarios. The first eight response items comprised over 50% of the cumulative percentage.

Table 4.17: Items greater than 10% in any one of the five responses influencing choice of treatment in the treatment pair scenarios

Response item	Percent of total	Cum. percent	Pair 1: Exam *vs* xray	Pair 2: Prevent. *vs* restorat.	Pair 3: Crown *vs* amalgam	Pair 4: Root canal *vs* extract.	Pair 5: Bridge *vs* denture	Pair 6: Prophy *vs* scaling
Cost to patient/affordability	12.1	12.1						
Caries rate/risk	7.4	19.5						
Patient preference/approval	6.9	26.4						
Periodontal status/pockets	6.4	32.8						
Oral hygiene status	5.8	38.6						
Age of patient	5.5	44.1						
Extent of tooth damage	4.0	48.1						
Role in occlusion/function	3.3	51.4						
Extent of calculus	2.8	54.2						
Abutment strength/condition	2.7	56.9						
Time since last xray/checkup/visit	2.5	59.4						
Future plans/treatment plan	1.8	61.2						
Medical history/general health	1.8	63.0						
Gingival status/bleeding	1.7	64.7						
Length of edentulous span	1.5	66.2						
Anatomy/difficulty of canals	1.3	67.5						
Tooth mobility	1.3	68.8						
Existing partial denture	1.1	69.9						
Duration/type of infection	0.9	70.8						

Treatment choice was analysed further to derive clusters of dentists based on counts of their responses to the treatment choice scenarios (see Section 4.6 Treatment choice clusters) for use as an independent variable in models of service provision.

4.4.5 Dentist preferences for patients

The distribution of the items concerning dentist preferences for patients is presented in Table 4.18. Items were based on the findings of Rouse and Hamilton (1991). Responses were scored from 1 (strongly agree) to 5 (strongly disagree) for each particular item. The direction of responses was reversed for items 14, 17, 21, 26, 33 and 35 during subsequent scale development (see Section 4.5 Scale development). These items were all skewed towards 5 (strongly disagree), with items 33 and 35 also having a substantial percentage (i.e., great than 20%) of responses with a value of 3 (mid-point). Most of the remaining items were skewed towards 1 (strongly agree), with items 2, 8, 10, 13, 20, 22, 25, 27, 28 and 30 also having greater than 20% of responses with a value of 3 (mid-point). Items 12, 24 and 29 had over 40% of responses with a value of 3 (mid-point). Item 18 showed a bi-modal trend, with a high percentage of responses at both 3 (mid-point) and 5 (strongly disagree).

Table 4.18: Distribution of dentist preference for patients items

Item	Description of item "I prefer patients ...."	(a)Distribution of responses (%) 1	2	3	4	5	Skew	Mean	S.E.
1	who come in at recall	55.6	28.9	12.0	2.6	0.9	1.35	1.64	0.05
2	who are emotionally secure	37.6	31.5	25.7	4.4	0.9	0.58	1.99	0.05
3	who co-operate with me	57.1	35.0	6.8	0.9	0.3	1.33	1.52	0.04
4	who are content with the service provided	62.1	30.3	6.1	1.2	0.3	1.57	1.47	0.04
5	who are patient	44.0	37.0	16.6	1.7	0.6	0.87	1.78	0.05
6	who are polite	54.8	34.7	9.3	0.9	0.3	1.18	1.57	0.04
7	who are on time for appointments	67.9	28.9	2.6	0.0	0.6	2.08	1.36	0.03
8	who are warm	36.2	34.1	26.2	2.0	1.5	0.65	1.99	0.05
9	who respect my opinion	50.0	35.1	13.7	0.9	0.3	0.93	1.66	0.04
10	who are sociable	28.1	36.0	28.9	5.3	1.8	0.51	2.17	0.05
11	who maintain their oral health	64.1	27.4	5.2	2.3	0.9	1.95	1.48	0.04
12	who are charming	16.0	22.7	41.7	13.7	5.8	0.11	2.71	0.06
13	who accept my treatment plans	34.1	35.3	26.8	2.9	0.9	0.51	2.01	0.05
14*	to be late for appointments	1.5	0.6	2.6	12.8	82.6	-3.51	4.74	0.04
15	who are thankful for care provided	47.5	33.5	16.9	1.7	0.3	0.84	1.74	0.04
16	who trust me	61.5	31.5	5.8	0.9	0.3	1.52	1.47	0.04
17*	to not respect my opinion	1.7	2.6	4.7	12.5	78.4	-2.63	4.63	0.05
18	who are attractive	6.2	10.3	36.1	17.6	29.9	-0.31	3.55	0.06
19	to be manageable in the dental surgery	44.2	38.6	14.6	2.0	0.6	0.95	1.76	0.04
20	to be cheerful	29.2	36.7	29.7	2.9	1.5	0.49	2.11	0.05
21*	who have negative attitudes about oral health	1.5	0.6	5.2	23.0	69.8	-2.38	4.59	0.04
22	who are kind	25.1	28.0	37.8	5.9	3.2	0.35	2.34	0.06
23	who give 24-hour notice when cancelling an appointment	59.5	30.6	7.0	1.5	1.5	1.84	1.55	0.04
24	who are self-confident	11.7	23.7	50.3	10.2	4.1	0.05	2.71	0.05
25	who are fun to work with	33.8	29.1	30.6	4.4	2.1	0.53	2.12	0.05
26*	not to come in at recall	0.3	0.6	3.2	18.9	77.0	-2.48	4.72	0.03
27	who are interpersonally responsive	22.3	41.2	29.1	5.9	1.5	0.47	2.23	0.05
28	who are able to afford optimal treatment	30.6	30.9	30.6	4.1	3.8	0.64	2.20	0.06
29	who have private insurance	11.4	16.7	45.3	13.2	13.5	0.07	3.01	0.06
30	who have a good dental knowledge	19.0	31.8	39.1	7.3	2.9	0.28	2.43	0.05
31	who follow instructions (e.g., for home care, other procedures)	56.9	36.3	6.2	0.3	0.3	1.25	1.51	0.04
32	who are willing to pay for recommended optimal care	43.9	38.3	16.1	1.5	0.3	0.77	1.76	0.04
33*	who present significant problems to providing good dental care	2.3	5.5	34.4	27.4	30.3	-0.40	3.78	0.06
34	who value good dental care	69.4	26.8	2.9	0.6	0.3	1.97	1.36	0.03
35*	who are anxious	0.6	2.3	26.1	36.4	34.6	-0.47	4.02	0.05
36	who appreciate the need for preventive care	58.7	31.7	8.7	0.3	0.6	1.43	1.52	0.04
37	who are relaxed	47.1	35.2	16.0	1.5	0.3	0.84	1.73	0.04

(a) responses were scored from 1 (strongly agree) to 5 (strongly disagree)
*direction reversed in subsequent scale development

4.4.6 Patient, visit and oral health variables

This section provides the distributions of patient, visit and oral health variables collected through the service log. These variables will be used as independent variables in further analysis of service rates. Table 4.19 presents distributions of patient and visit characteristics by age of patient. Overall, there was a slightly higher percentage of female patients compared to males, approximately one fifth of visits were for emergency care, just over half the patients had dental insurance, the majority of patients were not new to the dentist, and over two thirds of patients were from capital city locations.

Table 4.19: Distributions of patient and visit characteristics

	Age of patient (years)							
	<5	5-11	12-17	18-24	25-44	45-64	65+	All
	Column percentages							
Sex of patient								
Male	64.9	51.5	43.4	40.7	43.5	45.8	48.0	45.2
Female	35.1	48.5	56.6	59.3	56.5	54.2	52.0	54.8
Visit type								
Emergency	8.1	12.2	6.2	21.9	26.3	25.0	18.0	21.8
Non-emergency	91.9	87.8	93.8	78.1	73.7	75.0	82.1	78.2
Insurance status								
Insured	48.5	57.4	63.8	36.0	45.9	59.4	52.3	52.2
Uninsured	51.5	42.7	36.2	64.0	54.1	40.6	47.7	47.8
Patient status								
New	47.1	20.5	10.5	20.1	15.9	9.2	10.6	13.8
Previous	52.9	79.5	89.5	79.9	84.1	90.8	89.5	86.2
Geographic location								
Capital city	50.0	59.3	67.0	74.3	71.6	73.7	65.9	70.5
Non-capital	50.0	40.7	33.0	25.7	28.4	26.3	34.1	29.5
Age (row percent)	0.9	7.3	7.5	7.4	34.4	30.6	12.0	-

Table 4.20 shows dentate status of patients who were aged 18 years or more. Overall, the majority of patients were dentate, with only a small percentage of patients being edentulous. The percentage of edentulous patients increased across older age groups.

Table 4.20: Dentate status by age among patients aged 18 years or more

	Age of patient (years)				
	18-24	25-44	45-64	65+	All
	Column percentages				
Dentate status					
Dentate	100.0	99.7	97.8	91.4	97.9
Edentulous	0.0	0.3	2.2	8.6	2.1

Oral health status variables are presented in Table 4.21 for dentate adults. Just over one fifth of patients had a denture (either partial or full, in either the upper or lower jaw). Approximately one third of patients combined had between 1-20 and 21-24 teeth. Just over one half of patients combined had some decayed teeth (i.e., between 1-4 and 5+ decayed teeth) with approximately 10% of patients having 5 or more decayed teeth.

Table 4.21: Oral health status by age among dentate patients aged 18 years or more

	Age of patient (years)				
	18-24	25-44	45-64	65+	All
	Column percentages				
Denture status					
Present	3.3	7.3	28.5	59.6	21.7
Absent	96.7	92.7	71.5	40.4	78.3
Number of teeth					
1-20 teeth	0.7	4.6	24.3	56.9	18.3
21-24 teeth	6.6	10.4	20.4	20.5	15.0
25-28 teeth	53.1	54.6	42.2	18.8	45.2
29-32 teeth	39.6	30.4	13.2	3.8	21.4
Decayed teeth					
No decay	50.6	42.4	49.8	56.2	47.7
1-4 decayed	36.4	44.0	42.3	36.6	41.7
5+ decayed	13.1	13.6	7.9	7.3	10.6

4.4.7 Patient evaluation items

The distribution of the patient evaluation items is presented in Table 4.22. Items were based on the findings of Weinstein et al. (1979). Responses were scored from 1 (strongly agree) to 5 (strongly disagree) for each particular item. The direction of responses was reversed for item 3 during subsequent scale development (see section 4.5 Scale development). All items, except item 3, were skewed towards 1 (strongly agree). However, all five items had a substantial percentage of responses (i.e., greater than 20%) with a value of 3 (mid-point).

Table 4.22: Distribution of patient evaluation items

Item	Description of item	(a)Distribution of responses (%)					Skew	Mean	S.E.
		1	2	3	4	5			
1	Does this patient have a good dental knowledge?	13.4	30.4	30.9	17.0	8.3	0.26	2.76	0.02
2	Does this patient follow your instructions? (e.g., concerning home care or other recommended procedures)	21.9	32.7	29.1	11.5	4.8	0.45	2.44	0.02
3*	Does this patient present any significant problems that create obstacles to providing good dental care?	8.1	12.7	21.8	28.3	29.1	-0.54	3.58	0.02
4	Is this patient willing to pay for recommended optimal care?	34.4	31.3	21.1	9.1	4.0	0.74	2.17	0.02
5	Is this patient financially able to pay for recommended optimal care?	33.3	31.2	22.8	8.4	4.3	0.72	2.19	0.02

(a) responses were scored from 1 (strongly agree) to 5 (strongly disagree)
*direction reversed in subsequent scale development

4.4.8 Area-based indicators of socio-economic status

This section presents the distribution of an area-based indicator of socio-economic status. The indicator consists of the Index of Relative Socio-economic Disadvantage from the Socio-economic indexes for areas (SEIFA) database produced by the Australia Bureau of Statistics (1993a). These were first produced in their present form in 1990 using data from the 1971 Census. The Index of Relative Socio-economic Disadvantage summarises variables related to the economic resources of households, education and occupation, with a focus on attributes such as low income, low educational attainment and high unemployment.

A higher score on the Index of Relative Socio-economic Disadvantage suggests that the area has fewer families of low income, fewer people with little training and fewer people in unskilled occupations. Lower scores indicate the area has more low income families, more people with little training, and more in unskilled occupations. The smallest area for which an index is available is the Collection District (CD), which is roughly equivalent to a small group of suburban blocks (e.g., an average of about 250 dwellings in urban areas). Each index is designed to have an average score across all CDs in Australia of 1000 with a standard deviation of 100 index points. Based on the scores for CDs, scores are also available for aggregated geographical areas such as postcodes. The index scores of postcodes are formed by taking the weighted average of index values of the CDs in the postcode area (Australian Bureau of Statistics, 1993a).

The residential postcode of patients treated by dentists during their service log was used to match with the Index of Relative Socio-economic Disadvantage in order to provide a measure of socio-economic status. This provides a measure of the socio-economic status of the geographical area in which the patient resides, based on data from the 1996 Census of Australia.

The distribution of the index scores are presented in Table 4.23. The mean for the sample was slightly above the average across all CDs in Australia. The median was similar to the mean. When coded as an indicator variable for later use in multivariate models by dividing patients on the basis of index scores less than or equal to the median and those above the median, there was a relatively even distribution of patients in both groups, with 46.7% of patients being above the median index score.

Table 4.23: Distribution of the Index of Relative Socio-economic Disadvantage

	Mean	S.E.	Median	% > median
Index	1029	1.16	1026	46.7

Table 4.24 presents mean index scores by patient and visit characteristics. Overall, there was little difference between index scores for male and female patients, but index scores tended to be slightly lower (i.e., lower SES) for emergency visits, uninsured patients and new patients, and there was a larger difference by location, with lower scores for non-capital locations. These relationships were observed consistently across most age groups of patients, with the exceptions to the trends occurring for the group of patients aged less than five years, which comprised only a small number of the total group of patients.

Table 4.24: Mean index scores by patient and visit characteristics

	Age of patient (years)							
	<5	5-11	12-17	18-24	25-44	45-64	65+	All
Sex of patient								
Male	1016	1033	1034	1033	1025	1028	1025	1028
Female	998	1029	1026	1032	1025	1034	1037	1030
Visit type								
Emergency	1011	1008	1046	1021	1018	1028	1019	1022
Non-emergency	1010	1033	1028	1037	1025	1033	1035	1031
Insurance status								
Insured	1019	1040	1032	1034	1030	1040	1034	1036
Uninsured	1012	1021	1028	1030	1020	1021	1031	1023
Patient status								
New	1020	1026	1023	1023	1020	1015	1020	1021
Previous	998	1034	1030	1035	1026	1033	1033	1031
Geographic location								
Capital city	1050	1066	1055	1048	1043	1051	1060	1051
Non-capital	969	979	975	987	980	975	975	978
All	1001	1031	1029	1033	1025	1031	1031	1029

Table 4.25 presents mean index scores by dentate status and age. Index scores were lower (i.e., lower SES) for edentulous patients overall, and this trend was apparent for each age group.

Table 4.25: Mean index scores by dentate status and age among patients aged 18 years or more

	Age of patient (years)				
	18-24	25-44	45-64	65+	All
Dentate status					
Dentate	1032	1025	1033	1034	1030
Edentulous	-	957	999	1001	998

Table 4.26 presents mean index scores by oral health status. Overall, poorer oral health status was associated with lower index scores of relative disadvantage (i.e., lower SES). There were lower index scores for those patients with dentures, with lower total numbers of teeth, and with greater numbers of decayed teeth.

While there was little difference in index scores between patients with and without dentures among the 18-24 years age group, the remaining older age groups all showed lower index scores among patients with dentures compared to those without dentures. The pattern of lower index scores for patients with lower total numbers of teeth was consistently observed for patients in the 25-44 and 45-64 years age groups, but not for the 18-24 and 65+ years age groups. The trend for lower index scores among patients with more decayed teeth was observed in each group except for those aged 65+ years.

Table 4.26: Mean index scores by oral health status and age for dentate patients aged 18 years or more

	Age of patient (years)				
	18-24	**25-44**	**45-64**	**65+**	**All**
Denture status					
Present	1033	1006	1015	1029	1019
Absent	1033	1027	1041	1042	1033
Number of teeth					
1-20 teeth	1068	1016	1007	1025	1016
21-24 teeth	1039	1020	1026	1036	1027
25-28 teeth	1030	1025	1044	1062	1034
29-32 teeth	1034	1029	1052	1026	1035
Decayed teeth					
No decay	1038	1033	1036	1042	1036
1-4 decayed	1032	1020	1033	1025	1027
5+ decayed	1016	1018	1018	1030	1019

4.5 Scale development

This section describes the development of scales to be used as independent variables in further analysis of service patterns. Items were collected from dentists concerning the themes of practice beliefs (Grembowski, Milgrom and Fiset, 1988; 1991), dentists' preferences for patients (Rouse and Hamilton, 1991), and evaluation of patients treated in their log of services provided (Weinstein et al., 1979). Each item was recorded as a five-point Likert scale. The approach adopted involved the use of factor analysis to examine each battery of items for underlying component dimensions or factors, which may comprise sub-scales. Scales and sub-scales derived from factor analysis were examined for reliability. The final factor-based scales were constructed giving consideration to the reasonableness of the factors (e.g., interpretation, conceptual coherence) and reliability of the scales. For ease of interpretation, the sub-scales were calculated by summing the items and dividing by the number of items to achieve a scale ranging from 1 to 5. Scales were then calculated by summing the sub-scales and dividing by the number of sub-scales. This results in a scale which conforms to the original range and where all sub-scales contribute equally (Streiner and Norman, 1995).

The factor analyses were performed using principal components with varimax rotation (SAS, 1988), and reliability of the factor-based scales was assessed by Cronbach's alpha (SPSS, 1988). Analysis involved determining the number of factors with eigenvalues greater then 1.0, examination of scree plots, measuring sampling adequacy by Kaiser MSA scores, examination of communalities and variance explained by each factor. Final decisions on the number of factors included consideration of proportion of sample variance explained, subject matter knowledge, and reasonableness of the results (Johnson and Wichern, 1988). Retaining factors with eigenvalues greater than 1.0 is commonly used, based on heuristic and practical grounds (Kim and Mueller, 1978), but this criterion is considered most reliable when the number of variables is between 20 and 50. If the number of variables is less than 20 there is a tendency to extract a conservative number of factors, while there is a tendency to extract too many factors with eigenvalues greater than one when there are 50 or more variables (Child, 1978). While scree plots can also be used to determine the number of factors, this is often very subjective (Kim and Mueller, 1978). Similarly, the substantive importance attached to the proportion of variance explained by each factor also involves judgement, and may be set at whatever the researcher considers to be important. Hence, Kim and Mueller (1978) conclude that there is no unambiguous rule to use when selecting the number of factors. Final judgement often involves the reasonableness of the solution and knowledge of the subject matter (Kim and Mueller, 1978; Johnson and Wichern, 1988). Sampling adequacy relates to the degree that the subset of variables used in the analysis represents a potentially larger domain, with a Kaiser's measure of sampling adequacy (MSA) of 0.50 or better being adequate (Kim and Mueller, 1978). Communality measures the common factor variance of a variable (i.e., variance shared in common with other variables) while the unique variance is measured as 1.0 minus the communality value. A communality of 0.3 or less indicates that a variable may be unreliable (Child, 1978). A large communality value (i.e., greater than 0.3) indicates that a large percentage of the sample variance of each variable is accounted for by the factors (Johnson and Wichern, 1988). Cronbach alpha measures the internal consistency of the items with values above 0.70 providing an indication of adequate reliability (Streiner and Norman, 1995).

4.5.1 Practice beliefs

Table 4.27 presents the results of a factor analysis of the practice belief items (Grembowski, Milgrom and Fiset, 1988; 1991). There were three factors with eigenvalues greater than 1.0, with a fourth factor just below 1.0. As the fourth factor accounted for a substantial percentage of variance (11.9%) a four-factor solution was obtained. Overall, the sampling adequacy was acceptable, being above 0.50, and the communality values were all above 0.30, indicating the factors accounted for a large percentage of the sample variance of each variable. Of the four factors obtained, all except the first were under-identified, having less than the preferred three to four items per factor (Short and Horn, 1984). This under-identification may contribute to the low values of Cronbach's alpha obtained for the items loading most strongly on each factor. Only the first factor, with α = 0.65, approached the minimum recommended level of 0.70. Items which loaded on a factor are indicated in the table by a box around the factor loading. While the reliability of the scales based on the factors was low, the factor structure which was obtained correlated well with the findings of Grembowski, Milgrom and Fiset (1991). The first factor (PB 1) consists of their factor, Information giving, with the addition of item 4. The second factor consists of their factor, Preventive orientation, while the third factor consists of their factor, Patient influence. The remaining factor consists of the single item, relating to controlling active disease versus developing better preventive advice. These factors are treated as separate scales which cover different practice beliefs and have not been combined into a single scale as while they reflect a common theme (i.e., beliefs underpinning clinical practice) they do not represent components which are readily combined to form a single entity, as for example the components of satisfaction with care can be summed to form a global measure of satisfaction (Davies and Ware, 1981).

Table 4.27: Factor analysis of practice beliefs

Initial statistics [a]				Final statistics [b]						
		Variance				Factor loadings				
Factor	Eigenvalue	%	Cum. %	Item	Item label	PB 1	PB 2	PB 3	PB 4	h^2
1	1.96	24.5	24.5	1	Plaque control	.07	$\boxed{.76}$	.01	-.25	.64
2	1.20	15.0	39.5	2	Disease *vs* Prevent	.02	-.00	.02	$\boxed{.93}$	.86
3	1.05	13.1	52.6	3	Convince to accept	-.03	$\boxed{.74}$	-.02	.23	.61
4	0.96	11.9	64.5	4	Inform about cost	$\boxed{.80}$	-.03	.14	.14	.68
5	0.89	11.1	75.6	5	Dentist advice	.15	.17	$\boxed{.70}$	.05	.54
6	0.80	10.0	85.6	*6	Dismiss from practice	.05	-.17	$\boxed{.75}$	-.03	.60
7	0.72	9.0	94.6	7	Treatment options	$\boxed{.58}$	.01	.30	-.20	.46
8	0.43	5.4	100.0	8	Know cost	$\boxed{.87}$	.06	-.05	.02	.77
					Variance (%):	22.1	14.9	14.5	13.0	
					Cronbach alpha:	0.65	0.29	0.21	-	

(a) method = principal components
(b) rotation = varimax
h^2= communality
Kaiser's measure of sampling adequacy = 0.62
* direction reversed

Table 4.28 presents the distribution of the factor-based practice belief scales. These scales are treated as continuous variables, ranging from 1 (strongly agree) to 5 (strongly disagree). Scores less than or equal to 2.0 represent agreement with the practice belief measured by a particular scale. Approximately 85% of responses were in agreement with the practice beliefs of Information giving and Patient influence. However, only 45% of practitioners indicated agreement with the Preventive orientation scale, and approximately 10% agreed with the item relating to controlling active disease rather than developing better preventive advice.

Table 4.28: Distribution of practice belief scales [(a)]

	Description of scale	Distribution of responses (%) 1	≤2	≤3	≤4	≤5	Skew	Mean	S.E.
PB1	Information giving scale	37.5	86.2	98.2	99.4	100.0	1.78	1.53	0.03
PB2	Preventive orientation scale	5.6	45.0	83.8	97.9	100.0	0.41	2.44	0.04
PB3	Patient influence scale	27.7	84.2	97.9	99.1	100.0	1.41	1.73	0.04
PB4	Controlling active disease item	4.1	9.7	40.8	77.2	100.0	-0.60	3.68	0.06

(a) scales range from 1 (strongly agree) to 5 (strongly disagree)

Table 4.29 presents the mean practice belief scales by dentist and practice characteristics. These scales are measured from 1 (strongly agree) to 5 (strongly disagree), with lower mean scores indicating higher agreement. Overall, there were few significant differences in practice belief scales.

The only statistically significant differences occurred for geographic location for the Preventive orientation scale, and for age and sex of dentist for the Controlling active disease item. Capital city dentists had a higher level of agreement with the Preventive orientation scale, while males and older dentists showed less disagreement with the Controlling active disease item, although they were still above 3.0 (the mid-point).

Table 4.29: Practice belief scales by dentist and practice characteristics (a)

	Information giving		Preventive orientation		Patient influence		Controlling active disease	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Sex of dentist							**	
Male	1.53	0.04	2.44	0.05	1.73	0.04	3.60	0.06
Female	1.52	0.09	2.46	0.09	1.72	0.08	4.01	0.12
Age of dentist							**	
20-29 years	1.64	0.12	2.41	0.09	1.81	0.11	4.06	0.12
30-39 years	1.48	0.05	2.42	0.08	1.78	0.07	3.74	0.11
40-49 years	1.61	0.07	2.50	0.07	1.69	0.07	3.80	0.09
50-59 years	1.48	0.07	2.43	0.11	1.69	0.07	3.38	0.13
60+ years	1.39	0.07	2.44	0.19	1.63	0.01	3.20	0.18
Location			*					
Capital city	1.52	0.04	2.41	0.05	1.71	0.04	3.67	0.06
Non-capital	1.59	0.10	2.62	0.10	1.79	0.11	3.80	0.13
Practice type								
Solo	1.53	0.04	2.39	0.06	1.71	0.05	3.66	0.08
Non-solo	1.53	0.05	2.50	0.06	1.74	0.05	3.71	0.08

(a) scales range from 1 (strongly agree) to 5 (strongly disagree)
*(P<0.05), **(P<0.01) Mann-Whitney, Kruskal-Wallis test

4.5.2 Dentist preferences for patients

Table 4.30 presents the results of a factor analysis of the dentists preferences for patients items (Rouse and Hamilton, 1991). Five factors had eigenvalues greater than 1.0, plus another two factors had eigenvalues just below 1.0. The first factor accounted for 41.8% of the variance, but none of the remaining factors accounted for more than 7.5% of the variance. The measure of sampling adequacy was high (0.95). A four-factor solution, comprising 31 of the original set of 37 items is presented.

This solution was developed through consideration of four- to seven-factor solutions, initially comprising all 37 items. The structure of the first three factors (DP 1 to DP 3) was relatively stable regardless of the number of factors or items specified. Items that were dropped consisted of items 14, 17, 21 and 26, which consisted of negative items such as "not respect my opinion" and "not to come in at recall".

These items tended to load together but had low reliability as measured by Cronbach's alpha and added little explanatory value as a subject matter dimension. Similarly items 33 and 35, consisting of "significant problems" and "anxious" tended to load together, and while of some subject matter interest, were low in terms of reliability, and hence were dropped from the analysis.

The four-factor solution has communality values all above 0.30, indicating the factors account for a large percentage of the sample variance. The values of Cronbach's alpha are above 0.70, indicating adequate reliability for the items loading strongly on each factor, which are indicated by boxes around the factor loadings in the table.

The factor structure and items loading on each factor obtained from the factor analysis was interpreted as follows:

- The first factor (DP 1) comprises a range of items related to dental behaviour, such as "come in at recall", "maintain oral health", "value good dental care" and "follow instructions".
- The second factor (DP 2) consists of items relating to personality, such as "sociable", "charming", and "warm".
- The third factor (DP 3) comprises items related to general behaviour, such as "content", "patient", "respectful", "co-operative" and "polite".
- The fourth factor (DP 4) has mainly finance related items, such as "afford optimal treatment", "have insurance", and "willing to pay".

Table 4.30: Factor analysis of dentist preferences for patients

Initial statistics [a]				Final statistics [b]						
		Variance				Factor loadings				
Factor	Eigenvalue	%	Cum. %	Item	Item label	DP 1	DP 2	DP 3	DP 4	h^2
1	12.96	41.8	41.8	1	come in at recall	.39	.19	.38	.14	.35
2	2.32	7.5	49.3	2	emotionally secure	.18	.24	.63	.17	.52
3	1.47	4.7	54.0	3	co-operate with me	.34	.11	.72	.19	.69
4	1.33	4.3	58.3	4	content	.32	.11	.71	.15	.64
5	1.08	3.5	61.8	5	patient	.19	.37	.70	.09	.68
6	0.94	3.0	64.8	6	polite	.27	.45	.65	-.04	.70
7	0.90	2.9	67.7	7	on time	.51	.19	.41	.10	.48
8	0.73	2.4	70.1	8	warm	.20	.67	.42	.03	.66
9	0.72	2.3	72.4	9	respect my opinion	.47	.31	.52	.19	.62
10	0.64	2.1	74.5	10	sociable	.13	.74	.31	.19	.70
11	0.60	1.9	76.4	11	maintain oral health	.67	.23	.20	.08	.56
12	0.56	1.8	78.2	12	charming	.08	.71	.22	.21	.61
13	0.56	1.8	80.0	13	accept treatment plan	.45	.25	.38	.39	.56
14	0.54	1.7	81.8	15	thankful	.41	.49	.34	.15	.55
15	0.50	1.6	83.4	16	trust me	.52	.29	.39	.10	.51
16	0.46	1.5	84.9	18	attractive	-.15	.27	.15	.66	.56
17	0.45	1.4	86.3	19	manageable	.52	.27	.34	.18	.49
18	0.43	1.4	87.7	20	cheerful	.21	.75	.26	.19	.71
19	0.40	1.3	89.0	22	kind	.15	.75	.20	.15	.65
20	0.37	1.2	90.2	23	notice of cancelling	.61	.04	.16	.02	.40
21	0.35	1.1	91.3	24	self confident	.25	.51	-.00	.39	.47
22	0.35	1.1	92.4	25	fun to work with	.33	.72	.09	.18	.67
23	0.33	1.1	93.5	27	responsive	.33	.56	.17	.21	.50
24	0.32	1.0	94.6	28	afford optimal treatment	.28	.09	.13	.78	.71
25	0.29	0.9	95.5	29	have insurance	-.03	.16	.11	.58	.38
26	0.26	0.9	96.3	30	good dental knowledge	.31	.44	-.02	.47	.51
27	0.24	0.8	97.1	31	follow instructions	.77	.14	.26	.10	.69
28	0.24	0.8	97.9	32	willing to pay	.49	.16	.32	.49	.61
29	0.23	0.8	98.6	34	value good dental care	.77	.23	.22	.06	.70
30	0.23	0.7	99.4	36	appreciate prevention	.77	.23	.10	-.05	.65
31	0.19	0.6	100.0	37	relaxed	.49	.43	.33	.12	.55
					Variance (%):	18.1	17.6	14.1	8.5	
					Cronbach alpha:	0.89	0.90	0.86	0.71	

(a) method = principal components
(b) rotation = varimax
h^2 = communality
Kaiser's measure of sampling adequacy = 0.95
Cronbach alpha for scale containing all items = 0.94

The distribution of the dentist preferences for patients scales are presented in Table 4.31. These scales are treated as continuous variables, ranging from 1 (strongly agree) to 5 (strongly disagree). Scores less than or equal to 2.0 represent agreement with the preference for patients measured by a particular scale. Approximately 80% of dentists were in agreement with the preferences relating to the Dental behaviour and General behaviour sub-scales, while 40.6% agreed with the Personality sub-scale, and 23.9% agreed with the Finance sub-scale. The dentist preferences are treated as sub-scales as they are also combined to form a single scale relating to degree of selectivity in terms of the preferences for patients shown by a dentist.

When the sub-scales were summed to produce an overall scale of selectivity relating to preferences for patients, nearly half showed agreement with the scale. Of those dentists not showing agreement with the sub-scales or scale, most were in the region of less than or equal to 3. This is reflected in the mean values, which range from 1.58 for the Dental behaviour sub-scale to 2.59 for the Finance sub-scale.

Table 4.31: Distribution of dentist preferences for patients scales [a]

		Distribution of responses (%)							
	Description of scale	1	≤2	≤3	≤4	≤5	Skew	Mean	S.E.
DP1	Dental behaviour sub-scale	14.8	82.5	99.4	99.4	100.0	1.62	1.58	0.03
DP2	Personality sub-scale	5.5	40.6	90.3	99.4	100.0	0.29	2.24	0.04
DP3	General behaviour sub-scale	25.7	78.5	98.8	99.7	100.0	1.01	1.66	0.03
DP4	Finance sub-scale	1.5	23.9	77.9	97.6	100.0	0.26	2.59	0.04
	Selectivity scale	0.3	49.7	97.2	99.7	100.0	0.67	2.02	0.03

(a) scales range from 1 (strongly agree) to 5 (strongly disagree)

Table 4.32 presents the mean dentist preference for patients sub-scales and the Selectivity scale by dentist and practice characteristics. These scales are measured from 1 (strongly agree) to 5 (strongly disagree), with lower mean scores indicating higher agreement. Sex of dentist was only associated with the Finance sub-scale, with males having a higher level of agreement. Age of dentist was associated with the Dental behaviour, General behaviour, and Finance sub-scale as well as the Selectivity scale, with the youngest and oldest age groups showing the highest level of agreement in each case. Practice type of non-solo had a higher level of agreement with the Dental behaviour sub-scale than solo practice.

Table 4.32: Dentist preferences for patients scales by dentist and practice characteristics [a]

	Dental behaviour		Personality		General behaviour		Finance		Selectivity	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Sex of dentist							**			
Male	1.60	0.03	2.21	0.04	1.66	0.04	2.54	0.04	2.00	0.03
Female	1.51	0.05	2.36	0.09	1.67	0.07	2.80	0.08	2.09	0.06
Age of dentist	*				*		*		*	
20-29 years	1.44	0.07	1.97	0.10	1.48	0.08	2.43	0.11	1.81	0.08
30-39 years	1.58	0.06	2.33	0.08	1.73	0.07	2.76	0.08	2.11	0.06
40-49 years	1.67	0.05	2.29	0.06	1.72	0.06	2.59	0.06	2.05	0.05
50-59 years	1.58	0.06	2.26	0.09	1.68	0.07	2.59	0.08	2.03	0.06
60+ years	1.55	0.09	2.13	0.12	1.56	0.11	2.34	0.13	1.91	0.10
Location										
Capital city	1.59	0.03	2.25	0.04	1.68	0.04	2.58	0.04	2.03	0.03
Non-capital	1.53	0.08	2.13	0.10	1.56	0.08	2.63	0.11	1.95	0.08
Practice type	*									
Solo	1.66	0.04	2.27	0.06	1.71	0.05	2.63	0.06	2.07	0.05
Non-solo	1.51	0.03	2.20	0.05	1.61	0.04	2.55	0.05	1.96	0.04

(a) scales range from 1 (strongly agree) to 5 (strongly disagree)
*(P<0.05) Mann-Whitney, Kruskal-Wallis test

4.5.3 Patient evaluation items

Table 4.33 presents the results of a factor analysis of the patient evaluation items (Weinstein et al., 1979). Only one factor had an eigenvalue greater than 1.0, but the second factor had an eigenvalue just below 1.0 and a large percentage of variance was accounted for by each of the first three factors. With only five items any solution greater than one-factor will be under-identified. However, the three-factor solution presented provides a good conceptual grouping of the items. Overall, the measure of sampling adequacy is above 0.50 and the communality values are all above 0.30. Measures of reliability for all five items combined and for both the two-item factors are in excess of 0.70.

The items loading strongly on each factor are indicated in the table by boxes around the factor loadings. The first factor (PE 1) comprises payment items of "willing to pay" and "able to pay". The second factor (PE 2) comprises knowledge items of "good dental knowledge" and "follows instructions". The third factor (PE 3) comprises the item "presents problems". This item was recoded to reverse the coding direction of the scale, which is presented in Table 4.34 as the No problems sub-scale.

Sub-scales are differentiated from scales as the sub-scales of Payment, Knowledge and No problems are combined to form an overall scale, the Patient evaluation scale.

Table 4.33: Factor analysis of patient evaluation items

Initial statistics (a)				Final statistics (b)					
		Variance				Factor loadings			
Factor	Eigenvalue	%	Cum. %	Item	Item label	PE 1	PE 2	PE 3	h^2
1	2.52	50.3	50.3	1	Good dental knowledge	.17	.88	.10	.81
2	0.98	19.6	69.9	2	Follow instructions	.20	.86	.15	.80
3	0.79	15.9	85.8	3	Presents problems	.12	.17	.98	.99
4	0.40	8.0	93.8	4	Willing to pay	.86	.28	.09	.82
5	0.31	6.2	100.0	5	Able to pay	.91	.11	.09	.86
					Variance (%):	33.1	32.5	20.1	
					Cronbach alpha:	0.80	0.76	-	

(a) method = principal components
(b) rotation = varimax
h^2 = communality
Kaiser's measure of sampling adequacy = 0.68
Cronbach alpha for scale containing all items = 0.74

The distribution of the dentist preferences for patients scales are presented in Table 4.34. These scales are treated as continuous variables, ranging from 1 (strongly agree) to 5 (strongly disagree). Scores less than or equal to 2.0 represent agreement with the evaluation of patients measured by a particular scale. Nearly 60% of patients were evaluated as being in agreement with the Payment and No problems sub-scales, while 39.9% were evaluated as agreeing with the Knowledge sub-scale, and 36.4% were evaluated as agreeing with the Patient evaluation scale.

Table 4.34: Distribution of patient evaluation scales (a)

		Distribution of responses (%)							
	Description of scale	1	≤2	≤3	≤4	≤5	Skew	Mean	S.E.
PE1	Payment sub-scale	26.4	59.6	85.6	96.4	100.0	0.66	2.18	0.02
PE2	Knowledge sub-scale	10.2	39.9	75.5	93.7	100.0	0.34	2.60	0.02
PE3	No problems sub-scale	29.1	57.4	79.2	91.9	100.0	0.54	2.42	0.02
	Patient evaluation scale	4.5	36.4	80.2	97.4	100.0	0.37	2.40	0.01

(a) scales range from 1 (strongly agree) to 5 (strongly disagree)

Table 4.35 presents the mean patient evaluation scales by patient and visit characteristics. These data were collected through the service log and were analysed with the patient as the unit of analysis, hence a different set of variables (i.e., those representing the patient level) are used as compared to the other scales relating to practice beliefs and preferences for patients which were collected at the dentist level and analysed using the dentist as the unit of analysis. These scales are measured from 1 (strongly agree) to 5 (strongly disagree), with lower mean scores indicating higher agreement. All patient evaluation sub-scales and scales were associated with patient age, visit type, insurance, patient status, and decayed teeth. In each case lower scores indicating an evaluation of agreement (i.e., a positive impression of the patient) occurred for non-emergency visits, insured patients, new patients, and patients with no decayed teeth.

The Payment sub-scale was also associated with age and denture status (with better scores for younger patients and those with no dentures). The Knowledge sub-scale was also associated with dentate status, sex, and location (with better scores for dentate patients, females, and those in capital cities). The No problems sub-scale was also associated with dentate status, sex and denture status (with better scores for the dentate, female patients, and those with no dentures). The Patient evaluation scale was also associated with dentate status, sex, age, location and denture wearing (with better scores for the dentate, females, adolescent to middle-aged adults, capital city patients, and those without dentures).

Table 4.35: Patient evaluation scales by patient and visit characteristics [a]

	Payment		Knowledge		No Problems		Patient evaluation	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Dentate status			**		**		**	
Dentate	2.17	0.02	2.58	0.02	2.41	0.02	2.39	0.01
Edentulous	2.39	0.13	3.15	0.12	2.90	0.17	2.82	0.10
Sex of patient [b]			**		**		**	
Male	2.18	0.03	2.74	0.03	2.50	0.03	2.47	0.02
Female	2.16	0.02	2.46	0.02	2.34	0.03	2.32	0.02
Age of patient [b]	**		**				*	
<5 years	1.79	0.12	3.16	0.22	2.34	0.22	2.46	0.16
5-11 years	2.06	0.06	3.04	0.06	2.34	0.08	2.47	0.05
12-17 years	1.92	0.05	2.60	0.05	2.26	0.08	2.25	0.04
18-24 years	2.23	0.06	2.54	0.06	2.28	0.07	2.35	0.05
25-44 years	2.23	0.03	2.53	0.03	2.41	0.04	2.39	0.02
45-64 years	2.16	0.03	2.49	0.03	2.41	0.04	2.35	0.03
65+ years	2.29	0.06	2.58	0.05	2.55	0.07	2.48	0.04
Visit type [b]	**		**		**		**	
Non-emergency	2.09	0.02	2.50	0.02	2.32	0.02	2.31	0.02
Emergency	2.46	0.04	2.86	0.04	2.63	0.05	2.64	0.03
Insurance [b]	**		**		**		**	
Non-insured	2.40	0.03	2.72	0.03	2.50	0.03	2.53	0.02
Insured	1.96	0.02	2.45	0.02	2.31	0.03	2.24	0.02
Patient status [b]	**		**		*		**	
New patient	2.15	0.02	2.52	0.02	2.39	0.02	2.35	0.02
Previous patient	2.34	0.05	2.95	0.04	2.50	0.06	2.59	0.04
Location [b]			**				*	
Capital city	2.17	0.02	2.56	0.02	2.38	0.02	2.37	0.02
Non-capital	2.20	0.04	2.69	0.04	2.44	0.05	2.44	0.03
Decayed teeth [b]	**		**		**		**	
None	2.04	0.02	2.39	0.02	2.31	0.03	2.25	0.02
1 or more	2.30	0.03	2.74	0.02	2.48	0.03	2.50	0.02
Dentures [b]	*				**		**	
Yes	2.29	0.05	2.63	0.04	2.61	0.05	2.52	0.03
No	2.15	0.02	2.57	0.02	2.36	0.02	2.36	0.02

(a) scales range from 1 (strongly agree) to 5 (strongly disagree)
(b) Dentate patients
*(P<0.05), **(P<0.01) Mann-Whitney, Kruskal-Wallis test

4.6 Treatment choice clusters

The grouped treatment choice responses described in Section 4.4.4 where dentists provided up to five responses which they judged to be important in selecting one of two alternative treatment pairs based on Grembowski, Milgrom and Fiset (1988) were further analysed, to summarise their effects and examine correlates of these responses.

The response groups comprising the 10 highest percentages across all six treatment choice scenarios were used to identify clusters of dentists who rated the responses which influence treatment choice in a similar manner. Although the respondents were instructed to list their treatment choice responses in order of importance there was some doubt stemming from the pilot study (see Section 3.2 Collection instrument and data items) as to how fully they understood the concept of ranking and some respondents wrote comments on their questionnaires that while they could list multiple responses there was no implied order due to the fact that they considered all the responses to be important considerations in choosing between alternative treatments.

Therefore, there was no differential weighting of responses in the analysis. For each group of responses a count was performed across the six treatment scenarios, and these counts were used as the input into the cluster analysis. A three-group solution was obtained from a k-means clustering method (Johnson and Wichern, 1988; Romesburg, 1984; SAS, 1988), the results of which are shown in Table 4.36.

The clusters showed little overlap when canonical variables from a canonical discriminant analysis were plotted and discriminant function analysis when used as a measure of secondary validity, showed that 87.9% of cluster members were correctly predicted. Cluster 1 was characterised by a high value for patient factors, cluster 2 had a high value for treatment constraints, and cluster 3 had high values for mouth, tooth and periodontal status.

Table 4.36: Cluster membership by mean values of treatment choice counts

	Cluster 1 (n=83)	Cluster 2 (n=79)	Cluster 3 (n=168)
Background	1.89	1.58	1.97
Caries status	1.61	1.37	1.93
Mouth status	1.54	1.52	3.03
Tooth status	2.11	1.85	3.13
Root status	0.42	0.53	0.84
Denture status	1.14	0.94	1.60
Periodontal status	2.20	2.22	3.27
Visit history	1.40	0.90	0.79
Treatment constraints	2.02	5.10	3.28
Patient	3.66	2.30	1.50

The clusters were named "patient", "cost" and "oral health" according to the mean values of treatment choice counts with which they were characterised. Therefore cluster 1 reflects patient preference factors, cluster 2 reflects treatment constraints which are primarily cost factors, and cluster 3 reflects a grouping of oral health factors.

Associations of dentist and practice characteristics with cluster membership are presented in Table 4.37. No associations were statistically significant, although sex of dentist showed some variation, with a lower percentage of male dentists in the Oral health cluster compared to the Patient cluster and Cost cluster. While there was also some variation in age distributions between clusters, the chi-square values did not approach significance, nor did type of practice or geographic location which exhibited little variation.

Table 4.37: Cluster membership by dentist and practice characteristics

	Cluster 1 (n=82) Patient cluster	Cluster 2 (n=79) Cost cluster	Cluster 3 (n=168) Oral health cluster	P value (chi-square)
Sex of dentist				
Male	84.2	86.1	75.0	0.070
Female	15.9	13.9	25.0	
Age of dentist				
20-29 years	13.4	7.6	17.9	0.177
30-39 years	24.4	25.3	31.0	
40-49 years	28.1	36.7	27.4	
50-59 years	20.7	16.5	17.3	
60+ years	13.4	13.9	6.6	
Type of practice				
Solo	46.3	54.4	50.6	0.590
Other	53.7	45.6	49.4	
Location				
Capital city	82.7	87.2	83.5	0.701
Non-capital	17.3	12.8	16.5	

4.7 Bivariate associations with services

This section presents the bivariate associations of services with the set of independent variables described in Section 4.2 (Comparison of respondents by service log status), Section 4.3 (Age and sex distributions: private general practice) and Section 4.4 (Distributions of dependent and independent variables). The set of independent variables are structured in this section under the headings of dentist and practice characteristics, practice beliefs, treatment choice, dentist preferences for patients, patient, visit and oral health variables, patient evaluation items, and area-based indicators of socio-economic status.

4.7.1 Dentist and practice characteristics

Table 4.38 presents mean services per visit by dentist and practice characteristics for the service areas of diagnostic, preventive, periodontic and extraction. Diagnostic services were provided at higher rates among younger dentists, a rate ratio (RR) of 1.24 for 20-29 year olds compared to those aged over 50 years, for non-solo practitioners (RR=0.82 for solo practitioners), at capital city locations (RR=1.16), those who worked with higher numbers of dentists (RR=0.86 for those who worked with lower numbers of dentists), for those who worked with higher numbers of non-dentist staff (RR=0.88 for those with lower numbers of non-dentist staff), and for those who had lower numbers of patient visits per year (RR=1.19).

Preventive services were provided at higher rates by female dentists (RR=0.85 for males), by younger dentists (RR=1.29 for 20-29 year olds compared to those aged 50 years or more), for those at capital city locations (RR=1.48), for those with shorter waiting times (RR=1.15), and for those with lower numbers of patient visits per year (RR=1.13).

Periodontic services were provided at higher rates for those greater numbers of non-dentist staff (RR=0.60 for those with lower numbers of non-dentist staff), and for those with lower numbers of patient visits per year (RR=1.86).

Extraction services were provided at higher rates at non-capital city locations (RR=0.60 for capital city locations), for those working with greater numbers of other dentists (RR=0.77 for those working with lower numbers of other dentists), and for those with shorter waiting times (RR=1.41).

Table 4.38: Mean services per visit by dentist and practice characteristics (part 1)

	Diagnostic		Preventive		Periodontic		Extraction	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Sex of dentist			*					
Male	0.67	0.02	0.35	0.02	0.026	0.005	0.08	0.01
Female	0.71	0.05	0.41	0.04	0.011	0.004	0.10	0.02
Age of dentist	**		**					
20-29 years	0.81	0.07	0.43	0.05	0.023	0.010	0.10	0.02
30-39 years	0.67	0.04	0.36	0.03	0.023	0.008	0.09	0.01
40-49 years	0.68	0.04	0.35	0.03	0.027	0.008	0.07	0.01
50+ years	0.62	0.04	0.33	0.03	0.017	0.006	0.10	0.02
Practice type	**							
Solo	0.62	0.03	0.37	0.02	0.022	0.005	0.09	0.01
Non-solo	0.75	0.03	0.35	0.02	0.023	0.006	0.09	0.01
Location	**		**				**	
Capital city	0.71	0.03	0.40	0.02	0.026	0.005	0.07	0.01
Non-capital	0.60	0.04	0.26	0.02	0.014	0.005	0.12	0.03
Time since graduation								
Long (> median)[a]	0.66	0.03	0.35	0.02	0.026	0.006	0.09	0.01
Short (≤ median)	0.70	0.03	0.37	0.02	0.020	0.005	0.09	0.01
Other dentists[b]	**						*	
Higher (> median)[a]	0.73	0.04	0.33	0.03	0.022	0.006	0.11	0.02
Lower (≤ median)	0.66	0.03	0.38	0.02	0.023	0.005	0.08	0.01
Waiting time[b]			*				**	
Long (> median)[a]	0.66	0.03	0.34	0.02	0.027	0.005	0.07	0.01
Short (≤ median)	0.70	0.03	0.38	0.02	0.019	0.006	0.10	0.01
Non-dentist staff[b]	**				*			
Higher (> median)[a]	0.71	0.03	0.36	0.03	0.029	0.006	0.09	0.02
Lower (≤ median)	0.65	0.03	0.36	0.02	0.018	0.005	0.09	0.01
Patients per year[b]	**		*		*			
Higher (> median)[a]	0.61	0.02	0.34	0.02	0.017	0.004	0.08	0.01
Lower (≤ median)	0.75	0.03	0.38	0.02	0.028	0.007	0.10	0.01

(a) median time since graduation = 17.5 years; median number of other dentists = 1; median waiting time = 4 days; median number of non-dentist staff = 2.11 FTE; median number of patient visits per year = 2,664

(b) in main private practice

*(P<0.05), **(P<0.01) Poisson regression

Table 4.39 presents mean services per visit by dentist and practice characteristics for the main areas of endodontic, restorative, crown and bridge, and prosthodontic services. Endodontic services were provided at higher rates by younger dentists (RR=2.26 for 20-29 year olds compared to 50+ year olds), and for those with less time since graduation (RR=1.66).

Restorative services were provided at higher rates among younger dentists (e.g., RR=1.21 for 30-39 year olds compared to 50+ year olds), for dentists in non-solo practices (RR=0.90 for solo practices), for those with a shorter time since graduation (RR=1.12), and for those with longer waiting times (RR=0.89 for those with shorter waiting times).

Crown and bridge services were provided at higher rates by male dentists (RR=1.83), by dentists aged greater than 20-29 years (e.g., RR=0.32 for 20-29 year olds compared to 50+ year olds), for solo practitioners (RR=1.40), for those at capital city locations (RR=1.40), and for those with a longer time since graduation (RR=0.73 for those with a shorter time since graduation).

Prosthodontic services were provided at higher rates by middle-aged dentists (e.g., RR=1.55 for 40-49 year olds compared to 50+ year olds), by solo practitioners (RR=1.56), at non-capital city locations (RR=0.59 for capital city locations), and for those with a shorter time since graduation (RR=1.27).

Table 4.39: Mean services per visit by dentist and practice characteristics (part 2)

	Endodontic		Restorative		Crown/bridge		Prosthodontic	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Sex of dentist					**			
Male	0.13	0.01	0.64	0.03	0.10	0.01	0.12	0.03
Female	0.15	0.03	0.65	0.06	0.06	0.02	0.07	0.02
Age of dentist	**		**		**		**	
20-29 years	0.20	0.04	0.61	0.05	0.03	0.01	0.06	0.02
30-39 years	0.16	0.02	0.72	0.05	0.10	0.02	0.10	0.02
40-49 years	0.12	0.02	0.64	0.04	0.11	0.02	0.18	0.07
50+ years	0.09	0.02	0.59	0.04	0.10	0.02	0.09	0.02
Practice type			*		**		**	
Solo	0.12	0.01	0.62	0.04	0.11	0.01	0.15	0.04
Non-solo	0.15	0.02	0.66	0.03	0.07	0.01	0.08	0.02
Location					*		**	
Capital city	0.14	0.01	0.65	0.03	0.10	0.01	0.07	0.01
Non-capital	0.12	0.02	0.61	0.04	0.08	0.02	0.21	0.08
Time since graduation	**		*		**		*	
Long (> median)[a]	0.11	0.01	0.61	0.03	0.11	0.01	0.08	0.01
Short (≤ median)	0.16	0.02	0.68	0.04	0.08	0.01	0.14	0.04
Other dentists[b]								
Higher (> median)[a]	0.16	0.02	0.67	0.05	0.08	0.01	0.09	0.02
Lower (≤ median)	0.12	0.01	0.63	0.03	0.10	0.01	0.12	0.03
Waiting time[b]			**					
Long (> median)[a]	0.13	0.01	0.68	0.04	0.09	0.01	0.10	0.02
Short (≤ median)	0.14	0.01	0.61	0.03	0.09	0.01	0.13	0.04
Non-dentist staff[b]								
Higher (> median)[a]	0.13	0.02	0.68	0.04	0.08	0.01	0.13	0.04
Lower (≤ median)	0.13	0.01	0.61	0.03	0.10	0.01	0.10	0.02
Patients per year[b]								
Higher (> median)[a]	0.13	0.01	0.67	0.03	0.09	0.01	0.14	0.04
Lower (≤ median)	0.14	0.02	0.62	0.04	0.09	0.01	0.09	0.02

(a) median time since graduation = 17.5 years; median number of other dentists = 1; median waiting time = 4 days; median number of non-dentist staff = 2.11 FTE; median number of patient visits per year = 2,664

(b) in main private practice

*(P<0.05), **(P<0.01) Poisson regression

Table 4.40 presents mean services per visit by dentist and practice characteristics for orthodontic, general/miscellaneous, and total services per visit. Orthodontic services were provided at low rates by private general practitioners and showed no significant variation by dentist and practice characteristics.

General/miscellaneous services were provided at higher rates by non-solo practitioners (RR=0.69 for solo practitioners), for those with a longer time since graduation (RR=0.62 for those with a shorter time since graduation), for those with longer waiting times (RR=0.60 for those with shorter waiting times), and for those who worked with a higher number of non-dentist staff (RR=0.55 for those who worked with a lower number of non-dentist staff).

Total services per visit were provided at a higher rate among younger dentists (e.g., RR=1.14 for 20-29 year olds compared to 50+ year olds), for non-solo practitioners (RR=0.94 for solo practitioners), for those at capital city locations (RR=1.09), for those with a shorter time since graduation (RR=1.10), for those who worked with a higher number of other dentists (RR=0.95 for those who worked with a lower number of other dentists), for those who worked with a higher number of non-dentist staff (RR=0.93 for those who worked with a lower number of non-dentist staff), and for those who had fewer patient visits per year (RR=1.07).

Table 4.40: Mean services per visit by dentist and practice characteristics (part 3)

	Orthodontic		General/misc.		Total services	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
Sex of dentist						
Male	0.004	0.002	0.05	0.01	2.18	0.04
Female	0.000	0.000	0.04	0.01	2.21	0.07
Age of dentist					**	
20-29 years	0.000	0.000	0.04	0.01	2.30	0.09
30-39 years	0.006	0.003	0.04	0.01	2.26	0.07
40-49 years	0.005	0.003	0.04	0.01	2.22	0.08
50+ years	0.001	0.001	0.06	0.01	2.01	0.06
Practice type			*		**	
Solo	0.004	0.002	0.04	0.01	2.15	0.06
Non-solo	0.003	0.002	0.06	0.01	2.23	0.05
Location					**	
Capital city	0.004	0.001	0.05	0.01	2.23	0.04
Non-capital	0.003	0.003	0.05	0.01	2.07	0.08
Time since graduation			**		**	
Long (> median)[a]	0.004	0.002	0.06	0.01	2.09	0.05
Short (≤ median)	0.003	0.001	0.03	0.01	2.27	0.06
Other dentists[b]					*	
Higher (> median)[a]	0.003	0.002	0.05	0.01	2.23	0.07
Lower (≤ median)	0.004	0.001	0.05	0.01	2.17	0.04
Waiting time[b]			**			
Long (> median)[a]	0.003	0.002	0.06	0.01	2.16	0.05
Short (≤ median)	0.004	0.002	0.04	0.01	2.21	0.05
Non-dentist staff[b]			**		**	
Higher (> median)[a]	0.004	0.002	0.06	0.01	2.29	0.06
Lower (≤ median)	0.003	0.001	0.03	0.01	2.10	0.04
Patients per year[b]					**	
Higher (> median)[a]	0.005	0.002	0.04	0.01	2.12	0.05
Lower (≤ median)	0.003	0.002	0.05	0.01	2.24	0.05

(a) median time since graduation = 17.5 years; median number of other dentists = 1; median waiting time = 4 days; median number of non-dentist staff = 2.11 FTE; median number of patient visits per year = 2,664
(b) in main private practice
*(P<0.05), **(P<0.01) Poisson regression

4.7.2 Practice beliefs

Tables 4.41, 4.42 and 4.43 present the mean rate of services per patient visit by the practice belief scales which have been dichotomised into less than or equal to the median (i.e., strongly agree or agree) and greater than the median (i.e., towards the disagree to strongly disagree end of the scale). Those agreeing (i.e., categorised as higher belief) with the Information giving scale had scores less than or equal to the median of 1.33, those agreeing with the Preventive orientation scale had scores less than or equal to the median of 2.5, those agreeing with the Patient influence scale had scores less than or equal to the median of 1.5, and the Controlling active disease item was dichotomised using scores less than or equal to the median of 4.

Diagnostic services were not statistically associated with the practice belief scales. Preventive services were provided at higher rates for those with higher agreement with the Patient influence scale (RR=1.11), but at lower rates (RR=0.80) for those with higher agreement with the Controlling active disease item. Periodontic services were also provided at lower rates (RR=0.57) for those with higher agreement with the Controlling active disease item. Extraction services were provided at lower rates for those with higher agreement with the Information giving scale (RR=0.77), the Preventive orientation scale (RR=0.80), and the Controlling active disease item (RR=0.72).

Table 4.41: Mean services per visit by dichotomised practice belief scales [a] (part 1)

	Diagnostic		Preventive		Periodontic		Extraction	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Information giving							*	
Lower belief	0.65	0.03	0.39	0.03	0.023	0.006	0.10	0.01
Higher belief [a]	0.68	0.02	0.39	0.02	0.016	0.004	0.09	0.01
Preventive orientation							*	
Lower belief	0.65	0.03	0.38	0.03	0.020	0.007	0.10	0.01
Higher belief [a]	0.68	0.02	0.40	0.02	0.019	0.004	0.09	0.01
Patient influence			*					
Lower belief	0.67	0.03	0.37	0.03	0.022	0.006	0.09	0.01
Higher belief [a]	0.67	0.02	0.40	0.02	0.017	0.004	0.09	0.01
Controlling active disease			**		*		**	
Lower belief	0.66	0.04	0.45	0.04	0.026	0.010	0.12	0.02
Higher belief [a]	0.67	0.02	0.37	0.02	0.017	0.017	0.08	0.01

(a) scores ≤ median indicate stronger agreement on a scale
*(P<0.05), **(P<0.01) Poisson regression

Endodontic services showed no statistically significant associations with practice beliefs. Restorative services were provided at a higher rate for those who had higher agreement with the Preventive orientation scale (RR=1.21). Crown and bridge services were provided at a higher rate for those who had higher agreement with the Information giving scale (RR=1.38) and with the Controlling active disease item (RR=1.38). Prosthodontic services were provided at a lower rate for those who had higher agreement with the Information giving scale (RR=0.75).

Table 4.42: Mean services per visit by dichotomised practice belief scales [a] (part 2)

	Endodontic		Restorative		Crown/bridge		Prosthodontic	
	Mean	**S.E.**	**Mean**	**S.E.**	**Mean**	**S.E.**	**Mean**	**S.E.**
Information giving					**		**	
Lower belief	0.12	0.01	0.60	0.03	0.07	0.01	0.11	0.02
Higher belief [a]	0.12	0.01	0.57	0.03	0.09	0.01	0.09	0.01
Preventive orientation			**					
Lower belief	0.11	0.02	0.51	0.03	0.07	0.01	0.09	0.02
Higher belief [a]	0.13	0.01	0.62	0.03	0.09	0.01	0.10	0.01
Patient influence								
Lower belief	0.11	0.01	0.56	0.03	0.09	0.01	0.09	0.02
Higher belief [a]	0.13	0.01	0.60	0.03	0.08	0.01	0.10	0.01
Controlling active disease					*			
Lower belief	0.14	0.02	0.61	0.04	0.06	0.01	0.07	0.01
Higher belief [a]	0.12	0.01	0.58	0.02	0.09	0.01	0.10	0.01

(a) scores ≤ median indicate stronger agreement on a scale
*(P<0.05), **(P<0.01) Poisson regression

Orthodontic services showed no statistically significant associations with practice beliefs. General/miscellaneous services were provided at a higher rate for those who had higher agreement with the Controlling active disease item (RR=1.63). Total services per visit were provided at a higher rate for those who had higher agreement with the Preventive orientation scale (RR=1.08).

Table 4.43: Mean services per visit by dichotomised practice belief scales [a] (part 3)

	Orthodontic		General/misc.		Total services	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
Information giving						
Lower belief	0.017	0.005	0.04	0.01	2.12	0.05
Higher belief [a]	0.016	0.004	0.04	0.01	2.09	0.04
Preventive orientation					**	
Lower belief	0.015	0.005	0.04	0.01	1.98	0.05
Higher belief [a]	0.017	0.004	0.04	0.01	2.17	0.04
Patient influence						
Lower belief	0.016	0.005	0.04	0.01	2.06	0.05
Higher belief [a]	0.016	0.004	0.04	0.01	2.14	0.05
Controlling active disease			*			
Lower belief	0.013	0.005	0.03	0.01	2.17	0.07
Higher belief [a]	0.017	0.004	0.04	0.01	2.09	0.04

(a) scores ≤ median indicate stronger agreement on a scale
*(P<0.05), **(P<0.01) Poisson regression

4.7.3 Treatment choice

Variation in service rates is presented in Tables 4.44, 4.45 and 4.46 by cluster membership. Compared to the reference category of the Oral health cluster, dentists in the Cost cluster showed higher rates of extraction and prosthodontic services (rate ratios of 1.52 and 1.32 respectively), while dentists in the Patient cluster had slightly higher rates of restorative services (with a rate ratio of 1.13).

Table 4.44: Service rates by cluster membership (part 1)

	Diagnostic		Preventive		Periodontic		Extraction	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Cluster membership							**	
Patient	0.65	0.03	0.39	0.04	0.018	0.007	0.08	0.01
Cost	0.69	0.04	0.39	0.04	0.027	0.010	0.12	0.02
Oral health	0.68	0.03	0.40	0.02	0.017	0.004	0.09	0.01

*(P<0.05), **(P<0.01) Poisson regression

Table 4.45: Service rates by cluster membership (part 2)

	Endodontic		Restorative		Crown/bridge		Prosthodontic	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Cluster membership			*				*	
Patient	0.12	0.02	0.66	0.05	0.08	0.01	0.09	0.02
Cost	0.12	0.02	0.55	0.04	0.10	0.02	0.12	0.02
Oral health	0.12	0.01	0.56	0.03	0.07	0.01	0.09	0.01

*(P<0.05), **(P<0.01) Poisson regression

Table 4.46: Service rates by cluster membership (part 3)

	Orthodontic		General/misc.		Total services	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
Cluster membership						
Patient	0.022	0.009	0.03	0.01	2.14	0.07
Cost	0.015	0.005	0.04	0.01	2.16	0.08
Oral health	0.015	0.004	0.04	0.01	2.08	0.04

*(P<0.05), **(P<0.01) Poisson regression

4.7.4 Dentist preferences for patients

Tables 4.47, 4.48 and 4.49 present mean service rates per visit by the dentist preferences for patients scales, dichotomised into less than or equal to the median and greater than the median. Those agreeing with (i.e., higher preference) the Dental behaviour sub-scale had scores less than or equal to the median of 1.55, those agreeing with the Personality sub-scale had scores less than or equal to the median of 2.22, those agreeing with the General behaviour sub-scale had scores less than or equal to the median of 1.67, those agreeing with the Finance sub-scale had scores less than or equal to the median of 2.6, and those agreeing with the Selectivity scale had scores less than or equal to the median of 2.01.

Diagnostic services were provided at higher rates by those who had higher agreement with the Dental behaviour sub-scale (RR=1.11). Preventive services were provided at a higher rate among those who had higher agreement with the Dental behaviour sub-scale (RR=1.22), and General behaviour sub-scale (RR=1.13). Periodontic services were provided at a higher rate by those who had higher agreement with the General behaviour sub-scale (RR=1.72). Extraction services were not significantly associated with dentist preferences for patients.

Table 4.47: Mean services per visit by dichotomised dentist preferences for patients scales (a) (part 1)

	Diagnostic		Preventive		Periodontic		Extraction	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Dental behaviour	*		**					
Lower preference	0.63	0.03	0.35	0.03	0.022	0.006	0.10	0.01
Higher preference (a)	0.70	0.03	0.42	0.02	0.017	0.004	0.09	0.01
Personality								
Lower preference	0.66	0.03	0.39	0.03	0.017	0.005	0.08	0.01
Higher preference (a)	0.68	0.03	0.39	0.02	0.022	0.004	0.10	0.01
General behaviour			*		*			
Lower preference	0.65	0.03	0.37	0.03	0.013	0.004	0.09	0.01
Higher preference (a)	0.68	0.03	0.41	0.02	0.024	0.005	0.09	0.01
Finance								
Lower preference	0.68	0.03	0.41	0.03	0.019	0.006	0.08	0.01
Higher preference (a)	0.66	0.03	0.38	0.02	0.019	0.004	0.10	0.01
Selectivity								
Lower preference	0.65	0.03	0.37	0.03	0.017	0.005	0.09	0.01
Higher preference (a)	0.68	0.03	0.41	0.02	0.021	0.004	0.09	0.01

(a) scores ≤ median indicate stronger agreement on a scale
*(P<0.05), **(P<0.01) Poisson regression

Endodontic services were provided at a lower rate by those who had higher agreement with the General behaviour sub-scale (RR=0.81). Restorative services were provided at a higher rate by those who had higher agreement with the Finance sub-scale (RR=1.13). There were no significant associations between dentist preferences for patients and crown and bridge services. Prosthodontic services were provided at a higher rate for those who had higher agreement with the Personality sub-scale (RR=1.23), and the General behaviour sub-scale (RR=1.27).

Table 4.48: Mean services per visit by dichotomised dentist preferences for patients scales [a] (part 2)

	Endodontic		Restorative		Crown/bridge		Prosthodontic	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Dental behaviour								
Lower preference	0.12	0.02	0.58	0.03	0.08	0.01	0.09	0.02
Higher preference [a]	0.12	0.01	0.59	0.03	0.08	0.01	0.10	0.01
Personality							*	
Lower preference	0.12	0.02	0.56	0.03	0.08	0.01	0.08	0.01
Higher preference [a]	0.12	0.01	0.61	0.03	0.08	0.01	0.11	0.01
General behaviour	*						*	
Lower preference	0.14	0.02	0.61	0.04	0.08	0.01	0.08	0.01
Higher preference [a]	0.11	0.01	0.56	0.02	0.08	0.01	0.10	0.01
Finance			**					
Lower preference	0.12	0.02	0.54	0.03	0.08	0.01	0.10	0.02
Higher preference [a]	0.13	0.01	0.62	0.03	0.08	0.01	0.09	0.01
Selectivity								
Lower preference	0.12	0.02	0.58	0.03	0.08	0.01	0.09	0.01
Higher preference [a]	0.12	0.01	0.59	0.03	0.09	0.01	0.10	0.01

(a) scores ≤ median indicate stronger agreement on a scale
*(P<0.05), **(P<0.01) Poisson regression

Orthodontic services were provided at a higher rate for those who had higher agreement with the Finance sub-scale (RR=2.03). General services were provided at a lower rate by those who had higher agreement with the Finance sub-scale (RR=0.72). The rate of total services per visit was higher for those who had higher agreement with the Dental behaviour sub-scale (RR=1.08) and for those who had higher agreement with the Selectivity scale (RR=1.05).

Table 4.49: Mean services per visit by dichotomised dentist preferences for patients scales [a] (part 3)

	Orthodontic		General/misc.		Total services	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
Dental behaviour					**	
Lower preference	0.015	0.005	0.03	0.01	2.02	0.05
Higher preference [a]	0.016	0.004	0.05	0.01	2.18	0.04
Personality						
Lower preference	0.017	0.006	0.04	0.01	2.05	0.05
Higher preference [a]	0.016	0.003	0.04	0.01	2.15	0.05
General behaviour						
Lower preference	0.013	0.004	0.04	0.01	2.09	0.05
Higher preference [a]	0.018	0.004	0.04	0.01	2.12	0.04
Finance	**		*			
Lower preference	0.012	0.005	0.05	0.01	2.07	0.05
Higher preference [a]	0.019	0.004	0.04	0.01	2.13	0.04
Selectivity					*	
Lower preference	0.015	0.004	0.04	0.01	2.06	0.05
Higher preference [a]	0.017	0.004	0.04	0.01	2.15	0.04

(a) scores ≤ median indicate stronger agreement on a scale
*(P<0.05), **(P<0.01) Poisson regression

4.7.5 Patient, visit, and oral health variables

Table 4.50 presents mean services per visit by patient, visit and oral health variables for diagnostic, preventive, periodontic and extraction services. Diagnostic services were provided at higher rates among younger patients (e.g., RR=1.66 for 18-24 year olds compared to 65+ year olds), new patients (RR=1.77), patients in capital cities (RR=1.13), dentate patients (RR=0.26 for edentulous patients), for those without any dentures (RR=0.68 for those with dentures), for those with higher numbers of teeth (e.g., RR=1.56 for 29-32 teeth compared to 1-20 teeth), and for those with either no decay or 5+ decayed teeth (e.g., RR=0.87 for 1-4 decayed teeth compared to no decay). Preventive services were provided at higher rates among younger patients (e.g., RR=1.37 for 18-24 year olds compared to 65+ year olds), for non-emergency visits (RR=0.19 for emergency visits), for insured patients (RR=1.45), for patients in capital cities (RR=1.47), for those without dentures (RR=0.61 for those with dentures), for those with higher numbers of teeth (e.g., RR=1.81 for those with 29-32 teeth compared to 1-20 teeth), and for those with fewer decayed teeth (RR=0.30 for those with 5+ decayed teeth compared to no decay). Periodontic services were provided at higher rates among middle age groups (i.e., RR=2.42 for 45-64 year olds compared to 65+ year olds), for insured patients (RR=1.78), and for patient in capital cities (RR=2.05). Extraction services were provided at a higher rate for male patients (RR=1.33), emergency visits (RR=10.07), uninsured patients (RR=0.33 for insured patients), new patients (RR=2.11), patients at non-capital locations (RR=0.64 at capital city locations), for those with fewer teeth (RR=0.51 for those with 29-32 teeth compared to 1-20 teeth), and for those with more decayed teeth (RR=2.49 for those with 5+ decayed teeth compared to no decayed teeth).

Table 4.50: Mean services per visit by patient, visit and oral health variables (part 1)

	Diagnostic		Preventive		Periodontic		Extraction	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Age of patient	**		**		*			
18-24 years	0.85	0.05	0.47	0.04	0.010	0.006	0.09	0.02
25-44 years	0.69	0.02	0.38	0.02	0.017	0.004	0.09	0.01
45-64 years	0.61	0.02	0.31	0.02	0.034	0.006	0.08	0.01
65+ years	0.51	0.03	0.34	0.03	0.014	0.006	0.08	0.02
Sex of patient							*	
Male	0.67	0.02	0.35	0.02	0.023	0.005	0.10	0.01
Female	0.64	0.02	0.36	0.02	0.022	0.004	0.07	0.01
Visit type			**				**	
Emergency	0.70	0.03	0.09	0.01	0.027	0.006	0.25	0.02
Non-emergency	0.67	0.02	0.46	0.02	0.023	0.004	0.02	0.004
Insurance status			**		*		**	
Insured	0.66	0.02	0.42	0.02	0.029	0.005	0.04	0.01
Uninsured	0.65	0.02	0.29	0.02	0.016	0.004	0.13	0.01
Patient status	**						**	
New	1.05	0.05	0.31	0.03	0.013	0.006	0.15	0.02
Previous	0.59	0.01	0.36	0.01	0.024	0.003	0.07	0.01
Location	*		**		*		**	
Capital city	0.67	0.02	0.39	0.01	0.027	0.004	0.07	0.01
Non-capital	0.60	0.03	0.27	0.02	0.013	0.004	0.11	0.02
Dentate status (a)	**							
Dentate	0.65	0.01	0.36	0.01	0.023	0.003	0.08	0.01
Edentulous	0.17	0.05	-	-	-	-	0.01	0.01
Denture status (b)	**		**					
Present	0.47	0.03	0.24	0.02	0.015	0.005	0.10	0.01
Absent	0.70	0.02	0.39	0.01	0.025	0.004	0.08	0.01
Number of teeth (b)	**		**				**	
1-20	0.49	0.03	0.22	0.02	0.015	0.006	0.15	0.03
21-24	0.58	0.03	0.33	0.03	0.017	0.006	0.08	0.01
25-28	0.69	0.02	0.40	0.02	0.028	0.005	0.06	0.01
29-32	0.77	0.04	0.40	0.03	0.020	0.005	0.08	0.01
Decayed teeth (b)	**		**				**	
No decay	0.68	0.02	0.48	0.02	0.024	0.004	0.07	0.01
1-4 decayed	0.59	0.02	0.26	0.02	0.022	0.005	0.08	0.01
5+ decayed	0.69	0.05	0.15	0.02	0.025	0.009	0.16	0.02

(a) patients aged 18 years or more; (b) dentate patients aged 18 years or more
*(P<0.05), **(P<0.01) Poisson regression

Table 4.51 presents mean services per visit by patient, visit and oral health variables for endodontic, restorative, crown and bridge, and prosthodontic services. Endodontic services were provided at higher rates among younger patients (e.g., RR=1.69 for 25-44 year olds compared to 65+ year olds), male patients (RR=1.25), emergency visits (RR=2.87), previous patients (RR=0.64 for new patients), those without dentures (RR=0.61 for those with dentures), and those with more decay (RR=1.76 for 5+ compared to no decayed teeth). Restorative services were provided at higher rates among older patients (e.g., RR=0.56 for 18-24 year olds compared to 65+ year olds), male patients (RR=1.16), non-emergency visits (RR=0.85 for emergency visits), previous patients (RR=0.80 for new patients), for those without dentures (RR=0.80 for those with dentures), those with few missing teeth (e.g., RR=1.24 for 21-24 compared to 1-20 missing teeth), and those with more decay (e.g., RR=3.42 for 5+ compared to no decayed teeth). Crown and bridge services were provided at higher rates among middle age groups (e.g., RR=2.55 for 45-64 year olds compared to 65+ year olds), non-emergency visits (RR=0.25 for emergency visits), insured patients (RR=2.14), previous patients (RR=0.12 for new patients), in capital cities (RR=1.45), for those with few missing teeth (e.g., RR=1.89 for 21-24 compared to 1-20 missing teeth), and for those with no decayed teeth (RR=0.38 for 5+ compared to no decayed teeth). Prosthodontic services were provided at higher rates among older patients (e.g., RR=0.16 for 18-24 year olds compared to 65+ year olds), non-emergency visits (RR=0.70 for emergency visits), previous patients (RR=0.54 for new patients), in non-capital cities (RR=0.56 in capital cities), for the edentulous (RR=9.11), for those with dentures (RR=35.26), for those with fewer teeth (e.g., RR=0.03 for 29-32 compared to 1-20 teeth), and those with no or 5+ decayed teeth (e.g., RR=0.21 for 1-4 compared to no decayed teeth).

Table 4.51: Mean services per visit by patient, visit and oral health variables (part 2)

	Endodontic		Restorative		Crown & bridge		Prosthodontic	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Age of patient	**		**		**		**	
18-24 years	0.14	0.03	0.39	0.05	0.01	0.01	0.03	0.02
25-44 years	0.15	0.02	0.66	0.03	0.08	0.01	0.04	0.01
45-64 years	0.12	0.01	0.64	0.03	0.14	0.01	0.14	0.02
65+ years	0.09	0.02	0.70	0.06	0.05	0.01	0.21	0.03
Sex of patient	*		**					
Male	0.15	0.01	0.69	0.03	0.09	0.01	0.10	0.01
Female	0.12	0.01	0.59	0.02	0.09	0.01	0.10	0.01
Visit type	**		**		**		*	
Emergency	0.25	0.02	0.53	0.03	0.03	0.01	0.08	0.02
Non-emergency	0.09	0.01	0.62	0.02	0.11	0.01	0.11	0.01
Insurance status					**			
Insured	0.13	0.01	0.66	0.03	0.13	0.01	0.09	0.02
Uninsured	0.13	0.01	0.60	0.02	0.06	0.01	0.11	0.01
Patient status	*		**		**		**	
New	0.09	0.02	0.52	0.05	0.01	0.01	0.06	0.01
Previous	0.14	0.01	0.65	0.02	0.10	0.01	0.11	0.01
Location					*		**	
Capital city	0.14	0.01	0.63	0.02	0.10	0.01	0.08	0.01
Non-capital	0.12	0.02	0.66	0.03	0.07	0.01	0.15	0.03
Dentate status (a)							**	
Dentate	0.13	0.01	0.64	0.02	0.09	0.01	0.10	0.01
Edentulous	-	-	-	-	-	-	0.91	0.06
Denture status (b)	**		**				**	
Present	0.09	0.01	0.53	0.04	0.10	0.02	0.43	0.04
Absent	0.14	0.01	0.66	0.02	0.09	0.01	0.01	0.005
Number of teeth (b)			**		**		**	
1-20	0.11	0.02	0.56	0.05	0.07	0.02	0.40	0.04
21-24	0.13	0.03	0.70	0.05	0.14	0.02	0.11	0.03
25-28	0.14	0.01	0.65	0.03	0.10	0.01	0.02	0.01
29-32	0.13	0.02	0.63	0.04	0.06	0.01	0.01	0.004
Decayed teeth (b)	**		**		**		**	
No decay	0.11	0.01	0.32	0.02	0.13	0.01	0.16	0.02
1-4 decayed	0.14	0.01	0.88	0.03	0.06	0.01	0.03	0.01
5+ decayed	0.18	0.04	1.09	0.08	0.05	0.02	0.12	0.04

(a) patients aged 18 years or more; (b) dentate patients aged 18 years or more
*(P<0.05), **(P<0.01) Poisson regression

Table 4.52 presents mean services per visit by patient, visit and oral health variables for orthodontic, general and total services. Orthodontic services were provided at low rates in private general practice, but there were no statistically significant associations by patient, visit and oral health variables. General services were provided at higher rates for emergency visits (RR=2.88), and for those with few missing teeth (i.e., RR=1.71 for 25-28 compared to 1-20 teeth present). Total services per visit were provided at a higher rate for male patients (RR=1.07), insured patients (RR=1.09), those from capital city locations (RR=1.06), dentate patients (RR=0.52 for edentulous patients), those without any dentures (RR=0.93 for those with dentures), and for those with more decayed teeth (RR=1.25 for 5+ compared to no decayed teeth).

Table 4.52: Mean services per visit by patient, visit and oral health variables (part 3)

	Orthodontic		General/misc.		Total services	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
Age of patient						
18-24 years	0.024	0.009	0.04	0.01	2.06	0.07
25-44 years	0.005	0.002	0.06	0.01	2.17	0.04
45-64 years	0.000	0.000	0.05	0.01	2.12	0.04
65+ years	0.000	0.000	0.04	0.01	2.05	0.06
Sex of patient					**	
Male	0.006	0.002	0.04	0.01	2.20	0.04
Female	0.003	0.001	0.06	0.01	2.07	0.03
Visit type			**			
Emergency	0.000	0.000	0.10	0.01	2.05	0.05
Non-emergency	0.006	0.002	0.03	0.004	2.15	0.03
Insurance status					**	
Insured	0.005	0.002	0.05	0.01	2.22	0.03
Uninsured	0.004	0.002	0.05	0.01	2.04	0.03
Patient status						
New	0.003	0.003	0.04	0.01	2.25	0.07
Previous	0.005	0.001	0.05	0.005	2.11	0.02
Location					*	
Capital city	0.005	0.001	0.05	0.01	2.17	0.03
Non-capital	0.004	0.002	0.05	0.01	2.04	0.05
Dentate status [a]					**	
Dentate	0.004	0.001	0.05	0.004	2.13	0.02
Edentulous	-	-	-	-	1.10	0.04
Denture status [b]					*	
Present	0.001	0.001	0.04	0.01	2.00	0.05
Absent	0.005	0.001	0.05	0.01	2.16	0.03
Number of teeth [b]			*			
1-20	0.000	0.000	0.03	0.01	2.06	0.06
21-24	0.006	0.004	0.04	0.01	2.13	0.06
25-28	0.004	0.002	0.06	0.01	2.14	0.03
29-32	0.007	0.003	0.05	0.01	2.16	0.05
Decayed teeth [b]					**	
No decay	0.008	0.002	0.05	0.01	2.03	0.03
1-4 decayed	0.002	0.001	0.04	0.01	2.11	0.04
5+ decayed	0.000	0.000	0.06	0.02	2.54	0.09

(a) patients aged 18 years or more; (b) dentate patients aged 18 years or more
*(P<0.05), **(P<0.01) Poisson regression

4.7.6 Patient evaluation items

Tables 4.53, 4.54 and 4.55 present mean service rates per visit by the patient evaluation scales, dichotomised into less than or equal to the median (i.e., towards the strongly agree or agree end of the scale) and greater than the median (i.e., towards the disagree to strongly disagree end of the scale). Those evaluated as agreeing with (i.e., had a higher rating on) the Payment sub-scale had scores less than or equal to the median of 2.0, those evaluated as agreeing with the Knowledge sub-scale had scores less than or equal to the median of 2.5, those evaluated as agreeing with the No problems sub-scale had scores less than or equal to the median of 2.0, and those evaluated as agreeing with the Patient evaluation scale had scores less than or equal to the median of 2.33.

Diagnostic services had no statistically significant associations with the patient evaluation scores. Preventive services were provided at a higher rate for those with higher agreement ratings with the Payment sub-scale (RR=1.33), the Knowledge sub-scale (RR=1.33), the No problems sub-scale (RR=1.25), and the Patient evaluation scale (RR=1.42). Periodontic services were provided at a higher rate for those with higher agreement ratings with the Payment sub-scale (RR=1.98), and the Patient evaluation scale (RR=1.87). Extraction rates were lower for those with higher agreement ratings with the Payment sub-scale (RR=0.72), the Knowledge sub-scale (RR=0.52), the No problems sub-scale (RR=0.58), and the Patient evaluation scale (RR=0.58).

Table 4.53: Mean services per visit by dichotomised patient evaluation scales [a] (part 1)

	Diagnostic		Preventive		Periodontic		Extraction	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Payment			**		*		**	
Lower rating	0.65	0.02	0.31	0.02	0.011	0.003	0.11	0.01
Higher rating [a]	0.65	0.02	0.42	0.01	0.023	0.003	0.08	0.01
Knowledge			**				**	
Lower rating	0.66	0.02	0.32	0.02	0.014	0.003	0.12	0.01
Higher rating [a]	0.64	0.02	0.42	0.01	0.022	0.003	0.06	0.01
No problems			**				**	
Lower rating	0.64	0.02	0.33	0.02	0.014	0.003	0.12	0.01
Higher rating [a]	0.66	0.02	0.41	0.02	0.021	0.003	0.07	0.01
Patient evaluation			**		*		**	
Lower rating	0.63	0.02	0.30	0.02	0.012	0.003	0.11	0.01
Higher rating [a]	0.66	0.02	0.43	0.02	0.023	0.004	0.07	0.01

(a) scores ≤ median indicate stronger agreement on a scale
*(P<0.05), **(P<0.01) Poisson regression

Endodontic services were provided at a lower rate to those who had a higher agreement rating with the Patient evaluation scale (RR=0.75). Restorative services were provided at a lower rate to those who had a higher agreement rating with the Payment sub-scale (RR=0.92). Crown and bridge services were provided at a higher rate to those who had a higher agreement rating with the Payment sub-scale (RR=2.28), the Knowledge sub-scale (RR=1.90), and the Patient evaluation scale (RR=1.70). Prosthodontic services were provided at a lower rate to those who had a higher agreement rating with the No problems sub-scale (RR=0.77).

Table 4.54: Mean services per visit by dichotomised patient evaluation scales [a] (part 2)

	Endodontic		Restorative		Crown/bridge		Prosthodontic	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Payment			*		**			
Lower rating	0.13	0.01	0.60	0.02	0.04	0.01	0.09	0.01
Higher rating [a]	0.10	0.01	0.55	0.02	0.10	0.01	0.10	0.01
Knowledge					**			
Lower rating	0.12	0.01	0.58	0.03	0.05	0.01	0.10	0.01
Higher rating [a]	0.10	0.01	0.56	0.02	0.09	0.01	0.10	0.01
No problems							**	
Lower rating	0.12	0.01	0.54	0.02	0.07	0.01	0.11	0.01
Higher rating [a]	0.11	0.01	0.58	0.02	0.08	0.01	0.09	0.01
Patient evaluation	**				**			
Lower rating	0.13	0.01	0.57	0.02	0.05	0.01	0.10	0.01
Higher rating [a]	0.10	0.01	0.56	0.02	0.09	0.01	0.09	0.01

(a) scores ≤ median indicate stronger agreement on a scale
*(P<0.05), **(P<0.01) Poisson regression

Orthodontic services were provided at a higher rate to those who had a higher agreement rating with the Payment sub-scale (RR=2.98), the Knowledge sub-scale (RR=3.10), the No problems sub-scale (RR=1.79), and the Patient evaluation scale (RR=1.87). Total services per visit were provided at a higher rate for those with a higher agreement rating with the Payment sub-scale (RR=1.06), and the Patient evaluation scale (RR=1.06).

Table 4.55: Mean services per visit by dichotomised patient evaluation scales [a] (part 3)

	Orthodontic		General/misc.		Total services	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
Payment	**				*	
Lower rating	0.009	0.003	0.04	0.01	1.98	0.03
Higher rating [a]	0.028	0.003	0.04	0.01	2.09	0.03
Knowledge	**					
Lower rating	0.009	0.002	0.04	0.01	2.02	0.03
Higher rating [a]	0.029	0.003	0.04	0.004	2.07	0.03
No problems	*					
Lower rating	0.014	0.003	0.04	0.01	2.00	0.03
Higher rating [a]	0.026	0.003	0.04	0.004	2.08	0.03
Patient evaluation	**				*	
Lower rating	0.014	0.003	0.04	0.01	1.98	0.03
Higher rating [a]	0.026	0.003	0.04	0.01	2.10	0.03

(a) scores ≤ median indicate stronger agreement on a scale
*(P<0.05), **(P<0.01) Poisson regression

4.7.7 Area-based indicators of socio-economic status

Tables 4.56, 4.57 and 4.58 present mean services per visit by the Index of Relative Socio-economic Disadvantage dichotomised using the median as a cut-off point, with lower index scores indicating lower socio-economic areas. Patients residing in lower socio-economic areas had lower rates of preventive (RR=0.76), periodontic (RR=0.43), and crown and bridge services (RR=0.72), but had higher rates of extraction (RR=2.15) and prosthodontic services (RR=1.67).

Table 4.56: Mean services per visit by Index of Relative Socio-economic disadvantage (part 1)

	Diagnostic		Preventive		Periodontic		Extraction	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Index of Relative Socio-economic Disadvantage(a)			**		**		**	
Higher SES	0.67	0.02	0.41	0.02	0.032	0.005	0.05	0.01
Lower SES (a)	0.64	0.02	0.31	0.02	0.014	0.003	0.11	0.01

(a) Index ≤ median (lower scores) indicates more low income families, people with little training and in unskilled occupations
**(P<0.01) Poisson regression

Table 4.57: Mean services per visit by Index of Relative Socio-economic disadvantage (part 2)

	Endodontic		Restorative		Crown/bridge		Prosthodontic	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Index of Relative Socio-economic Disadvantage(a)					**		**	
Higher SES	0.14	0.01	0.64	0.03	0.11	0.01	0.07	0.01
Lower SES (a)	0.13	0.01	0.63	0.03	0.08	0.01	0.12	0.02

(a) Index ≤ median (lower scores) indicates more low income families, people with little training and in unskilled occupations
**(P<0.01) Poisson regression

Table 4.58: Mean services per visit by Index of Relative Socio-economic disadvantage (part 3)

	Orthodontic		General/misc.		Total services	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
Index of Relative Socio-economic Disadvantage(a)						
Higher SES	0.003	0.001	0.05	0.01	2.18	0.03
Lower SES (a)	0.006	0.002	0.05	0.01	2.09	0.03

(a) Index ≤ median (lower scores) indicates more low income families, people with little training and in unskilled occupations

4.8 Multivariate models of service provision

This section combines elements from the previous sections (e.g., use of scales) into multivariate models of service provision. Services provided per visit form a set of dependent variables which are modelled controlling for dentist, practice, patient, visit and oral health variables. As outlined in Table 4.59, analysis can be made at two levels, one is that of the patient where services provided to individual patients recorded in the service log form the basis of the analysis, with each patient being the unit of analysis. The other level of analysis is that of the dentist, where services provided to patients by dentists are aggregated within each dentist, with each dentist forming the unit of analysis. Analyses at the dentist level treat patients as replicate measurements from a dentist which are combined to yield an overall measure of their provision of services. Analyses at the patient level are analogous to a cluster design where dentists are sampled as clusters and patients are sampled as units within each cluster.

Table 4.59: Outline of patient and dentist models of service provision

	Patient level	Dentist level
Unit of analysis	Patient	Dentist
Sample size	4,115	345
Design	Clustered within dentists	Simple random sample
Dentist variables	Not included	Included
Patient variables	Included	Aggregate form
Weighting	By design effect	Not weighted

4.8.1 Patient level models

Since patient level models use measures derived from within clusters of dentists it can be argued that adjustment for clustering is desirable to allow for design effects due to clustering. The patient-level models can be considered as two-stage (cluster) designs with the dentist as the primary sampling unit and patients as the secondary sampling units. Cluster sampling has advantages such as reduced costs, simpler fieldwork, and more convenient administration, but has higher sampling error than for simple random sampling with the same sample size. This lower efficiency of two-stage sampling is measured by the design effect and all models in this section are weighted by the design effects to adjust for this (see Appendix D for details).

Table 4.60 presents rate ratios from multivariate models of service provision for diagnostic, preventive, periodontic and extraction services. Each column presents the results of a separate regression model with the service area listed at the top of the column as the dependent variable with the independent variables listed down the side of the table. Diagnostic services were provided at a higher rate to new patients, but at a lower rate to patients with dentures present, and with one or more decayed teeth. Preventive services were provided at a higher rate among insured patients and patients at capital city locations, but at lower rates for emergency visits and for patients with one or more decayed teeth. There were no statistically significant associations with periodontic services. Extraction services were provided at a higher rate for emergency visits, for patients with lower numbers of teeth, and for patients from lower socio-economic areas, but were provided at lower rates among insured compared to uninsured patients.

Table 4.60: Multivariate Poisson regression models of services per visit: dentate, 18+ years (part 1)

	Diagnostic	Preventive	Periodontic	Extraction
	Rate ratio (95% CI)	Rate ratio (95% CI)	Rate ratio (95% CI)	Rate ratio (95% CI)
Age of patient				
18-24 years	1.18 (0.88-1.59)	1.09 (0.75-1.59)	0.49 (0.05-4.52)	1.09 (0.51-2.35)
25-44 years	1.05 (0.82-1.34)	1.00 (0.73-1.36)	1.09 (0.28-4.33)	1.23 (0.68-2.21)
45-64 years	1.05 (0.83-1.33)	0.82 (0.61-1.11)	2.16 (0.61-7.72)	0.98 (0.56-1.71)
65+ years	Reference	Reference	Reference	Reference
Sex of patient				
Male	1.05 (0.92-1.20)	1.07 (0.90-1.27)	1.13 (0.59-2.17)	1.03 (0.75-1.42)
Female	Reference	Reference	Reference	Reference
Visit type				
Emergency	0.99 (0.85-1.16)	**0.22 (0.15-0.32)	1.21 (0.57-2.55)	**7.51 (5.18-10.89)
Non-emergency	Reference	Reference	Reference	Reference
Insurance status				
Insured	1.09 (0.95-1.24)	*1.26 (1.05-1.52)	1.35 (0.67-2.71)	**0.49 (0.34-0.70)
Uninsured	Reference	Reference	Reference	Reference
Patient status				
New	**1.70 (1.43-2.01)	1.16 (0.87-1.54)	0.56 (0.14-2.18)	1.30 (0.90-1.87)
Previous	Reference	Reference	Reference	Reference
Location				
Capital city	1.11 (0.94-1.30)	**1.38 (1.09-1.75)	1.91 (0.67-5.45)	1.02 (0.70-1.45)
Non-capital	Reference	Reference	Reference	Reference
Denture status				
Present	**0.74 (0.59-0.93)	0.78 (0.57-1.07)	0.61 (0.20-1.83)	0.82 (0.50-1.34)
Absent	Reference	Reference	Reference	Reference
Number of teeth				
1-20 teeth	0.86 (0.67-1.10)	0.72 (0.50-1.03)	0.99 (0.31-3.19)	**2.02 (1.25-3.27)
21-32 teeth	Reference	Reference	Reference	Reference
Decayed teeth				
No decay	Reference	Reference	Reference	Reference
1+ decayed	**0.83 (0.72-0.94)	**0.54 (0.45-0.66)	1.01 (0.52-1.97)	1.01 (0.72-1.43)
Knowledge sub-scale				
Lower rating	Reference	Reference	Reference	Reference
Higher rating (a)	0.90 (0.78-1.04)	0.99 (0.82-1.20)	0.90 (0.45-1.80)	0.75 (0.52-1.10)
Payment sub-scale				
Lower rating	Reference	Reference	Reference	Reference
Higher rating (b)	1.02 (0.89-1.18)	1.19 (0.97-1.45)	1.81 (0.80-4.06)	0.92 (0.65-1.28)
SEIFA Index				
Higher SES	Reference	Reference	Reference	Reference
Lower SES (c)	1.02 (0.88-1.17)	0.92 (0.76-1.11)	0.63 (0.29-1.34)	**1.65 (1.15-2.38)

(a) higher dental knowledge rating; (b) higher rating of willing & able to pay for care; (c) more disadvantaged postcode area
*(P<0.05), **(P<0.01) Poisson regression

Table 4.61 presents rate ratios from multivariate models of service provision for endodontic, restorative, crown and bridge, and prosthodontic services. Endodontic services were provided at higher rates for emergency visits and for those with one or more decayed teeth, but at lower rates for new patients and for patients with dentures present.

Restorative services were provided at a higher rate to insured patients and those with one or more decayed teeth, but at a lower rate among younger patients, emergency visits, new patients, and those with dentures present.

Crown and bridge services were provided at a higher rate among middle age groups and patients who had higher ratings on the Payment sub-scale, but at lower rates for emergency visits, new patients, and those with one or more decayed teeth.

Prosthodontic services were provided at a higher rate among middle age groups, those with a denture present, and for patients with lower numbers of teeth, but at lower rates for patients at capital city locations and for those with one or more decayed teeth.

Table 4.61: Multivariate Poisson regression models of services per visit: dentate, 18+ years (part 2)

	Endodontic	Restorative	Crown & bridge	Prosthodontic
	Rate ratio (95% CI)	Rate ratio (95% CI)	Rate ratio (95% CI)	Rate ratio (95% CI)
Age of patient				
18-24 years	1.59 (0.85-2.97)	**0.48 (0.35-0.65)	0.11 (0.01-1.14)	1.04 (0.27-3.98)
25-44 years	1.45 (0.87-2.43)	**0.73 (0.60-0.89)	*1.96 (1.01-3.78)	**2.20 (1.41-3.43)
45-64 years	1.19 (0.72-1.96)	*0.82 (0.68-0.99)	**2.90 (1.58-5.33)	*1.48 (1.07-2.05)
65+ years	Reference	Reference	Reference	Reference
Sex of patient				
Male	1.16 (0.90-1.49)	1.12 (1.00-1.26)	0.91 (0.66-1.24)	0.87 (0.66-1.15)
Female	Reference	Reference	Reference	Reference
Visit type				
Emergency	**2.69 (2.07-3.49)	**0.79 (0.68-0.91)	**0.25 (0.13-0.47)	0.75 (0.52-1.07)
Non-emergency	Reference	Reference	Reference	Reference
Insurance status				
Insured	1.14 (0.87-1.48)	*1.14 (1.01-1.29)	1.35 (0.96-1.88)	0.85 (0.64-1.13)
Uninsured	Reference	Reference	Reference	Reference
Patient status				
New	**0.45 (0.28-0.72)	**0.72 (0.59-0.87)	*0.27 (0.10-0.78)	0.83 (0.48-1.43)
Previous	Reference	Reference	Reference	Reference
Location				
Capital city	1.15 (0.83-1.58)	0.90 (0.78-1.04)	1.15 (0.77-1.73)	**0.64 (0.47-0.88)
Non-capital	Reference	Reference	Reference	Reference
Denture status				
Present	*0.59 (0.38-0.92)	**0.76 (0.62-0.92)	1.39 (0.89-2.16)	**22.29 (12.86-38.64)
Absent	Reference	Reference	Reference	Reference
Number of teeth				
1-20 teeth	1.40 (0.89-2.19)	0.88 (0.71-1.08)	0.77 (0.45-1.31)	**2.70 (1.87-3.91)
21-32 teeth	Reference	Reference	Reference	Reference
Decayed teeth				
No decay	Reference	Reference	Reference	Reference
1+ decayed	*1.35 (1.03-1.77)	**3.04 (2.64-3.49)	**0.60 (0.43-0.83)	**0.41 (0.30-0.56)
Knowledge sub-scale				
Lower rating	Reference	Reference	Reference	Reference
Higher rating (a)	1.09 (0.82-1.44)	0.94 (0.83-1.08)	1.22 (0.87-1.72)	1.07 (0.80-1.44)
Payment sub-scale				
Lower rating	Reference	Reference	Reference	Reference
Higher rating (b)	0.87 (0.66-1.15)	0.98 (0.86-1.11)	**1.81 (1.21-2.71)	1.31 (0.96-1.78)
SEIFA Index				
Higher SES	Reference	Reference	Reference	Reference
Lower SES (c)	1.04 (0.78-1.37)	0.94 (0.83-1.08)	0.91 (0.65-1.27)	1.26 (0.91-1.75)

(a) higher dental knowledge rating; (b) higher rating of willing & able to pay for care; (c) more disadvantaged postcode area
*(P<0.05), **(P<0.01) Poisson regression

Table 4.62 presents rate ratios from multivariate models of service provision for general/miscellaneous and total services. Models for orthodontic services are not presented as these services were provided at very low rates in private general practice which presents problems with model convergence.

General services were provided at a higher rate for emergency compared to non-emergency visits, but no other independent variables had statistically significant associations with general services.

Total services per visit showed no statistically significant associations with any of the independent variables in the multivariate model.

Table 4.62: Multivariate Poisson regression models of services per visit: dentate, 18+ years (part 3)

	General/misc.	Total services
	Rate ratio (95% CI)	Rate ratio (95% CI)
Age of patient		
18-24 years	0.67 (0.25-1.83)	0.96 (0.78-1.16)
25-44 years	0.88 (0.42-1.85)	1.02 (0.88-1.19)
45-64 years	0.71 (0.34-1.47)	1.02 (0.88-1.17)
65+ years	Reference	Reference
Sex of patient		
Male	0.66 (0.43-1.03)	1.05 (0.97-1.15)
Female	Reference	Reference
Visit type		
Emergency	**3.35 (2.19-5.12)	0.94 (0.85-1.04)
Non-emergency	Reference	Reference
Insurance status		
Insured	0.86 (0.56-1.32)	1.09 (1.002-1.19)
Uninsured	Reference	Reference
Patient status		
New	0.55 (0.26-1.16)	1.06 (0.94-1.21)
Previous	Reference	Reference
Location		
Capital city	0.99 (0.59-1.67)	1.05 (0.94-1.16)
Non-capital	Reference	Reference
Denture status		
Present	0.74 (0.36-1.53)	0.92 (0.81-1.05)
Absent	Reference	Reference
Number of teeth		
1-20 teeth	0.73 (0.32-1.62)	1.01 (0.87-1.17)
21-32 teeth	Reference	Reference
Decayed teeth		
No decay	Reference	Reference
1+ decayed	0.74 (0.48-1.14)	1.08 (0.99-1.18)
Knowledge sub-scale		
Lower rating	Reference	Reference
Higher rating [a]	0.82 (0.52-1.28)	0.95 (0.87-1.04)
Payment sub-scale		
Lower rating	Reference	Reference
Higher rating [b]	1.40 (0.88-2.24)	1.07 (0.97-1.17)
SEIFA Index		
Higher SES	Reference	Reference
Lower SES [c]	0.83 (0.52-1.33)	0.99 (0.91-1.09)

(a) higher dental knowledge rating; (b) higher rating of willing & able to pay for care; (c) more disadvantaged postcode area
*(P<0.05), **(P<0.01) Poisson regression

Consistency of effects across model types

Table 4.63 presents the pattern of statistically significant associations of services with the set of independent variables for diagnostic, preventive, periodontic and extraction services across the different model types of logistic regression, Poisson regression and ordinary least squares regression. The details of the effects for the Poisson models were presented in the previous tables in this section. For the details of the other model types see Appendix E (Logistic regression models: patient-level) and Appendix F (Ordinary least squares models: patient-level).

The models of diagnostic services were consistent across model types with the exception of additional significant effects for age of patient and insurance status in the OLS linear regression model.

For preventive services all three model types showed significant effects for visit type and decayed teeth. Both logistic and linear models also showed significant effects for denture status and Payment sub-scale, while both Poisson and linear models showed significant effects for insurance status and geographic location, and the linear model also exhibited a significant effect for number of teeth.

There were no significant effects for periodontic services in any of the three types of statistical models. For extraction services there were consistent effects across all three model types for visit type, insurance status and SEIFA index of disadvantage. The logistic and linear models also showed a significant effect for patient status, while the Poisson and linear models showed a significant effect for number of teeth.

Table 4.63: Pattern of statistically significant effects for services across model types (part 1)

	Diagnostic			Preventive			Periodontic			Extraction		
	LR	PR	OLS	LR	PR	OLS	LR	PR	OLS	LR	PR	OLS
Age of patient												
18-24 years	ns	ns	*(+)	ns	ns	ns	ns	ns	ns	ns	ns	ns
25-44 years	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
45-64 years	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
65+ years	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Sex of patient												
Male	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Female	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Visit type												
Emergency	ns	ns	ns	**(-)	**(-)	**(-)	ns	ns	ns	**(+)	**(+)	**(+)
Non-emergency	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Insurance status												
Insured	ns	ns	*(+)	ns	*(+)	**(+)	ns	ns	ns	**(-)	**(-)	**(-)
Uninsured	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Patient status												
New	**(+)	**(+)	**(+)	ns	ns	ns	ns	ns	ns	*(+)	ns	**(+)
Previous	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Location												
Capital city	ns	ns	ns	ns	**(+)	**(+)	ns	ns	ns	ns	ns	ns
Non-capital	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Denture status												
Present	*(-)	**(-)	**(-)	*(-)	ns	**(-)	ns	ns	ns	ns	ns	ns
Absent	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Number of teeth												
1-20 teeth	ns	ns	ns	ns	ns	*(-)	ns	ns	ns	ns	**(+)	**(+)
21-32 teeth	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Decayed teeth												
No decay	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
1+ decayed	**(-)	**(-)	**(-)	**(-)	**(-)	**(-)	ns	ns	ns	ns	ns	ns
Knowledge sub-scale												
Lower rating	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Higher rating [(a)]	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Payment sub-scale												
Lower rating	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Higher rating [(b)]	ns	ns	ns	*(+)	ns	*(+)	ns	ns	ns	ns	ns	ns
SEIFA Index												
Higher SES	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Lower SES [(c)]	ns	ns	ns	ns	ns	ns	ns	ns	ns	*(+)	**(+)	**(+)

LR = Logistic regression; PR = Poisson regression; OLS = Ordinary least squares regression
(a) higher dental knowledge rating; (b) higher rating of willing & able to pay for care; (c) more disadvantaged postcode area
*(P<0.05), **(P<0.01), ns (not significant)

Table 4.64 presents the pattern of statistically significant associations of services with the set of independent variables for endodontic, restorative, crown and bridge and prosthodontic services across the different model types of logistic regression, Poisson regression and ordinary least squares regression.

Endodontic services showed significant effects for visit type, patient status, and decayed teeth across all three types of model. The Poisson model also showed a significant effect for denture status.

Restorative services showed consistent effects across all three model types for age groups 18-24 and 25-44 years, patient status, and decayed teeth. The logistic and linear models also showed significant effects for geographic location and number of teeth, while the Poisson and linear models showed significant effects for visit type and denture status. The Poisson model also showed significant effects for the age group 45-64 years, and for insurance status.

Crown and bridge services showed consistent effects across all three model types for the 45-64 year age group, visit type, decayed teeth, and the Payment sub-scale. The logistic and Poisson models also showed a significant effect for patient status, while the Poisson model showed a significant effect for the 25-44 year age group.

Prosthodontic services showed consistent effects across all three model types for denture status, number of teeth, and decayed teeth. The logistic and linear models showed a significant effect for insurance status, while the Poisson model showed significant effects for age groups 25-44 and 45-64 years, and for location.

Table 4.64: Pattern of statistically significant effects for services across model types (part 2)

	Endodontic			Restorative			Crown/bridge			Prosthodontic		
	LR	PR	OLS	LR	PR	OLS	LR	PR	OLS	LR	PR	OLS
Age of patient												
18-24 years	ns	ns	ns	**(-)	**(-)	**(-)	ns	ns	ns	ns	ns	ns
25-44 years	ns	ns	ns	*(-)	**(-)	**(-)	ns	*(+)	ns	ns	**(+)	ns
45-64 years	ns	ns	ns	ns	*(-)	ns	**(+)	**(+)	**(+)	ns	*(+)	ns
65+ years	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Sex of patient												
Male	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Female	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Visit type												
Emergency	**(+)	**(+)	**(+)	ns	**(-)	**(-)	**(-)	**(-)	**(-)	ns	ns	ns
Non-emergency	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Insurance status												
Insured	ns	ns	ns	ns	*(+)	ns	ns	ns	ns	*(-)	ns	*(-)
Uninsured	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Patient status												
New	*(-)	**(-)	**(-)	**(-)	**(-)	**(-)	*(-)	*(-)	ns	ns	ns	ns
Previous	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Location												
Capital city	ns	ns	ns	*(-)	ns	*(-)	ns	ns	ns	ns	**(-)	ns
Non-capital	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Denture status												
Present	ns	*(-)	ns	ns	**(-)	*(-)	ns	ns	ns	**(+)	**(+)	**(+)
Absent	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Number of teeth												
1-20 teeth	ns	ns	ns	**(-)	ns	*(-)	ns	ns	ns	**(+)	**(+)	**(+)
21-32 teeth	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Decayed teeth												
No decay	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
1+ decayed	*(+)	*(+)	*(+)	**(+)	**(+)	**(+)	*(-)	**(-)	**(-)	**(-)	**(-)	**(-)
Knowledge sub-scale												
Lower rating	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Higher rating (a)	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Payment sub-scale												
Lower rating	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Higher rating (b)	ns	ns	ns	ns	ns	ns	**(+)	**(+)	**(+)	ns	ns	ns
SEIFA index												
Higher SES	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Lower SES (c)	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

LR = Logistic regression; PR = Poisson regression; OLS = Ordinary least squares regression
(a) higher dental knowledge rating; (b) higher rating of willing & able to pay for care; (c) more disadvantaged postcode area
*(P<0.05), **(P<0.01), ns (not significant)

Table 4.65 presents the pattern of statistically significant associations of services with the set of independent variables for general/miscellaneous and total services across the different model types of logistic regression, Poisson regression and ordinary least squares regression.

General/miscellaneous services showed a consistent effect across all three model types for visit type. The linear model also showed a significant effect for sex of patient.

Models of total services per visit were only applicable for Poisson and linear models which use the number of services as the dependent variable. The logistic model uses the presence or absence of a service as the dependent variable, and since all patients receive one or more services it is not possible to model this using logistic regression. There were no significant effects in the Poisson model of total services. However, the linear model showed significant effects for sex of patient, visit type, insurance status, denture status, decayed teeth, Knowledge sub-scale and Payment sub-scale.

Table 4.65: Pattern of statistically significant effects for services across model types (part 3)

	General/misc.			Total services		
	LR	PR	OLS	LR	PR	OLS
Age of patient						
18-24 years	ns	ns	ns	n/a	ns	ns
25-44 years	ns	ns	ns	n/a	ns	ns
45-64 years	ns	ns	ns	n/a	ns	ns
65+ years	ref.	ref.	ref.	ref.	ref.	ref.
Sex of patient						
Male	ns	ns	*(-)	n/a	ns	*(+)
Female	ref.	ref.	ref.	ref.	ref.	ref.
Visit type						
Emergency	**(+)	**(+)	**(+)	n/a	ns	*(-)
Non-emergency	ref.	ref.	ref.	ref.	ref.	ref.
Insurance status						
Insured	ns	ns	ns	n/a	ns	**(+)
Uninsured	ref.	ref.	ref.	ref.	ref.	ref.
Patient status						
New	ns	ns	ns	n/a	ns	ns
Previous	ref.	ref.	ref.	ref.	ref.	ref.
Location						
Capital city	ns	ns	ns	n/a	ns	ns
Non-capital	ref.	ref.	ref.	ref.	ref.	ref.
Denture status						
Present	ns	ns	ns	n/a	ns	*(-)
Absent	ref.	ref.	ref.	ref.	ref.	ref.
Number of teeth						
1-20 teeth	ns	ns	ns	n/a	ns	ns
21-32 teeth	ref.	ref.	ref.	ref.	ref.	ref.
Decayed teeth						
No decay	ref.	ref.	ref.	ref.	ref.	ref.
1+ decayed	ns	ns	ns	n/a	ns	**(+)
Knowledge sub-scale						
Lower rating	ref.	ref.	ref.	ref.	ref.	ref.
Higher rating (a)	ns	ns	ns	n/a	ns	*(-)
Payment sub-scale						
Lower rating	ref.	ref.	ref.	ref.	ref.	ref.
Higher rating (b)	ns	ns	ns	n/a	ns	*(+)
SEIFA Index						
Higher SES	ref.	ref.	ref.	ref.	ref.	ref.
Lower SES (c)	ns	ns	ns	n/a	ns	ns

LR = Logistic regression; PR = Poisson regression; OLS = Ordinary least squares regression
(a) higher dental knowledge rating; (b) higher rating of willing & able to pay for care; (c) more disadvantaged postcode area
*(P<0.05), **(P<0.01), ns (not significant), n/a (not applicable)

Summary of patient level service provision models

Table 4.66 provides a breakdown of the statistically significant associations across the 10 Poisson regression service provision models. In terms of individual variables: visit type and decayed teeth had the highest number of associations (6 out of 10 models), followed by patient status and denture status (4 out of 10 models), age and insurance were next in order (3 out of 10 models), location and number of teeth were next (2 out of 10 models), financial behaviour was next (1 out of 10 models). Sex of patient and dental knowledge had no significant associations (0 out of 10 models). In terms of groups of variables: visit characteristics and oral health status had the highest number of associations (8 and 7 out of 10 respectively), patient demographics were next in order (3 out of 10 models), while dental knowledge/behaviour and SES were lowest in rank order (1 out of 10 models).

Table 4.66: Number of statistically significant associations across the 10 service provision models

Variables	Number of sig. associations	At least 1 sig. association
Patient demographics		3
Age	3	
Sex	0	
Visit characteristics		8
Visit type (emergency)	6	
Insurance	3	
Patient status (new/previous)	4	
Location (capital/non-capital)	2	
Oral health status		7
Denture status	4	
Number of teeth	2	
Decayed teeth	6	
Dental knowledge/behaviour		1
Knowledge sub-scale	0	
Finance sub-scale	1	
Area-based SES		1
SEIFA Index of disadvantage	1	

Table 4.67 reinforces the result that visit characteristics and oral health status had the greatest number of associations, and these occurred for key service areas (e.g., high rate areas such as diagnostic, preventive and restorative). Patient demographics, while having fewer associations, was significantly associated with areas having high rates (e.g., restorative), or high costs (e.g., crown and bridge, and prosthodontic). Dental knowledge/behaviour and SES had few associations, but these occurred in areas of high cost (i.e., crown and bridge) and dental public health importance (i.e., extractions). General/miscellaneous, a low rate area of service, had only one significant association. There were no significant predictor variables for either periodontic or total services per visit.

Table 4.67: Number of statistically significant associations by grouped variables in each model

	Patient demographics	Visit characteristics	Oral health status	Dental know./behav.	Area-based SES
Diagnostic	0	1	2	0	0
Preventive	0	3	1	0	0
Periodontic	0	0	0	0	0
Extraction	0	2	1	0	1
Endodontic	0	2	2	0	0
Restorative	1	3	2	0	0
Crown/bridge	1	2	1	1	0
Prosthodontic	1	1	3	0	0
General/misc.	0	1	0	0	0
Total services	0	0	0	0	0

Table 4.68 presents the effect size of rate ratios for the statistically significant predictor variables across the 10 models, following the classification of effects outlined by Sahai and Khurshid (1996). Overall, weak effects occurred in 6 of the 10 models, moderate effects in 7 of the 10 models, and strong effects also in 7 of the 10 models. There was a distribution of weak, moderate and strong effects across the models, with 5 of the 10 models comprising a mixture of all three effect sizes.

Most groups of variables (e.g., oral health status) comprise a mixture of weak to strong effects. Among individual variables, visit type stands out as having predominantly strong effects. Finance and area-based SES had moderate effects only. Geographic location had only weak effects.

Table 4.68: Effect size of rate ratios for statistically significant predictors across the 10 models

	<u>Weak effect</u>: **0.6 - 0.8 or** **1.2 - 1.6**	<u>Moderate effect</u>: **0.4 - 0.5 or** **1.7 - 2.5**	<u>Strong effect</u>: **0.0 - 0.3 or** **≥ 2.6**
Patient demographics: Age of patient	Prosthodontic (1.48) Restorative (0.73; 0.82)	Prosthodontic (2.20) Restorative (0.48) Crown/Bridge (1.96)	Crown/Bridge (2.90)
Visit characteristics: Visit type (emergency)	Restorative (0.79)		Preventive (0.22) Extraction (7.51) Endodontic (2.69) Crown/Bridge (0.25) General/Misc. (3.35)
Insurance	Preventive (1.26)	Extraction (0.49)	
Patient status (new patient)	Restorative (0.72)	Diagnostic (1.70) Endodontic (0.45)	Crown/Bridge (0.27)
Location (capital city)	Preventive (1.38) Prosthodontic (0.64)		
Oral health status: Denture status	Diagnostic (0.74) Endodontic (0.59) Restorative (0.76)		Prosthodontic (22.29)
Number of teeth		Extraction (2.02)	Prosthodontic (2.70)
Decayed teeth	Diagnostic (0.83) Endodontic (1.35) Crown/Bridge (0.60)	Preventive (0.54) Prosthodontic (0.41)	Restorative(3.04)
Dental know/behav: Finance sub-scale		Crown/Bridge (1.81)	
Area-based SES: Index of disadvantage		Extraction (1.65)	

Percentage of variance explained was used to assess the goodness of fit of the models. The service rates were log transformed to improve their distributions and OLS regressions were performed. The highest R^2 values were obtained for prosthodontic (19.6%), restorative (14.4%), preventive (12.3%) and extraction (12.2%) services. Next in rank order were diagnostic (5.3%) and crown and bridge (4.0%), endodontic (2.7%), general/miscellaneous (2.0%) and total services (2.0%), and periodontic services (0.5%). Some high rate (e.g., diagnostic) or high cost (e.g., crown and bridge, endodontic) areas had only moderate to small amounts of variance explained by the models.

To summarise: a wide range of variables were associated with service rates - only 2 out of 10 models had no statistically significant predictors (i.e., periodontic and total services), only two variables out of 12 were not significantly associated with services (i.e., sex of patient and Knowledge sub-scale). Visit type and decayed teeth had the highest number of associations (significant in 6 out of 10 models). Visit characteristics and oral health status variables had at least one statistically significant association in most models (8 and 7 out of 10 models respectively). Models for prosthodontic, restorative, preventive and extraction services accounted for 12-19% of the variance in services, while models for diagnostic, crown and bridge, and endodontic services accounted for 2.7-5.3% of the variance in services. Most models and groups of predictor variables comprised a mixture of statistically significant effects ranging from weak to strong.

Oral health status: Dentures and number of teeth while inter-related (i.e., both had a strong effect on prosthodontic services) had different effects on other service provision; denture wearing had weak negative effects for diagnostic, endodontic and restorative services; while number of teeth had a moderate association with extraction services. Decayed teeth provides a measure of current disease, and had a strong association with restorative services, and moderate negative effects for preventive and prosthodontic services.

A range of patient and visit characteristics remained statistical significant predictors of service rates even when controlled for oral health status. Emergency visits indicate severity of symptoms (i.e., relief of pain), and had strong negative associations with preventive and crown and bridge services, and positive associations with extraction, endodontic and general services. New patients had a different service-mix (i.e., less crown and bridge, endodontic and restorative, more diagnostic services), and while of limited explanatory value, new patient status was useful to control for in an analysis. Insurance effects, while not strong, persisted for preventive and extraction services indicating this enabling factor was reflected in better service patterns. Location showed weak effects for prosthodontic and preventive services, with better services patterns for capital city patients. Patient age reflects cumulative effects of disease or treatment experience (and possibly cohort effects), and had a range of weak to strong effects for prosthodontic, restorative, and crown and bridge services. Dental knowledge/behaviour: the Finance sub-scale was related to crown and bridge (i.e., a high cost service). Area-based SES was associated with extractions (i.e., a low cost service)

Overall, while oral health and visit type had the greater number, and stronger effect sizes, a range of other variables also had important associations (e.g., insurance, age, location, ability to pay, SES status). These effects are outlined schematically in Fig 4.3, which summarises the results of the patient level models. According to this schematic model, oral health and visit type interact in the formulation of an ideal treatment plan. Age of patient represents another major influence on the pattern of treatment plan proposed. This ideal treatment plan may then be subject to modification following consideration of other factors such as access issues related to geographic location and enabling mechanisms such as financial and socio-economic status. Other potential sources of influence in this process comprise dentist and practice factors. These are considered in the next section which deals with dentist level models of service provision.

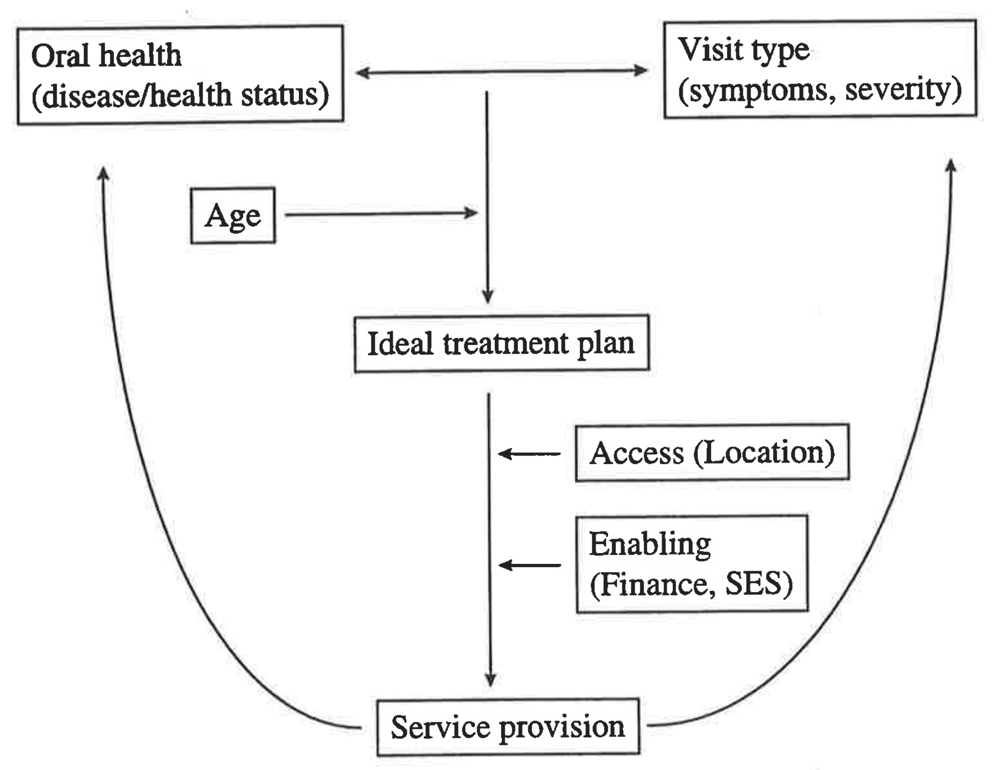


Fig. 4.3: Schematic model of patient level effects

4.8.2 Dentist level models

Table 4.69 presents the dentist level Poisson regression model for diagnostic services. Significant effects were observed for dentist preferences for patients, dentist characteristics, practice factors and patient factors. For dentist preferences, higher agreement with the Dental behaviour sub-scale was positively associated with diagnostic services (RR=1.16) while higher agreement with the Finance sub-scale had a negative association with diagnostic services (RR=0.90). The other significant dentist factor was age, with those aged 40-49 years having higher rates of diagnostic services (RR=1.15) compared to the reference of 50 years of age or older.

Significant practice factors included practice type, with solo practice associated with lower rates of diagnostic services (RR=0.88) compared to non-solo, and lower rates were also associated with lower numbers of non-dentist staff (RR=0.89) compared to numbers of non-dentist staff greater than the median of 2.11 staff members. Lower numbers of patient visits per year was positively associated with diagnostic services (RR=1.20) compared to dentists with numbers of patient visits per year greater than the median of 2,664 patient visits.

The only patient factor significantly associated with diagnostic services was the proportion of new patients. Dentists who had a higher proportion of new patients had higher rates of diagnostic services (RR=1.11) compared to dentists with a lower proportion of new patients.

Table 4.69: Poisson regression model of diagnostic services

Independent variable	Rate Ratio (95% CI)	Independent variable (cont.)	Rate Ratio (95% CI)
DENTIST FACTORS		**PRACTICE FACTORS [(a)]**	
		Type of practice	
1. TREATMENT CHOICE		Solo practice	*0.88 (0.79-0.97)
Treatment choice cluster		Non-solo practice	ref.
Patient cluster	0.96 (0.86-1.08)	**Geographic location**	
Cost cluster	1.05 (0.93-1.17)	Capital city	1.13 (0.99-1.28)
Oral health cluster	ref.	Non-capital	ref.
		Number of dentists	
2. PRACTICE BELIEFS		Higher (> median: 1 dentist)	ref.
Information giving scale		Lower (≤ median:1 dentist)	0.90 (0.80-1.01)
Lower belief (scale > median)	ref.	**Waiting time for appointment**	
Higher belief (scale ≤ median)	1.00 (0.91-1.10)	Longer (> median: 4.0 days)	ref.
Preventive orientation scale		Shorter (≤ median: 4.0 days)	1.05 (0.95-1.15)
Lower belief (scale > median)	ref.	**Number of non-dentist staff**	
Higher belief (scale ≤ median)	1.01 (0.92-1.12)	Higher (> median: 2.11 staff)	ref.
Patient influence scale		Lower (≤ median: 2.11 staff)	*0.89 (0.81-0.98)
Lower belief (scale > median)	ref.	**Number of patients per year**	
Higher belief (scale ≤ median)	0.99 (0.91-1.09)	Higher (> median: 2,664 patients)	ref.
		Lower (≤ median: 2,664 patients)	**1.20 (1.08-1.32)
3. DENTIST PREFERENCES			
Dental behaviour sub-scale		**PATIENT FACTORS [(b)]**	
Lower preference (scale > median)	ref.	**Proportion of emergencies**	
Higher preference (scale ≤ median)	*1.16 (1.03-1.30)	Higher (> median: 23%)	1.04 (0.95-1.14)
Personality sub-scale		Lower (≤ median: 23%)	ref.
Lower preference (scale > median)	ref.	**Proportion insured patients**	
Higher preference (scale ≤ median)	1.01 (0.90-1.13)	Higher (> median: 50%)	1.03 (0.94-1.14)
General behaviour sub-scale		Lower (≤ median: 50%)	ref.
Lower preference (scale > median)	ref.	**Proportion of patients 25-44 years**	
Higher preference (scale ≤ median)	0.97 (0.86-1.09)	Higher (> median: 42%)	0.99 (0.90-1.09)
Finance sub-scale		Lower (≤ median: 42%)	ref.
Lower preference (scale > median)	ref.	**Proportion with decayed teeth**	
Higher preference (scale ≤ median)	*0.90 (0.81-0.99)	Higher (> median: 56%)	0.93 (0.85-1.02)
		Lower (≤ median: 56%)	ref.
4. DENTIST CHARACTERISTICS		**Proportion of new patients**	
Sex of dentist		Higher (> median: 9%)	*1.11 (1.01-1.22)
Male dentist	1.02 (0.89-1.16)	Lower (≤ median: 9%)	ref.
Female dentist	ref.	**Proportion with dentures**	
Age of dentist		Higher (> median: 20%)	0.93 (0.84-1.02)
20-29 years	1.08 (0.92-1.26)	Lower (≤ median: 20%)	ref.
30-39 years	0.99 (0.87-1.13)	**Proportion disadvantaged areas**	
40-49 years	*1.15 (1.02-1.30)	Higher SES (index > median: 1029)	ref.
50+ years	ref.	Lower SES (index ≤ median: 1029) [(c)]	0.97 (0.87-1.07)

(a) main private practice; (b) dentate patients aged 18 years or more from service log; (c) more disadvantaged postcode areas
*(P<0.05); **(P<0.01)

Table 4.70 presents the dentist level Poisson regression model for preventive services. There were significant effects for dentist, practice and patient factors. Higher agreement with the Dental behaviour sub-scale had a positive association with preventive services (RR=1.24) compared to dentists with lower agreement scores. Male dentists had lower rates of preventive services (RR=0.74) than female dentists. Younger dentists, aged in the 20-29 years age group, had higher rates of preventive services (RR=1.28) than those aged 50 years or older.

The practice factors of type of practice and geographic location were significantly associated with preventive services. Solo practice had a positive association with preventive rates (RR=1.22) compared to non-solo practice, and preventive rates were higher for dentists at capital city (RR=1.29) compared to non-capital locations.

A range of patient factors were significantly associated with preventive rates. Lower preventive rates occurred for dentists with higher proportions of emergency patients (RR=0.79), patients with decayed teeth (RR=0.80), new patients (RR=0.86), patients with dentures (RR=0.85), and patients from lower socio-economic areas (RR=0.76). Higher rates of preventive services occurred for dentists with greater proportions of insured patients (RR=1.22).

Table 4.70: Poisson regression model of preventive services

Independent variable	Rate Ratio (95% CI)	Independent variable (cont.)	Rate Ratio (95% CI)
DENTIST FACTORS		**PRACTICE FACTORS [(a)]**	
		Type of practice	
1. TREATMENT CHOICE		Solo practice	**1.22 (1.05-1.40)
Treatment choice cluster		Non-solo practice	ref.
Patient cluster	1.02 (0.88-1.19)	**Geographic location**	
Cost cluster	0.93 (0.79-1.09)	Capital city	**1.29 (1.07-1.55)
Oral health cluster	ref.	Non-capital	ref.
		Number of dentists	
2. PRACTICE BELIEFS		Higher (> median: 1 dentist)	ref.
Information giving scale		Lower (≤ median:1 dentist)	1.03 (0.87-1.21)
Lower belief (scale > median)	ref.	**Waiting time for appointment**	
Higher belief (scale ≤ median)	0.95 (0.84-1.08)	Longer (> median: 4.0 days)	ref.
Preventive orientation scale		Shorter (≤ median: 4.0 days)	1.06 (0.93-1.20)
Lower belief (scale > median)	ref.	**Number of non-dentist staff**	
Higher belief (scale ≤ median)	0.95 (0.83-1.08)	Higher (> median: 2.11 staff)	ref.
Patient influence scale		Lower (≤ median: 2.11 staff)	0.90 (0.79-1.02)
Lower belief (scale > median)	ref.	**Number of patients per year**	
Higher belief (scale ≤ median)	1.07 (0.94-1.22)	Higher (> median: 2,664 patients)	ref.
		Lower (≤ median: 2,664 patients)	1.00 (0.88-1.15)
3. DENTIST PREFERENCES			
Dental behaviour sub-scale		**PATIENT FACTORS [(b)]**	
Lower preference (scale > median)	ref.	**Proportion of emergencies**	
Higher preference (scale ≤ median)	**1.24 (1.06-1.46)	Higher (> median: 23%)	**0.79 (0.70-0.90)
Personality sub-scale		Lower (≤ median: 23%)	ref.
Lower preference (scale > median)	ref.	**Proportion insured patients**	
Higher preference (scale ≤ median)	0.87 (0.74-1.01)	Higher (> median: 50%)	**1.22 (1.07-1.39)
General behaviour sub-scale		Lower (≤ median: 50%)	ref.
Lower preference (scale > median)	ref.	**Proportion of patients 25-44 years**	
Higher preference (scale ≤ median)	1.16 (0.98-1.37)	Higher (> median: 42%)	0.90 (0.79-1.02)
Finance sub-scale		Lower (≤ median: 42%)	ref.
Lower preference (scale > median)	ref.	**Proportion with decayed teeth**	
Higher preference (scale ≤ median)	0.88 (0.77-1.01)	Higher (> median: 56%)	**0.80 (0.70-0.91)
		Lower (≤ median: 56%)	ref.
4. DENTIST CHARACTERISTICS		**Proportion of new patients**	
Sex of dentist		Higher (> median: 9%)	*0.86 (0.75-0.98)
Male dentist	**0.74 (0.62-0.88)	Lower (≤ median: 9%)	ref.
Female dentist	ref.	**Proportion with dentures**	
Age of dentist		Higher (> median: 20%)	*0.85 (0.75-0.97)
20-29 years	*1.28 (1.03-1.59)	Lower (≤ median: 20%)	ref.
30-39 years	1.13 (0.94-1.35)	**Proportion disadvantaged areas**	
40-49 years	1.10 (0.93-1.30)	Higher SES (index > median: 1029)	ref.
50+ years	ref.	Lower SES (index ≤ median: 1029) [(c)]	**0.76 (0.66-0.88)

(a) main private practice; (b) dentate patients aged 18 years or more from service log; (c) more disadvantaged postcode areas
*(P<0.05); **(P<0.01)

Table 4.71 presents the dentist level Poisson regression model for periodontic services. Significant effects were observed for dentist, practice and patient factors. Higher agreement with the Dental behaviour sub-scale was negatively associated with periodontic rates (RR=0.39) while higher agreement with the General behaviour sub-scale was positively associated with periodontic services (RR=3.93). Dentist age was also associated with periodontic services, with those aged 30-39 years having higher rates (RR=2.21) than those aged 50 years or older.

Among the significant practice factors, those dentists with shorter waiting times for an appointment (RR=0.53) and lower numbers of non-dentist staff (RR=0.49) had lower rates of periodontic services. However, dentists who had fewer patient visits per year had higher rates (RR=2.30) of periodontic services compared to those with greater numbers of patient visits per year.

The Index of Relative Socio-economic Disadvantage was the only patient factor significantly associated with periodontic service rates. Dentists who had a higher proportion of patients from lower socio-economic areas had lower rates (RR=0.32) of periodontic services compared with dentists with lower proportions of patients from low socio-economic areas.

Table 4.71: Poisson regression model of periodontic services

Independent variable	Rate Ratio (95% CI)	Independent variable (cont.)	Rate Ratio (95% CI)
DENTIST FACTORS		**PRACTICE FACTORS [a]**	
		Type of practice	
1. TREATMENT CHOICE		Solo practice	1.40 (0.77-2.57)
Treatment choice cluster		Non-solo practice	ref.
Patient cluster	0.79 (0.41-1.51)	**Geographic location**	
Cost cluster	1.22 (0.68-2.19)	Capital city	1.16 (0.50-2.69)
Oral health cluster	ref.	Non-capital	ref.
		Number of dentists	
2. PRACTICE BELIEFS		Higher (> median: 1 dentist)	ref.
Information giving scale		Lower (≤ median:1 dentist)	0.74 (0.38-1.42)
Lower belief (scale > median)	ref.	**Waiting time for appointment**	
Higher belief (scale ≤ median)	0.71 (0.43-1.18)	Longer (> median: 4.0 days)	ref.
Preventive orientation scale		Shorter (≤ median: 4.0 days)	*0.53 (0.31-0.90)
Lower belief (scale > median)	ref.	**Number of non-dentist staff**	
Higher belief (scale ≤ median)	0.63 (0.37-1.08)	Higher (> median: 2.11 staff)	ref.
Patient influence scale		Lower (≤ median: 2.11 staff)	**0.49 (0.29-0.83)
Lower belief (scale > median)	ref.	**Number of patients per year**	
Higher belief (scale ≤ median)	0.93 (0.56-1.53)	Higher (> median: 2,664 patients)	ref.
		Lower (≤ median: 2,664 patients)	**2.30 (1.34-3.95)
3. DENTIST PREFERENCES			
Dental behaviour sub-scale		**PATIENT FACTORS [b]**	
Lower preference (scale > median)	ref.	**Proportion of emergencies**	
Higher preference (scale ≤ median)	**0.39 (0.21-0.74)	Higher (> median: 23%)	1.03 (0.62-1.72)
Personality sub-scale		Lower (≤ median: 23%)	ref.
Lower preference (scale > median)	ref.	**Proportion insured patients**	
Higher preference (scale ≤ median)	0.86 (0.46-1.60)	Higher (> median: 50%)	0.93 (0.56-1.55)
General behaviour sub-scale		Lower (≤ median: 50%)	ref.
Lower preference (scale > median)	ref.	**Proportion of patients 25-44 years**	
Higher preference (scale ≤ median)	**3.93 (2.00-7.74)	Higher (> median: 42%)	0.63 (0.36-1.10)
Finance sub-scale		Lower (≤ median: 42%)	ref.
Lower preference (scale > median)	ref.	**Proportion with decayed teeth**	
Higher preference (scale ≤ median)	0.94 (0.53-1.66)	Higher (> median: 56%)	1.33 (0.79-2.23)
		Lower (≤ median: 56%)	ref.
4. DENTIST CHARACTERISTICS		**Proportion of new patients**	
Sex of dentist		Higher (> median: 9%)	0.81 (0.47-1.39)
Male dentist	1.43 (0.62-3.30)	Lower (≤ median: 9%)	ref.
Female dentist	ref.	**Proportion with dentures**	
Age of dentist		Higher (> median: 20%)	1.04 (0.62-1.73)
20-29 years	2.02 (0.78-5.25)	Lower (≤ median: 20%)	ref.
30-39 years	*2.21 (1.02-4.81)	**Proportion disadvantaged areas**	
40-49 years	1.97 (0.97-3.99)	Higher SES (index > median: 1029)	ref.
50+ years	ref.	Lower SES (index ≤ median: 1029) [c]	**0.32 (0.16-0.62)

(a) main private practice; (b) dentate patients aged 18 years or more from service log; (c) more disadvantaged postcode areas
*(P<0.05); **(P<0.01)

Table 4.72 presents the dentist level Poisson regression model for extraction services. Significant effects were observed for dentist, practice and patients factors. Dentists with higher agreement with the Patient influence scale had higher rates of extraction (RR=1.32) than dentists with lower agreement ratings with the scale, as did dentists with higher agreement with the Personality sub-scale for dentist preferences for patients (RR=2.14). Dentists aged 40-49 years had lower rates of extraction (RR=0.67) compared with dentists aged 50 years or more.

Number of other dentists working in the main private practice was the only significant practice factor. Dentists who worked with fewer other dentists had a lower rate of extraction (RR=0.65) than those who worked with a higher number of other dentists.

All the patient factors were significantly associated with extraction rates. Dentists with higher proportions of emergency visits (RR=1.34), patients aged 25-44 years (RR=1.35), patients with decayed teeth (RR=1.33), new patients (RR=1.54), patients with dentures (RR=1.39), and patients from low socio-economic areas (RR=2.06) had higher rates of extraction. Dentists with higher proportions of insured patients (RR=0.59) had lower rates of extraction.

Table 4.72: Poisson regression model of extraction services

Independent variable	Rate Ratio (95% CI)	Independent variable (cont.)	Rate Ratio (95% CI)
DENTIST FACTORS		**PRACTICE FACTORS** (a)	
		Type of practice	
1. TREATMENT CHOICE		Solo practice	1.01 (0.73-1.39)
Treatment choice cluster		Non-solo practice	ref.
Patient cluster	0.81 (0.56-1.15)	**Geographic location**	
Cost cluster	1.35 (0.98-1.84)	Capital city	0.86 (0.62-1.18)
Oral health cluster	ref.	Non-capital	ref.
		Number of dentists	
2. PRACTICE BELIEFS		Higher (> median: 1 dentist)	ref.
Information giving scale		Lower (≤ median:1 dentist)	*0.65 (0.46-0.91)
Lower belief (scale > median)	ref.	**Waiting time for appointment**	
Higher belief (scale ≤ median)	0.87 (0.66-1.14)	Longer (> median: 4.0 days)	ref.
Preventive orientation scale		Shorter (≤ median: 4.0 days)	1.31 (0.99-1.74)
Lower belief (scale > median)	ref.	**Number of non-dentist staff**	
Higher belief (scale ≤ median)	0.77 (0.58-1.02)	Higher (> median: 2.11 staff)	ref.
Patient influence scale		Lower (≤ median: 2.11 staff)	1.03 (0.78-1.37)
Lower belief (scale > median)	ref.	**Number of patients per year**	
Higher belief (scale ≤ median)	*1.32 (1.01-1.73)	Higher (> median: 2,664 patients)	ref.
		Lower (≤ median: 2,664 patients)	1.32 (0.99-1.76)
3. DENTIST PREFERENCES			
Dental behaviour sub-scale		**PATIENT FACTORS** (b)	
Lower preference (scale > median)	ref.	**Proportion of emergencies**	
Higher preference (scale ≤ median)	0.71 (0.49-1.01)	Higher (> median: 23%)	*1.34 (1.03-1.74)
Personality sub-scale		Lower (≤ median: 23%)	ref.
Lower preference (scale > median)	ref.	**Proportion insured patients**	
Higher preference (scale ≤ median)	**2.14 (1.50-3.06)	Higher (> median: 50%)	**0.59 (0.44-0.79)
General behaviour sub-scale		Lower (≤ median: 50%)	ref.
Lower preference (scale > median)	ref.	**Proportion of patients 25-44 years**	
Higher preference (scale ≤ median)	0.90 (0.65-1.26)	Higher (> median: 42%)	*1.35 (1.02-1.79)
Finance sub-scale		Lower (≤ median: 42%)	ref.
Lower preference (scale > median)	ref.	**Proportion with decayed teeth**	
Higher preference (scale ≤ median)	1.04 (0.76-1.41)	Higher (> median: 56%)	*1.33 (1.01-1.75)
		Lower (≤ median: 56%)	ref.
4. DENTIST CHARACTERISTICS		**Proportion of new patients**	
Sex of dentist		Higher (> median: 9%)	*1.54 (1.15-2.06)
Male dentist	1.27 (0.88-1.84)	Lower (≤ median: 9%)	ref.
Female dentist	ref.	**Proportion with dentures**	
Age of dentist		Higher (> median: 20%)	*1.39 (1.05-1.83)
20-29 years	0.84 (0.53-1.33)	Lower (≤ median: 20%)	ref.
30-39 years	0.87 (0.61-1.24)	**Proportion disadvantaged areas**	
40-49 years	*0.67 (0.47-0.95)	Higher SES (index > median: 1029)	ref.
50+ years	ref.	Lower SES (index ≤ median: 1029) (c)	**2.06 (1.50-2.83)

(a) main private practice; (b) dentate patients aged 18 years or more from service log; (c) more disadvantaged postcode areas
*(P<0.05); **(P<0.01)

Table 4.73 presents the dentist level Poisson regression model for endodontic services. Significant effects were observed for dentist and patient factors, but not for practice factors. Among the significant dentist factors, those dentists who had a higher agreement rating on the Patient influence scale had higher rates (RR=1.25) of endodontic services than those with lower agreement scores. However, dentists with higher agreement with the General behaviour sub-scale had lower rates (RR=0.59) of endodontic services. Younger dentists had higher endodontic rates than older dentists, with the highest rates among those aged 20-29 years (RR=2.34) followed by those aged 30-39 years (RR=1.73) compared with those aged 50 years or more.

Among the significant patient factors, dentists who had higher proportions of patients with insurance (RR=1.25), who were new (RR=1.29) and who were from low socio-economic areas (RR=1.27) had higher rates of endodontic services. Dentists who had higher proportions of patients aged 25-44 years had lower rates of endodontic services (RR=0.77).

Table 4.73: Poisson regression model of endodontic services

Independent variable	Rate Ratio (95% CI)	Independent variable (cont.)	Rate Ratio (95% CI)
DENTIST FACTORS		**PRACTICE FACTORS** [(a)]	
		Type of practice	
1. TREATMENT CHOICE		Solo practice	1.01 (0.79-1.29)
Treatment choice cluster		Non-solo practice	ref.
Patient cluster	0.97 (0.75-1.26)	**Geographic location**	
Cost cluster	0.85 (0.65-1.10)	Capital city	1.25 (0.95-1.63)
Oral health cluster	ref.	Non-capital	ref.
		Number of dentists	
2. PRACTICE BELIEFS		Higher (> median: 1 dentist)	ref.
Information giving scale		Lower (≤ median:1 dentist)	0.85 (0.65-1.10)
Lower belief (scale > median)	ref.	**Waiting time for appointment**	
Higher belief (scale ≤ median)	0.95 (0.77-1.17)	Longer (> median: 4.0 days)	ref.
Preventive orientation scale		Shorter (≤ median: 4.0 days)	1.08 (0.86-1.34)
Lower belief (scale > median)	ref.	**Number of non-dentist staff**	
Higher belief (scale ≤ median)	1.13 (0.90-1.42)	Higher (> median: 2.11 staff)	ref.
Patient influence scale		Lower (≤ median: 2.11 staff)	1.17 (0.94-1.45)
Lower belief (scale > median)	ref.	**Number of patients per year**	
Higher belief (scale ≤ median)	*1.25 (1.004-1.54)	Higher (> median: 2,664 patients)	ref.
		Lower (≤ median: 2,664 patients)	1.04 (0.83-1.30)
3. DENTIST PREFERENCES			
Dental behaviour sub-scale		**PATIENT FACTORS** [(b)]	
Lower preference (scale > median)	ref.	**Proportion of emergencies**	
Higher preference (scale ≤ median)	1.15 (0.88-1.51)	Higher (> median: 23%)	1.12 (0.91-1.38)
Personality sub-scale		Lower (≤ median: 23%)	ref.
Lower preference (scale > median)	ref.	**Proportion insured patients**	
Higher preference (scale ≤ median)	1.25 (0.96-1.62)	Higher (> median: 50%)	*1.25 (1.01-1.54)
General behaviour sub-scale		Lower (≤ median: 50%)	ref.
Lower preference (scale > median)	ref.	**Proportion of patients 25-44 years**	
Higher preference (scale ≤ median)	**0.59 (0.46-0.77)	Higher (> median: 42%)	*0.77 (0.62-0.95)
Finance sub-scale		Lower (≤ median: 42%)	ref.
Lower preference (scale > median)	ref.	**Proportion with decayed teeth**	
Higher preference (scale ≤ median)	1.02 (0.81-1.29)	Higher (> median: 56%)	1.22 (0.98-1.51)
		Lower (≤ median: 56%)	ref.
4. DENTIST CHARACTERISTICS		**Proportion of new patients**	
Sex of dentist		Higher (> median: 9%)	*1.29 (1.03-1.61)
Male dentist	1.05 (0.79-1.38)	Lower (≤ median: 9%)	ref.
Female dentist	ref.	**Proportion with dentures**	
Age of dentist		Higher (> median: 20%)	1.01 (0.81-1.26)
20-29 years	**2.34 (1.63-3.35)	Lower (≤ median: 20%)	ref.
30-39 years	**1.73 (1.28-2.34)	**Proportion disadvantaged areas**	
40-49 years	1.31 (0.96-1.78)	Higher SES (index > median: 1029)	ref.
50+ years	ref.	Lower SES (index ≤ median: 1029) [(c)]	*1.27 (1.01-1.58)

(a) main private practice; (b) dentate patients aged 18 years or more from service log; (c) more disadvantaged postcode areas
*(P<0.05); **(P<0.01)

Table 4.74 presents the dentist level Poisson regression model for restorative services. Significant effects were observed for dentist and patient factors. Among the dentist factors those dentists who were classified in the Patient cluster for the treatment choice items had a higher rate (RR=1.19) of restorative services compared to the reference category of dentists classified in the Oral health cluster. Dentists with higher agreement ratings on the Preventive orientation scale had higher rates (RR=1.16) of restorative services, as did dentists with higher agreement ratings on the Finance sub-scale (RR=1.20). Dentists aged 30-39 years had higher restorative rates (RR=1.24) than dentists aged 50 years or older.

Among the significant patient factors, dentists with higher proportions of insured patients (RR=1.12) and patients with decayed teeth (RR=1.34) had higher rates of restorative services. Lower rates of restorative services were observed for dentists with a higher proportion of emergency visits (RR=0.90).

Table 4.74: Poisson regression model of restorative services

Independent variable	Rate Ratio (95% CI)	Independent variable (cont.)	Rate Ratio (95% CI)
DENTIST FACTORS		**PRACTICE FACTORS [a]**	
		Type of practice	
1. TREATMENT CHOICE		Solo practice	0.91 (0.81-1.01)
Treatment choice cluster		Non-solo practice	ref.
Patient cluster	**1.19 (1.06-1.33)	**Geographic location**	
Cost cluster	1.01 (0.89-1.13)	Capital city	0.94 (0.83-1.07)
Oral health cluster	ref.	Non-capital	ref.
		Number of dentists	
2. PRACTICE BELIEFS		Higher (> median: 1 dentist)	ref.
Information giving scale		Lower (≤ median:1 dentist)	1.08 (0.96-1.22)
Lower belief (scale > median)	ref.	**Waiting time for appointment**	
Higher belief (scale ≤ median)	0.96 (0.87-1.06)	Longer (> median: 4.0 days)	ref.
Preventive orientation scale		Shorter (≤ median: 4.0 days)	0.95 (0.86-1.05)
Lower belief (scale > median)	ref.	**Number of non-dentist staff**	
Higher belief (scale ≤ median)	**1.16 (1.04-1.28)	Higher (> median: 2.11 staff)	ref.
Patient influence scale		Lower (≤ median: 2.11 staff)	0.95 (0.86-1.05)
Lower belief (scale > median)	ref.	**Number of patients per year**	
Higher belief (scale ≤ median)	1.05 (0.96-1.16)	Higher (> median: 2,664 patients)	ref.
		Lower (≤ median: 2,664 patients)	0.91 (0.82-1.003)
3. DENTIST PREFERENCES			
Dental behaviour sub-scale		**PATIENT FACTORS [b]**	
Lower preference (scale > median)	ref.	**Proportion of emergencies**	
Higher preference (scale ≤ median)	0.96 (0.85-1.08)	Higher (> median: 23%)	*0.90 (0.82-0.99)
Personality sub-scale		Lower (≤ median: 23%)	ref.
Lower preference (scale > median)	ref.	**Proportion insured patients**	
Higher preference (scale ≤ median)	1.02 (0.91-1.15)	Higher (> median: 50%)	*1.12 (1.01-1.23)
General behaviour sub-scale		Lower (≤ median: 50%)	ref.
Lower preference (scale > median)	ref.	**Proportion of patients 25-44 years**	
Higher preference (scale ≤ median)	0.89 (0.79-1.003)	Higher (> median: 42%)	1.05 (0.96-1.16)
Finance sub-scale		Lower (≤ median: 42%)	ref.
Lower preference (scale > median)	ref.	**Proportion with decayed teeth**	
Higher preference (scale ≤ median)	**1.20 (1.08-1.33)	Higher (> median: 56%)	**1.34 (1.21-1.47)
		Lower (≤ median: 56%)	ref.
4. DENTIST CHARACTERISTICS		**Proportion of new patients**	
Sex of dentist		Higher (> median: 9%)	1.00 (0.91-1.11)
Male dentist	0.93 (0.81-1.07)	Lower (≤ median: 9%)	ref.
Female dentist	ref.	**Proportion with dentures**	
Age of dentist		Higher (> median: 20%)	0.97 (0.88-1.07)
20-29 years	1.08 (0.91-1.28)	Lower (≤ median: 20%)	ref.
30-39 years	**1.24 (1.08-1.41)	**Proportion disadvantaged areas**	
40-49 years	1.06 (0.93-1.20)	Higher SES (index > median: 1029)	ref.
50+ years	ref.	Lower SES (index ≤ median: 1029) [c]	0.90 (0.81-1.002)

(a) main private practice; (b) dentate patients aged 18 years or more from service log; (c) more disadvantaged postcode areas
*(P<0.05); **(P<0.01)

Table 4.75 presents the dentist level Poisson regression model for crown and bridge services. There were significant effects for both dentist and patient factors. Among the significant dentist factors, there were higher rates of crown and bridge services for those dentists with higher agreement ratings on the Information giving scale (RR=1.45) and also the Preventive orientation scale (RR=1.33), but lower rates of crown and bridge services for dentists with higher agreement on the Patient influence scale (RR=0.73). Dentists aged 20-29 years had lower rates of provision of crown and bridge services (RR=0.42) and dentists aged 40-49 years had higher crown and bridge rates (RR=1.39) compared to dentists aged 50 years or older.

The only significant effect among the patient factors occurred for proportions of patients with decayed teeth. Dentists with higher proportions of patients with decayed teeth had lower rates of crown and bridge services (RR=0.74).

Table 4.75: Poisson regression model of crown and bridge services

Independent variable	Rate Ratio (95% CI)
DENTIST FACTORS	
1. Treatment choice	
Treatment choice cluster	
Patient cluster	1.11 (0.82-1.50)
Cost cluster	1.26 (0.94-1.68)
Oral health cluster	ref.
2. Practice beliefs	
Information giving scale	
Lower belief (scale > median)	ref.
Higher belief (scale ≤ median)	**1.45 (1.12-1.88)
Preventive orientation scale	
Lower belief (scale > median)	ref.
Higher belief (scale ≤ median)	*1.33 (1.01-1.75)
Patient influence scale	
Lower belief (scale > median)	ref.
Higher belief (scale ≤ median)	*0.73 (0.57-0.93)
3. Dentist preferences	
Dental behaviour sub-scale	
Lower preference (scale > median)	ref.
Higher preference (scale ≤ median)	1.01 (0.74-1.38)
Personality sub-scale	
Lower preference (scale > median)	ref.
Higher preference (scale ≤ median)	1.04 (0.78-1.40)
General behaviour sub-scale	
Lower preference (scale > median)	ref.
Higher preference (scale ≤ median)	0.96 (0.71-1.31)
Finance sub-scale	
Lower preference (scale > median)	ref.
Higher preference (scale ≤ median)	0.97 (0.74-1.28)
4. Dentist characteristics	
Sex of dentist	
Male dentist	1.33 (0.86-2.05)
Female dentist	ref.
Age of dentist	
20-29 years	**0.42 (0.22-0.80)
30-39 years	1.07 (0.76-1.51)
40-49 years	*1.39 (1.02-1.88)
50+ years	ref.
Independent variable (cont.)	**Rate Ratio (95% CI)**
PRACTICE FACTORS [a]	
Type of practice	
Solo practice	1.32 (0.99-1.75)
Non-solo practice	ref.
Geographic location	
Capital city	1.14 (0.79-1.63)
Non-capital	ref.
Number of dentists	
Higher (> median: 1 dentist)	ref.
Lower (≤ median:1 dentist)	0.93 (0.66-1.30)
Waiting time for appointment	
Longer (> median: 4.0 days)	ref.
Shorter (≤ median: 4.0 days)	0.88 (0.68-1.14)
Number of non-dentist staff	
Higher (> median: 2.11 staff)	ref.
Lower (≤ median: 2.11 staff)	1.15 (0.89-1.49)
Number of patients per year	
Higher (> median: 2,664 patients)	ref.
Lower (≤ median: 2,664 patients)	0.97 (0.75-1.25)
PATIENT FACTORS [b]	
Proportion of emergencies	
Higher (> median: 23%)	0.98 (0.76-1.26)
Lower (≤ median: 23%)	ref.
Proportion insured patients	
Higher (> median: 50%)	1.11 (0.86-1.42)
Lower (≤ median: 50%)	ref.
Proportion of patients 25-44 years	
Higher (> median: 42%)	0.94 (0.72-1.23)
Lower (≤ median: 42%)	ref.
Proportion with decayed teeth	
Higher (> median: 56%)	*0.74 (0.57-0.95)
Lower (≤ median: 56%)	ref.
Proportion of new patients	
Higher (> median: 9%)	1.10 (0.84-1.43)
Lower (≤ median: 9%)	ref.
Proportion with dentures	
Higher (> median: 20%)	0.95 (0.74-1.23)
Lower (≤ median: 20%)	ref.
Proportion disadvantaged areas	
Higher SES (index > median: 1029)	ref.
Lower SES (index ≤ median: 1029) [c]	0.76 (0.58-1.02)

(a) main private practice; (b) dentate patients aged 18 years or more from service log; (c) more disadvantaged postcode areas
*(P<0.05); **(P<0.01)

Table 4.76 presents the dentist level Poisson regression model for prosthodontic services. Significant effects were observed for dentist, practice and patient factors. Dentists classified in the Cost cluster from the treatment choice items had higher rates of prosthodontic services (RR=1.52) than dentists classified in the Oral health cluster. Dentists with a higher agreement rating on the Information giving scale had lower rates (RR=0.74) of prosthodontic services than those with lower agreement ratings. However, higher rates of prosthodontic services were observed for dentists with higher agreement ratings on the Preventive orientation (RR=1.47) and Patient influence scales (RR=1.38). Dentists with a higher agreement rating on the Personality sub-scale for dentist preferences had higher rates (RR=1.40) of prosthodontic services, while dentists with a higher agreement rating on the Finance sub-scale had lower prosthodontic service rates (RR=0.75). Dentists aged 40-49 years had higher rates (RR=1.98) of prosthodontic services.

Among the significant practice factors, dentists at capital city locations had lower rates (RR=0.71) of prosthodontic services than those at non-capital locations. Dentists with shorter waiting times for an appointment had higher prosthodontic services rates (RR=1.40) than dentists with longer waiting times.

Among the significant patient factors, there were higher rates of prosthodontic services among dentists who had higher proportions of insured patients (RR=1.63) and patients with dentures (RR=3.52). There were lower rates of prosthodontic services among dentists who had higher proportions of patients with decayed teeth (RR=0.69).

Table 4.76: Poisson regression model of prosthodontic services

Independent variable	Rate Ratio (95% CI)	Independent variable (cont.)	Rate Ratio (95% CI)
DENTIST FACTORS		**PRACTICE FACTORS** [(a)]	
		Type of practice	
1. TREATMENT CHOICE		Solo practice	1.35 (0.99-1.84)
Treatment choice cluster		Non-solo practice	ref.
Patient cluster	1.20 (0.88-1.63)	**Geographic location**	
Cost cluster	**1.52 (1.13-2.05)	Capital city	*0.71 (0.51-0.97)
Oral health cluster	ref.	Non-capital	ref.
		Number of dentists	
2. PRACTICE BELIEFS		Higher (> median: 1 dentist)	ref.
Information giving scale		Lower (≤ median:1 dentist)	0.79 (0.55-1.13)
Lower belief (scale > median)	ref.	**Waiting time for appointment**	
Higher belief (scale ≤ median)	*0.74 (0.58-0.96)	Longer (> median: 4.0 days)	ref.
Preventive orientation scale		Shorter (≤ median: 4.0 days)	*1.40 (1.06-1.85)
Lower belief (scale > median)	ref.	**Number of non-dentist staff**	
Higher belief (scale ≤ median)	**1.47 (1.11-1.94)	Higher (> median: 2.11 staff)	ref.
Patient influence scale		Lower (≤ median: 2.11 staff)	1.21 (0.93-1.59)
Lower belief (scale > median)	ref.	**Number of patients per year**	
Higher belief (scale ≤ median)	*1.38 (1.07-1.78)	Higher (> median: 2,664 patients)	ref.
		Lower (≤ median: 2,664 patients)	0.95 (0.73-1.24)
3. DENTIST PREFERENCES			
Dental behaviour sub-scale		**PATIENT FACTORS** [(b)]	
Lower preference (scale > median)	ref.	**Proportion of emergencies**	
Higher preference (scale ≤ median)	1.13 (0.82-1.56)	Higher (> median: 23%)	0.94 (0.72-1.21)
Personality sub-scale		Lower (≤ median: 23%)	ref.
Lower preference (scale > median)	ref.	**Proportion insured patients**	
Higher preference (scale ≤ median)	*1.40 (1.03-1.91)	Higher (> median: 50%)	**1.63 (1.24-2.15)
General behaviour sub-scale		Lower (≤ median: 50%)	ref.
Lower preference (scale > median)	ref.	**Proportion of patients 25-44 years**	
Higher preference (scale ≤ median)	0.96 (0.70-1.32)	Higher (> median: 42%)	0.96 (0.73-1.25)
Finance sub-scale		Lower (≤ median: 42%)	ref.
Lower preference (scale > median)	ref.	**Proportion with decayed teeth**	
Higher preference (scale ≤ median)	*0.75 (0.56-0.99)	Higher (> median: 56%)	**0.69 (0.53-0.90)
		Lower (≤ median: 56%)	ref.
4. DENTIST CHARACTERISTICS		**Proportion of new patients**	
Sex of dentist		Higher (> median: 9%)	1.13 (0.86-1.48)
Male dentist	1.15 (0.77-1.72)	Lower (≤ median: 9%)	ref.
Female dentist	ref.	**Proportion with dentures**	
Age of dentist		Higher (> median: 20%)	**3.52 (2.62-4.72)
20-29 years	0.86 (0.49-1.50)	Lower (≤ median: 20%)	ref.
30-39 years	1.37 (0.96-1.97)	**Proportion disadvantaged areas**	
40-49 years	**1.98 (1.44-2.71)	Higher SES (index > median: 1029)	ref.
50+ years	ref.	Lower SES (index ≤ median: 1029) [(c)]	1.32 (0.97-1.79)

(a) main private practice; (b) dentate patients aged 18 years or more from service log; (c) more disadvantaged postcode areas
*(P<0.05); **(P<0.01)

Table 4.77 presents the dentist level Poisson regression model for general/miscellaneous services. Significant effects were observed for dentist, practice and patient factors. Among the significant dentist factors, there were higher rates of general/miscellaneous services among dentists who had a higher agreement rating on the Dental behaviour sub-scale (RR=1.72), but a lower rates of general services among dentists who had a higher agreement rating on the Finance sub-scale (RR=0.66). Dentists aged 30-39 years had lower rates of general services (RR=0.53) compared with dentists aged 50 years or more.

Among the significant practice factors, there were lower rates of general services for dentists who had shorter waiting times for an appointment (RR=0.68). There were also lower general services rates for dentists who worked with lower numbers of non-dentist staff members (RR=0.49).

The only significant patient factor associated with general services was the Index of Relative Socio-economic Disadvantage. Dentists who had more patients from low socio-economic areas (i.e., a lower index value across the patients they treated) had lower rates (RR=0.55) of general services.

Table 4.77: Poisson regression model of general/miscellaneous services

Independent variable	Rate Ratio (95% CI)	Independent variable (cont.)	Rate Ratio (95% CI)
DENTIST FACTORS		**PRACTICE FACTORS [a]**	
		Type of practice	
1. TREATMENT CHOICE		Solo practice	0.71 (0.48-1.05)
Treatment choice cluster		Non-solo practice	ref.
Patient cluster	0.71 (0.46-1.10)	**Geographic location**	
Cost cluster	0.98 (0.64-1.49)	Capital city	0.69 (0.43-1.11)
Oral health cluster	ref.	Non-capital	ref.
		Number of dentists	
2. PRACTICE BELIEFS		Higher (> median: 1 dentist)	ref.
Information giving scale		Lower (≤ median:1 dentist)	1.31 (0.85-2.01)
Lower belief (scale > median)	ref.	**Waiting time for appointment**	
Higher belief (scale ≤ median)	0.79 (0.56-1.12)	Longer (> median: 4.0 days)	ref.
Preventive orientation scale		Shorter (≤ median: 4.0 days)	*0.68 (0.47-0.98)
Lower belief (scale > median)	ref.	**Number of non-dentist staff**	
Higher belief (scale ≤ median)	0.99 (0.67-1.45)	Higher (> median: 2.11 staff)	ref.
Patient influence scale		Lower (≤ median: 2.11 staff)	**0.49 (0.34-0.71)
Lower belief (scale > median)	ref.	**Number of patients per year**	
Higher belief (scale ≤ median)	0.88 (0.62-1.24)	Higher (> median: 2,664 patients)	ref.
		Lower (≤ median: 2,664 patients)	1.42 (0.99-2.05)
3. DENTIST PREFERENCES			
Dental behaviour sub-scale		**PATIENT FACTORS [b]**	
Lower preference (scale > median)	ref.	**Proportion of emergencies**	
Higher preference (scale ≤ median)	*1.72 (1.12-2.62)	Higher (> median: 23%)	1.00 (0.71-1.42)
Personality sub-scale		Lower (≤ median: 23%)	ref.
Lower preference (scale > median)	ref.	**Proportion insured patients**	
Higher preference (scale ≤ median)	0.77 (0.51-1.16)	Higher (> median: 50%)	0.99 (0.69-1.42)
General behaviour sub-scale		Lower (≤ median: 50%)	ref.
Lower preference (scale > median)	ref.	**Proportion of patients 25-44 years**	
Higher preference (scale ≤ median)	0.85 (0.55-1.30)	Higher (> median: 42%)	0.93 (0.64-1.34)
Finance sub-scale		Lower (≤ median: 42%)	ref.
Lower preference (scale > median)	ref.	**Proportion with decayed teeth**	
Higher preference (scale ≤ median)	*0.66 (0.46-0.97)	Higher (> median: 56%)	1.06 (0.74-1.52)
		Lower (≤ median: 56%)	ref.
4. DENTIST CHARACTERISTICS		**Proportion of new patients**	
Sex of dentist		Higher (> median: 9%)	1.19 (0.82-1.74)
Male dentist	1.04 (0.61-1.79)	Lower (≤ median: 9%)	ref.
Female dentist	ref.	**Proportion with dentures**	
Age of dentist		Higher (> median: 20%)	1.30 (0.90-1.87)
20-29 years	0.79 (0.44-1.40)	Lower (≤ median: 20%)	ref.
30-39 years	*0.53 (0.33-0.87)	**Proportion disadvantaged areas**	
40-49 years	0.73 (0.46-1.15)	Higher SES (index > median: 1029)	ref.
50+ years	ref.	Lower SES (index ≤ median: 1029) [c]	**0.55 (0.36-0.84)

(a) main private practice; (b) dentate patients aged 18 years or more from service log; (c) more disadvantaged postcode areas
*(P<0.05); **(P<0.01)

Table 4.78 presents the dentist level Poisson regression model for total services per visit. Significant effects were observed for dentist, practice and patient factors. Among the significant dentist factors, those dentists who had a higher agreement rating on the Dental behaviour sub-scale had higher total service rates (RR=1.09) than dentists with a lower agreement rating. Dentists aged less than 50 years of age all had higher rates of total services (RR=1.13) compared with dentists aged 50 years or more.

The only significant practice factor associated with total services was number of non-dentist staff. Dentists who worked with lower numbers of non-dentist staff members had lower rates of total services (RR=0.94) compared with those who worked with higher numbers of non-dentist staff.

Among the significant patient factors, dentists with a higher proportion of insured patients had higher rates of total services (RR=1.09). Dentists who had more patients from low socio-economic areas had lower rates of provision of total services (RR=0.94) compared to dentists with less patients from disadvantaged areas.

Table 4.78: Poisson regression model of total services per visit

Independent variable	Rate Ratio (95% CI)	Independent variable (cont.)	Rate Ratio (95% CI)
DENTIST FACTORS		**PRACTICE FACTORS [a]**	
		Type of practice	
1. TREATMENT CHOICE		Solo practice	0.98 (0.92-1.04)
Treatment choice cluster		Non-solo practice	ref.
Patient cluster	1.04 (0.98-1.11)	**Geographic location**	
Cost cluster	1.04 (0.98-1.11)	Capital city	1.05 (0.98-1.12)
Oral health cluster	ref.	Non-capital	ref.
		Number of dentists	
2. PRACTICE BELIEFS		Higher (> median: 1 dentist)	ref.
Information giving scale		Lower (≤ median:1 dentist)	0.96 (0.90-1.02)
Lower belief (scale > median)	ref.	**Waiting time for appointment**	
Higher belief (scale ≤ median)	0.96 (0.91-1.01)	Longer (> median: 4.0 days)	ref.
Preventive orientation scale		Shorter (≤ median: 4.0 days)	1.03 (0.97-1.08)
Lower belief (scale > median)	ref.	**Number of non-dentist staff**	
Higher belief (scale ≤ median)	1.05 (0.99-1.11)	Higher (> median: 2.11 staff)	ref.
Patient influence scale		Lower (≤ median: 2.11 staff)	*0.94 (0.89-0.99)
Lower belief (scale > median)	ref.	**Number of patients per year**	
Higher belief (scale ≤ median)	1.04 (0.99-1.09)	Higher (> median: 2,664 patients)	ref.
		Lower (≤ median: 2,664 patients)	1.05 (0.99-1.11)
3. DENTIST PREFERENCES			
Dental behaviour sub-scale		**PATIENT FACTORS [b]**	
Lower preference (scale > median)	ref.	**Proportion of emergencies**	
Higher preference (scale ≤ median)	*1.09 (1.02-1.16)	Higher (> median: 23%)	0.96 (0.91-1.01)
Personality sub-scale		Lower (≤ median: 23%)	ref.
Lower preference (scale > median)	ref.	**Proportion insured patients**	
Higher preference (scale ≤ median)	1.03 (0.96-1.09)	Higher (> median: 50%)	**1.09 (1.04-1.15)
General behaviour sub-scale		Lower (≤ median: 50%)	ref.
Lower preference (scale > median)	ref.	**Proportion of patients 25-44 years**	
Higher preference (scale ≤ median)	0.95 (0.89-1.01)	Higher (> median: 42%)	0.98 (0.93-1.03)
Finance sub-scale		Lower (≤ median: 42%)	ref.
Lower preference (scale > median)	ref.	**Proportion with decayed teeth**	
Higher preference (scale ≤ median)	0.99 (0.93-1.05)	Higher (> median: 56%)	1.02 (0.97-1.08)
		Lower (≤ median: 56%)	ref.
4. DENTIST CHARACTERISTICS		**Proportion of new patients**	
Sex of dentist		Higher (> median: 9%)	1.05 (0.99-1.11)
Male dentist	0.98 (0.91-1.06)	Lower (≤ median: 9%)	ref.
Female dentist	ref.	**Proportion with dentures**	
Age of dentist		Higher (> median: 20%)	1.01 (0.96-1.07)
20-29 years	**1.13 (1.03-1.24)	Lower (≤ median: 20%)	ref.
30-39 years	**1.13 (1.05-1.21)	**Proportion disadvantaged areas**	
40-49 years	**1.13 (1.06-1.21)	Higher SES (index > median: 1029)	ref.
50+ years	ref.	Lower SES (index ≤ median: 1029) [c]	*0.94 (0.89-0.99)

(a) main private practice; (b) dentate patients aged 18 years or more from service log; (c) more disadvantaged postcode areas
*(P<0.05); **(P<0.01)

Consistency of effects across model types

Table 4.79 presents the pattern of statistically significant associations of services with the set of independent variables for diagnostic, preventive, periodontic and extraction services across the different model types of Poisson regression and ordinary least squares regression. The details of the effects for the Poisson models were presented in the previous tables in this section. For details of the other models see Appendix G (Ordinary least squares models: dentist-level).

Diagnostic services showed consistent effects across the two models for the Dental behaviour sub-scale, number of patient visits per year, and proportion of new patients. The Poisson regression model also found significant effects for the Finance sub-scale, age of dentist, practice type and number of non-dentist staff. Preventive services showed consistent effects across the two model types for the Dental behaviour sub-scale, sex of dentist, proportion of emergency visits, patients with decayed teeth, and patients from disadvantaged areas. The Poisson regression model also showed significant effects for age of dentist, type of practice, geographic location, proportion of insured patients, new patients and patients with dentures. Periodontic services were not significant for the linear model. The Poisson model had significant effects for the Dental and General behaviour sub-scales, dentist age, waiting time, non-dentist staff numbers, patient visits per year and disadvantage index. Extraction services had consistent effects across the models for the Personality sub-scale, emergency visits, insured patients, and patients from disadvantaged areas. The Poisson model also included the Patient influence scale, dentist age, number of dentists, patient age, decayed teeth, new patients, and patients with dentures. The linear model included patient visits per year as a significant effect.

Table 4.79: Summary of Poisson and OLS regression models (part 1)

	Diagnostic		Preventive		Periodontic		Extraction	
	PR	OLS	PR	OLS	PR	OLS	PR	OLS
DENTIST FACTORS:								
1. Treatment choice								
Treatment choice: Patient cluster (1)	ns	ns	ns	ns	ns	ns	ns	ns
Treatment choice: Cost cluster (1)	ns	ns	ns	ns	ns	ns	ns	ns
2. Practice beliefs								
Information giving scale (2)	ns	ns	ns	ns	ns	ns	ns	ns
Preventive orientation scale (2)	ns	ns	ns	ns	ns	ns	ns	ns
Patient influence scale (2)	ns	ns	ns	ns	ns	ns	*(+)	ns
3. Dentist preferences								
Dental behaviour sub-scale (2)	*(+)	*(+)	**(+)	*(+)	**(-)	ns	ns	ns
Personality sub-scale (2)	ns	ns	ns	ns	ns	ns	**(+)	**(+)
General behaviour sub-scale (2)	ns	ns	ns	ns	**(+)	ns	ns	ns
Finance sub-scale (2)	*(-)	ns	ns	ns	ns	ns	ns	ns
4. Dentist characteristics								
Male dentist (3)	ns	ns	**(-)	*(-)	ns	ns	ns	ns
Dentist age: 20-29 years (4)	ns	ns	*(+)	ns	ns	ns	ns	ns
Dentist age: 30-39 years (4)	ns	ns	ns	ns	*(+)	ns	ns	ns
Dentist age: 40-49 years (4)	*(+)	ns	ns	ns	ns	ns	*(-)	ns
PRACTICE FACTORS (a)								
Solo practice (5)	*(-)	ns	**(+)	ns	ns	ns	ns	ns
Capital city (6)	ns	ns	**(+)	ns	ns	ns	ns	ns
Number of dentists (≤ median: 1.0) (7)	ns	ns	ns	ns	ns	ns	*(-)	ns
Waiting time (≤ median: 4.0 days) (8)	ns	ns	ns	ns	*(-)	ns	ns	ns
No. non-dentist staff (≤ median: 2.11) (9)	*(-)	ns	ns	ns	**(-)	ns	ns	ns
Patients per year (≤ median: 2,664) (10)	**(+)	*(+)	ns	ns	**(+)	ns	ns	*(+)
PATIENT FACTORS (b)								
Emergencies (> median: 23%) (11)	ns	ns	**(-)	**(-)	ns	ns	*(+)	**(+)
Insured patients (> median: 50%) (12)	ns	ns	**(+)	ns	ns	ns	**(-)	*(-)
Patients 25 - 44 yrs (> median: 42%) (13)	ns	ns	ns	ns	ns	ns	*(+)	ns
Patients with decay (> median: 56%) (14)	ns	ns	**(-)	*(-)	ns	ns	*(+)	ns
New patients (> median: 9%) (15)	*(+)	*(+)	*(-)	ns	ns	ns	*(+)	ns
Patients with dentures (> median: 20%) (16)	ns	ns	*(-)	ns	ns	ns	*(+)	ns
Disadvantaged patients (SES index) (17)	ns	ns	**(-)	*(-)	**(-)	ns	**(+)	**(+)
P-value for model:	**	*	**	**	**	ns	**	**
Adjusted R^2		5.2%		13.2%		2.1%		15.5%

(a) main private practice; (b) dentate patients aged 18 years or more from service log

Reference categories: (1) oral health cluster; (2) scale > median (less agreement); (3) female dentists; (4) dentists aged 50+ years; (5) non-solo practice; (6) non-capital city; (7) number of dentists > median; (8) waiting time > median; (9) number of non-dentist staff > median; (10) patients per year > median; (11) emergencies ≤ median; (12) insured patients ≤ median; (13) patients aged 25-44 years ≤ median; (14) patients with decayed teeth ≤ median; (15) new patients ≤ median; (16) patients with dentures ≤ median; (17) patients with index scores > median (from less disadvantaged postcode areas)

*(P<0.05); **(P<0.01); ns (not significant)

Table 4.80 presents the pattern of statistically significant associations of services with the set of independent variables for endodontic, restorative, crown and bridge, and prosthodontic services across the different model types of Poisson regression and ordinary least squares regression. Endodontic services showed no significant effects in the linear model. The Poisson model showed significant effects for the Patient influence scale, General behaviour sub-scale, age of dentist, insurance status, patient age, new patients and disadvantage index.

Restorative services showed consistent effects across the two models for the Patient treatment choice cluster, Finance sub-scale, and proportion of patients with decayed teeth. The Poisson model also found significant effects for the Preventive orientation scale, age of dentist, emergency visits, and insurance status.

Crown and bridge services showed no significant effects in the linear model. The Poisson model found significant effects for the three practice belief scales, age of dentist, and proportion of patients with decayed teeth.

Prosthodontic services exhibited consistent effects across the two models for capital city location and proportion of patients with dentures. The Poisson model also found significant effects for the Cost treatment choice cluster, the three practice belief scales, the Personality and Finance sub-scales, age of dentist, waiting time for appointments, insurance status, and proportion of patients with decayed teeth.

Table 4.80: Summary of Poisson and OLS regression models (part 2)

	Endodontic		Restorative		Crown/bridge		Prosthodontic	
	PR	OLS	PR	OLS	PR	OLS	PR	OLS
DENTIST FACTORS:								
1. Treatment choice								
Treatment choice: Patient cluster (1)	ns	ns	**(+)	*(+)	ns	ns	ns	ns
Treatment choice: Cost cluster (1)	ns	ns	ns	ns	ns	ns	**(+)	ns
2. Practice beliefs								
Information giving scale (2)	ns	ns	ns	ns	**(+)	ns	*(-)	ns
Preventive orientation scale (2)	ns	ns	**(+)	ns	*(+)	ns	**(+)	ns
Patient influence scale (2)	*(+)	ns	ns	ns	*(-)	ns	*(+)	ns
3. Dentist preferences								
Dental behaviour sub-scale (2)	ns	ns	ns	ns	ns	ns	ns	ns
Personality sub-scale (2)	ns	ns	ns	ns	ns	ns	*(+)	ns
General behaviour sub-scale (2)	**(-)	ns	ns	ns	ns	ns	ns	ns
Finance sub-scale (2)	ns	ns	**(+)	*(+)	ns	ns	*(-)	ns
4. Dentist characteristics								
Male dentist (3)	ns	ns	ns	ns	ns	ns	ns	ns
Dentist age: 20-29 years (4)	**(+)	ns	ns	ns	**(-)	ns	ns	ns
Dentist age: 30-39 years (4)	**(+)	ns	**(+)	ns	ns	ns	ns	ns
Dentist age: 40-49 years (4)	ns	ns	ns	ns	*(+)	ns	**(+)	ns
PRACTICE FACTORS (a)								
Solo practice (5)	ns	ns	ns	ns	ns	ns	ns	ns
Capital city (6)	ns	ns	ns	ns	ns	ns	*(-)	*(-)
Number of dentists (≤ median: 1.0) (7)	ns	ns	ns	ns	ns	ns	ns	ns
Waiting time (≤ median: 4.0 days) (8)	ns	ns	ns	ns	ns	ns	*(+)	ns
No. non-dentist staff (≤ median: 2.11) (9)	ns	ns	ns	ns	ns	ns	ns	ns
Patients per year (≤ median: 2,664) (10)	ns	ns	ns	ns	ns	ns	ns	ns
PATIENT FACTORS (b)								
Emergencies (> median: 23%) (11)	ns	ns	*(-)	ns	ns	ns	ns	ns
Insured patients (> median: 50%) (12)	*(+)	ns	*(+)	ns	ns	ns	**(+)	ns
Patients 25 - 44 yrs (> median: 42%) (13)	*(-)	ns	ns	ns	ns	ns	ns	ns
Patients with decay (> median: 56%) (14)	ns	ns	**(+)	*(+)	*(-)	ns	**(-)	ns
New patients (> median: 9%) (15)	*(+)	ns	ns	ns	ns	ns	ns	ns
Patients with dentures (> median: 20%) (16)	ns	ns	ns	ns	ns	ns	**(+)	**(+)
Disadvantaged patients (SES index) (17)	*(+)	ns	ns	ns	ns	ns	ns	ns
P-value for model:	**	ns	**	**	**	ns	**	**
Adjusted R^2		3.9%		9.5%		1.9%		9.9%

(a) main private practice; (b) dentate patients aged 18 years or more from service log

Reference categories: (1) oral health cluster; (2) scale > median (less agreement); (3) female dentists; (4) dentists aged 50+ years; (5) non-solo practice; (6) non-capital city; (7) number of dentists > median; (8) waiting time > median; (9) number of non-dentist staff > median; (10) patients per year > median; (11) emergencies ≤ median; (12) insured patients ≤ median; (13) patients aged 25-44 years ≤ median; (14) patients with decayed teeth ≤ median; (15) new patients ≤ median; (16) patients with dentures ≤ median; (17) patients with index scores > median (from less disadvantaged postcode areas)

*(P<0.05); **(P<0.01); ns (not significant)

Table 4.81 presents the pattern of statistically significant associations of services with the set of independent variables for orthodontic and general/miscellaneous services, and total services per visit across the different model types of Poisson regression and ordinary least squares regression.

There were no significant effects in the linear model for orthodontic services, and the Poisson model for orthodontic services had questionable fit due to quasi-complete separation of sample points and hence is not presented.

The models for general services showed no significant effects in the linear model. The Poisson model found significant effects for the Dental behaviour and Finance sub-scales, age of dentist, waiting time, number of non-dentist staff, and patients from disadvantaged areas.

The models for total services per visit showed consistent effects for age of dentist and proportion of insured patients. The Poisson model also found significant effects for the Dental behaviour sub-scale, number of non-dentist staff and patients from disadvantaged areas.

Table 4.81: Summary of Poisson and OLS regression models (part 3)

	Orthodontic		General		Total services	
	PR	OLS	PR	OLS	PR	OLS
DENTIST FACTORS:						
1. Treatment choice						
Treatment choice: Patient cluster (1)	n/a	ns	ns	ns	ns	ns
Treatment choice: Cost cluster (1)	n/a	ns	ns	ns	ns	ns
2. Practice beliefs						
Information giving scale (2)	n/a	ns	ns	ns	ns	ns
Preventive orientation scale (2)	n/a	ns	ns	ns	ns	ns
Patient influence scale (2)	n/a	ns	ns	ns	ns	ns
3. Dentist preferences						
Dental behaviour sub-scale (2)	n/a	ns	*(+)	ns	*(+)	ns
Personality sub-scale (2)	n/a	ns	ns	ns	ns	ns
General behaviour sub-scale (2)	n/a	ns	ns	ns	ns	ns
Finance sub-scale (2)	n/a	ns	*(-)	ns	ns	ns
4. Dentist characteristics						
Male dentist (3)	n/a	ns	ns	ns	ns	ns
Dentist age: 20-29 years (4)	n/a	ns	ns	ns	**(+)	*(+)
Dentist age: 30-39 years (4)	n/a	ns	*(-)	ns	**(+)	*(+)
Dentist age: 40-49 years (4)	n/a	ns	ns	ns	**(+)	*(+)
PRACTICE FACTORS (a)						
Solo practice (5)	n/a	ns	ns	ns	ns	ns
Capital city (6)	n/a	ns	ns	ns	ns	ns
Number of dentists (≤ median: 1.0) (7)	n/a	ns	ns	ns	ns	ns
Waiting time (≤ median: 4.0 days) (8)	n/a	ns	*(-)	ns	ns	ns
No. non-dentist staff (≤ median: 2.11) (9)	n/a	ns	**(-)	ns	**(-)	ns
Patients per year (≤ median: 2,664) (10)	n/a	ns	ns	ns	ns	ns
PATIENT FACTORS (b)						
Emergencies (> median: 23%) (11)	n/a	ns	ns	ns	ns	ns
Insured patients (> median: 50%) (12)	n/a	ns	ns	ns	**(+)	*(+)
Patients 25 - 44 yrs (> median: 42%) (13)	n/a	ns	ns	ns	ns	ns
Patients with decay (> median: 56%) (14)	n/a	ns	ns	ns	ns	ns
New patients (> median: 9%) (15)	n/a	ns	ns	ns	ns	ns
Patients with dentures (> median: 20%) (16)	n/a	ns	ns	ns	ns	ns
Disadvantaged patients (SES index) (17)	n/a	ns	**(-)	ns	*(-)	ns
P-value for model:	n/a	ns	**	ns	**	**
Adjusted R^2		0.7%		3.1%		6.4%

(a) main private practice; (b) dentate patients aged 18 years or more from service log

Reference categories: (1) oral health cluster; (2) scale > median (less agreement); (3) female dentists; (4) dentists aged 50+ years; (5) non-solo practice; (6) non-capital city; (7) number of dentists > median; (8) waiting time > median; (9) number of non-dentist staff > median; (10) patients per year > median; (11) emergencies ≤ median; (12) insured patients ≤ median; (13) patients aged 25-44 years ≤ median; (14) patients with decayed teeth ≤ median; (15) new patients ≤ median; (16) patients with dentures ≤ median; (17) patients with index scores > median (from less disadvantaged postcode areas)

*(P<0.05); **(P<0.01); ns (not significant); n/a (not applicable)

Summary of dentist level models of service provision

Comparisons across model types showed that OLS regression was more conservative than Poisson regression. With 26 terms in each model, by 10 models (excluding orthodontic services) gives a total of 260 terms overall. There were 82 significant terms from the Poisson models (31.5%) compared to 22 (8.5%) from the OLS models. Only one term which was significant in the OLS models was not also significant in the Poisson models. However, all other terms which were significant in the OLS models were also significant in the Poisson models, but the Poisson models had many additional significant terms compared to the OLS models.

While the Poisson models may be preferred on the basis of providing a more natural model for data based on counts, the OLS models provide some indication of goodness of fit between different service area models. Percentage of variance explained was highest for extraction (15.5%) and preventive services (13.2%), followed by prosthodontic (9.9%) and restorative services (9.5%). Next in order were total services per visit (6.4%) and diagnostic services (5.2%), then endodontic (3.9%), general (3.1%), periodontic (2.1%), crown and bridge (1.9%) and orthodontic services (0.7%). Overall, the percentage of variance explained by the dentist level models was comparable to the patient level models.

Table 4.82 presents a summary of the significant effects using the Poisson models. All variables were significant in at least one model. The highest number occurred for the Dental behaviour sub-scale, dentist age, insurance status, decayed teeth, and disadvantage index. When aggregated into conceptual sub-groups, only treatment choice and patient demographics were not significant in five or more models.

Table 4.82: Summary of significant effects in the Poisson regression models [a]

	Number of models with significant associations	Number of models with at least one significant association per group	
	Individual variables	Sub-groups	Main groups
DENTIST FACTORS:			10
1. Treatment choice		2	
Treatment choice: Patient cluster	1		
Treatment choice: Cost cluster	1		
2. Practice beliefs		5	
Information giving scale	2		
Preventive orientation scale	3		
Patient influence scale	4		
3. Dentist preferences		9	
Dental behaviour sub-scale	5		
Personality sub-scale	2		
General behaviour sub-scale	2		
Finance sub-scale	4		
4. Dentist characteristics		10	
Male dentist	1		
Dentist age: 20-29 years	4		
Dentist age: 30-39 years	5		
Dentist age: 40-49 years	5		
PRACTICE FACTORS		7	7
Solo practice	2		
Capital city	2		
Number of dentists	1		
Waiting time	3		
Number of non-dentist staff	4		
Patients per year	2		
PATIENT FACTORS			10
1. Visit factors		7	
Emergency visits	3		
Insurance status of patients	6		
New patient status	4		
2. Patient demographics		2	
Patients aged 25 - 44 yrs	2		
3. Oral health factors		5	
Patients with decay	5		
Patients with dentures	3		
4. Area-based SES		6	
Disadvantage index	6		

(a) number of significant effects can range up to a maximum of 10 (i.e., significant in every model)

Table 4.83 presents the number of statistically significant effects by grouped variables for each model. Consistent with Table 4.82, there were a range of significant dentist factors after controlling for practice and patient factors. Dentist preferences and dentist characteristics were significant in most models. Practice beliefs were also important, being significant in 5 out of 10 models, not being significant for the low rate areas of periodontic and general services, or the routine scheduled areas of preventive and diagnostic. Treatment choice clusters were only significant in 2 of 10 models, but one is of public health significance (i.e., prosthodontic) and the other being the high rate area of restorative services. Practice factors were common effects being significant across most models. Among patient factors, there was a tendency for these variables not to be significantly associated with the low rate areas of periodontic and general services except for area-based socio-economic status, the routine area of diagnostic services except for visit factors, and for crown and bridge services with the exception of oral health status.

Table 4.83: Number of statistically significant associations by grouped variables in each model

	Dentist				Practice	Patient			
Model:	Treat-ment choice	Practice beliefs	Dentist prefer-ences	Dentist charact-eristics	Practice factors	Visit factors	Oral health factors	Area-based SES	Patient demo-graphics
1. Diagnostic	0	0	2	1	3	1	0	0	0
2. Preventive	0	0	1	2	2	3	2	1	0
3. Periodontic	0	0	2	1	3	0	0	1	0
4. Extraction	0	1	1	1	1	3	2	1	1
5. Endodontic	0	1	1	2	0	2	0	1	1
6. Restorative	1	1	1	1	0	2	1	0	0
7. Crown/bridge	0	3	0	2	0	0	1	0	0
8. Prosthodontic	1	3	2	1	2	1	2	0	0
9. General	0	0	2	1	2	0	0	1	0
10. Total services	0	0	1	3	1	1	0	1	0

In terms of the number of significant individual items (i.e., summing across the rows in Table 4.83), prosthodontic (12 items) and both preventive and extraction services

(11 items) have the highest number, followed by endodontic (8 items), and diagnostic, periodontic, restorative and total services (all with 7 items), and then general and crown and bridge services (6 items). The ordering of models by number of significant items tends to also be reflected in the number of groups of significant items, with extraction (8 groups) and prosthodontic services (7 groups) having the highest number, followed by preventive, endodontic and restorative (all with 6 groups), total services (5 groups), then diagnostic, periodontic and general services (each with 4 groups), and then crown and bridge (3 groups). This indicates that little clumping occurred within groups of items. Instead, the significant effects were dispersed across a range of factors.

The distribution of associations showed some skewing by groups of factors. In terms of both number of items and groups of items, prosthodontic services tended to be skewed towards dentist factors, while preventive and extraction services were skewed to patient factors, with endodontic services having an even mix of dentist and patient factors. Diagnostic and periodontic services showed an even mix of dentist and practice factors in terms of number of items, but were slightly skewed to dentist factors in terms of groups of items. Restorative services had an even mix of dentist and patient factors by number of items, but were skewed to dentist factors in terms of groups of items. Total services were skewed to dentist factors by number of items, but had an even mix of dentist and patient factors in terms of groups of items. However, this skewing of associations by service areas tends to be minor in nature. Instead, no one group of items dominates, and there is a spread of effects in all models. As well as considering the number of associations, the effect size of the associations should also be considered.

Table 4.84 presents the rate ratios for the significant variables in the 10 Poisson regression models classified by effect size (Sahai and Khurshid, 1996). Effects in the region of 0.90 to 1.10 were excluded as having no effect. Of the 69 effects retained, only three were classified as strong (4.3%), 16 were classified as moderate (23.2%), and 50 were classified as weak (72.5%). When examined separately for each group of factors a similar pattern emerged with the majority of effects being weak in size. Among dentist factors 24 out of 34 effects were weak (70.6%), while for practice factors seven out of 11 were weak (63.6%), and for patient factors 19 out of 24 were weak (79.2%).

Of the moderate and strong effects, some occurred in the areas of periodontic and general services which are of less interest due to their low rate of provision. The remaining moderate and strong effects occurred in the areas of extraction, endodontic, prosthodontic and crown and bridge services. These areas are of interest due to their public health significance in terms of their impact on oral health status and implications related to cost of care. The associations included effects for age of dentist, dentist preferences (Personality sub-scale), insurance status, area-based socio-economic status, and denture status.

Overall, service provision is influenced by a large number of small effects from a wide range of factors which spanned dentist, practice and patient factors.

Table 4.84: Effect size of rate ratios for statistically significant predictors across the 10 models

	Weak effect: 0.6 - 0.8 or 1.2 - 1.6	Moderate effect: 0.4 - 0.5 or 1.7 - 2.5	Strong effect: 0.0 - 0.3 or ≥ 2.6
DENTIST FACTORS: **1. Treatment choice:** Patient cluster	Restorative (1.19)		
Cost cluster	Prosthodontic (1.52)		
2. Practice beliefs: Information giving	Crown/bridge (1.45) Prosthodontic (0.74)		
Preventive orientation	Restorative (1.16) Crown/bridge (1.33) Prosthodontic (1.47)		
Patient influence	Extraction (1.32) Prosthodontic (1.38) Endodontic (1.25) Crown/bridge (0.73)		
3. Dentist preferences: Dental behaviour	Diagnostic (1.16) Preventive (1.24)	Periodontic (0.39) General (1.72)	
Personality	Prosthodontic (1.40)	Extraction (2.14)	
General behaviour	Endodontic (0.59)		Periodontic (3.93)
Finance	General (0.66) Restorative (1.20) Prosthodontic (0.75)		
4. Dentist characteristics: Male dentist	Preventive (0.74)		
Age of dentist: 20-29 years	Preventive (1.28)	Endodontic (2.34) Crown/bridge (1.73)	
Age of dentist: 30-39 years	Restorative (1.24)	Periodontic (2.21) Endodontic (1.73) General (0.53)	
Age of dentist: 40-49 years	Diagnostic (1.15) Crown/bridge (1.39) Extraction (0.67)	Prosthodontic (1.98)	
PRACTICE FACTORS: Solo	Preventive (1.22)		
Capital city	Preventive (1.29) Prosthodontic (0.71)		
Number of dentists	Extraction (0.65)		
Waiting time	Prosthodontic (1.40) General (0.68)	Periodontic (0.53)	
Non-dentist staff		Periodontic (0.49) General (0.49)	
Patients per year	Diagnostic (1.20)	Periodontic (2.30)	
PATIENT FACTORS: Emergency visits	Extraction (1.34) Preventive (0.79)		
Insurance status	Endodontic (1.25) Preventive (1.22)	Extraction (0.59) Prosthodontic (1.63)	
Patient age 25-44 years	Extraction (1.35) Endodontic (0.77)		
Decayed teeth	Extraction (1.33) Restorative (1.34) Prosthodontic (0.69) Preventive (0.80) Crown/bridge (0.74)		
New patients	Extraction (1.54) Endodontic (1.29) Preventive (0.86)		
Dentures	Extraction (1.39) Preventive (0.85)		Prosthodontic (3.52)
Area-based SES - Index of disadvantage	Endodontic (1.27) Preventive (0.76) General (0.55)	Extraction (2.06)	Periodontic (0.32)

5. Discussion

This section presents a discussion of the thesis results and the relationship of these results to other published findings. The first part of the section deals with findings from the study in terms of patient characteristics, dentist characteristics, practice factors and oral health status. The next part looks at limitations of the approach and methods adopted in the study. Then public health implications are discussed in relation to appropriateness of care and the development of parameters and guidelines.

5.1 Findings from the Study of Dental Services

The findings from the study are discussed in this section of the thesis. The discussion is structured in terms of patient characteristics, dentist characteristics, practice factors and oral health status.

5.1.1 Patient characteristics

Patient characteristics were included in both the patient level and dentist level models of service provision. In the patient level models each patient was the unit of analysis and the clustering of patients within a dentist was controlled for by weighting by the design effect calculated for each service area. Aggregated data on patients was included in the dentist level models. Looking at the patient level models of service provision, a range of factors were included from the among patient demographics, visit characteristics, oral health status, dentist ratings of dental knowledge and behaviour, and area-based socio-economic status.

Patient level models

Patient demographics (i.e., age and sex) had significant associations in 3 of 10 models, with patient age showing a range of weak to strong effects for prosthodontic, restorative and crown and bridge services. Age can reflect cumulative effects of disease and treatment history, and possible cohort effects. The higher rates of restorative services among older patients reflects a shift in emphasis towards older adults who are retaining teeth for longer, consistent with the improved patterns observed in oral health in Australia such as lower caries levels among children and declining edentulism among adults (NHMRC Expert Advisory Panel, 1993). Reductions in levels of tooth loss have been linked with increased treatment needs, especially in the elderly (Douglass, 1988; Reinhardt and Douglass, 1989). Crown and bridge services similarly reflect a trend towards retention of the natural dentition with higher provision among middle aged adults. In Australia, there have been increases in the number of services per visit provided to adults and also increased proportions of patients in the age groups 45-64 and 65 years or more over the period 1983 to 1994 (Brennan, Spencer and Szuster, 1998b), which point to a shift in treatment emphasis towards older adults. Predicted international trends include an increased preventive orientation, decreased requirements for dentures and shifts in restorative procedures such as more complex restorations in older teeth (Reinhardt and Douglass, 1989; Christensen, 1986; Weintraub and Burt, 1985).

The higher provision of prosthodontic services observed among middle aged adults seems counter intuitive, as denture services generally increase across older age groups in parallel with edentulism (Brennan, Spencer and Szuster, 1998b). However, the service patterns reported in this thesis reflect dentate patients and are controlled for both the presence of an existing denture and also number of teeth which could account for the pattern observed. Sex of patient was not significant in any model. While other analyses of dental service patterns in Australia have detected differences by sex of patient, they did not control for oral health status, and the differences tended to be fewer in number and less pronounced in size compared to those observed for age of patient (Brennan, Spencer and Szuster, 1998b).

Of the dental knowledge and behaviour ratings a significant effect was observed in only one model, with financial behaviour being associated with higher provision of crown and bridge services. This is consistent with provision of a higher cost treatment alternative. The knowledge and finance ratings had a wide range of significant associations with patient and visit characteristics as well as service rates in bivariate analyses. It would seem that most of these effects are removed after controlling for factors such as visit type and oral health. As these ratings are made by dentists, most likely with the aid of knowing the visit and oral health details of each patient, then the ratings on the scales probably reflect a proxy measure of such details and tend not to have an independent effect when modelled in the presence of the visit and oral health details.

A range of visit characteristics were associated with services. Emergency visits had strong negative associations with preventive and crown and bridge services, and positive associations with extraction, endodontic, and general services. Insurance was associated with higher preventive and lower extraction rates. These patterns are consistent with more favourable service patterns for non-emergency visits and insured patients observed in Australian private general practice (Brennan, Spencer and Szuster, 1997) and for non-emergency visits in the public sector (Brennan and Spencer, 1999). New patients had less crown and bridge, endodontic, and restorative, but more diagnostic service. This pattern reflects patients who are new at that visit, hence the emphasis on diagnostic services. The longer term pattern of care for patients who change dentist may be different. For example, in the General Dental Service in the U.K. there was overall a higher amount of treatment received by new patients who had changed dentist at least once in a five-year study period with little difference in the number of courses of care or scalings but higher provision of restorations and radiographs for patients who had changed dentist (Davies, 1984).

Geographic location within capital cities was associated with less prosthodontic and more preventive services per visit. In general, capital city residents in Australia enjoy better health both in terms of mortality trends and oral health status (AIHW, 1994; Carter et al., 1994), and this is reflected in more favourable patterns of dental service provision in terms of prevention and maintenance of a natural dentition (Brennan, 1996). The more favourable dental service patterns have been observed for both private general practice (Brennan, Spencer and Szuster, 1998a) and the public sector (Brennan, Spencer and Slade, 1996), and have been correlated with disparities in the level of supply of practitioners (Szuster, 1993). Similar trends have been noted in the U.K. with more emphasis on extraction in regions with lower rates of dentists to population (Ashford, 1978).

Relationships between socio-economic status and health have often involved consideration of mortality by factors such as occupation, income, ethnic group and social class (Marmot, Kogevinas and Elston, 1987; Feinstein, 1993). Large differentials in mortality and morbidity have been observed and reported to be widening (Davey Smith, Bartley and Blane, 1990). Such socio-economic differentials have been reported for dental care in Australia (National Health Strategy, 1992). For example, income, age of leaving school and occupation have been associated with use of dental services, and occupation with receipt of extractions (Roberts-Thomson, Brennan and Spencer, 1995). In this thesis, area-based socio-economic status was associated with extractions, with a higher extraction rate among patients from lower SES areas. This is consistent with population-level survey data for dentate adults in Australia, with those persons who had visited for a problem showing a consistent increase in the mean number of extractions from the highest to the lowest income group (Carter et al., 1994).

In general, the patient level models showed visit type as having an important effect on service patterns, with emergency visits associated with a less favourable mix of services. Insurance and capital city location were associated with more favourable service patterns.

Dentist level models

In addition to the patient level models a range of patient characteristics were also included in aggregate form in the dentist level models. For example, type of visit coded as emergency or non-emergency was included in the patient level models while the proportion of patients who visited a dentist for an emergency were included in the dentist level model. Looking at patient demographics age of patient coded as the proportion of 25-44 year old patients was associated with higher extraction and lower endodontic rates. Area-based socio-economic status indicated that higher proportions of patients from more disadvantaged areas were negatively associated with preventive, periodontic, general and total services and positively associated with extraction and endodontic services.

In terms of visit characteristics, emergency visits were negatively associated with preventive and restorative services and positively associated with extractions. Insurance was positively associated with preventive, endodontic, restorative, prosthodontic and total services and negatively associated with extractions. New patient status was positively associated with diagnostic, extraction, and endodontic services and negatively associated with preventive services.

In general, the dentist level models indicated more favourable service patterns for insured patients and less favourable patterns for emergency visits and patients from lower socioeconomic areas. Variation was also observed for new patient status and by age of patient.

Summary: patient characteristics

Patient characteristics were included in both the patient and dentist level models. Patient level models have the advantage of directly modelling the association at an individual level, rather than using aggregated data for patients as in the dentist level models. However, the dentist level models provide control for a range of dentist and practice characteristics which are not present in the patient level models. Table 5.1 provides a summary of the significant effects at the dentist and patient levels. For simplicity, periodontic and general services are not included as these areas of service were provided at low rates in private general practice. Both model levels (i.e., patient and dentist) converge on the associations of diagnostic rates with new patient status, preventive rates with visit type and insurance, extraction with visit type, insurance and socio-economic status, and restorative rates with visit type and insurance. A range of associations were significant in one of either the patient or dentist model, but not the other model level. A contradictory pattern for endodontic rates occurred, with new patient status associated with lower rates at patient level, but with higher rates at dentist level. Taking the common elements of both model levels as the most robust effects, visit type and insurance were both associated with rates of provision of preventive, extraction and restorative services with more favourable services patterns in terms of prevention and tooth retention for insured patients and non-emergency visits. New patients had higher rates of diagnostic services. Lower socio-economic status was associated with higher extraction rates.

Table 5.1: Summary of service patterns by patient characteristics

	Model level	Service areas: Diag -nostic	Prev -entive	Extract -ion	Endo -dontic	Restor -ative	Crown /bridge	Prostho -dontic	Total service
Patient age (25-44 years)	Patient:	-	-	-	-	(-)	(+)	(+)	-
	Dentist:	-	-	(+)	(-)	-	-	-	-
Visit type (emergency)	Patient:	-	(-)	(+)	(+)	(-)	(-)	-	-
	Dentist:	-	(-)	(+)	-	(-)	-	-	-
Insurance status (insured)	Patient:	-	(+)	(-)	-	(+)	-	-	-
	Dentist:	-	(+)	(-)	(+)	(+)	-	(+)	(+)
Patient status (new patient)	Patient:	(+)	-	-	(-)	(-)	(-)	-	-
	Dentist:	(+)	(-)	(+)	(+)	-	-	-	-
Area-based SES (Low SES)	Patient:	-	-	(+)	-	-	-	-	-
	Dentist:	-	(-)	(+)	(+)	-	-	-	(-)
Geographic location[(a)] (capital city)	Patient:	-	(+)	-	-	-	-	(-)	-
	Dentist:	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Payment sub-scale[(b)] (higher rating)	Patient:	-	-	-	-	-	(+)	-	-
	Dentist:	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

(a) Location in dentist level model refers to location of practice, not patient
(b) Not included in dentist level model

5.1.2 Dentist characteristics

Dentist characteristics were only present in the dentist level models. These characteristics included treatment choice factors, practice beliefs, dentist preferences for patients, and dentist demographics. Practice styles of providers have been suggested as one source of variation in services rates (Eisenberg, 1985; Maryniuk, 1990; Brennan, Spencer and Szuster, 1996a). Aspects of the dentist-patient relationship such as communication, expectations about roles, and shared values may also influence the service provision process (Bader and Shugars, 1995b; Maryniuk, 1990). Treatment provided may therefore reflect an interactive process between patient, practice and provider.

Treatment choice

Investigations of factors influencing the clinical decision making process have identified and compared the roles of technical and patient factors (Grembowski, Milgrom and Fiset, 1988; 1989). These studies have indicated that technical factors dominated over patient concerns in the choice of alternative treatments. The results of this thesis indicated that while there were a large number of items suggested as sources of influence in the choice of treatment among pairs of alternatives in hypothetical treatment choice scenarios, overall a few groups of responses dominated.

The dominance of key factors in choosing treatment may reflect the adoption of routines (Maryniuk, 1990). Such routines based on clinical experience may provide a means whereby practitioners can deal with the uncertainty involved in making treatment decisions. Dental students have been shown to rank a larger number of factors as important when choosing treatment compared to dentists, which may indicate that students have yet to develop routines for decision making (Grembowski, Milgrom and Fiset, 1989). Prognosis was not highly ranked as a factor, indicating an emphasis on technical and process factors rather than on outcomes. This may reflect the technical orientation with which dentistry is learned (Kress, 1980), where quality is defined more in terms of technical aspects than outcomes (Bader and Shugars, 1995b).

In this thesis, summing the treatment choice responses to the treatment pair scenarios showed that 'treatment constraints' ranked highest, primarily representing the item of 'cost' (15.0% of the total treatment choice responses). Oral health variables ranked second (periodontal status 12.1%), third (tooth status 11.3%) and fourth (mouth status 10.1%). Patient variables ranked fifth, primarily reflecting the item 'patient preference' (9.8% of the total). Three clusters of dentists emerged from the analysis of these treatment choice responses. Treatment choice was positively associated with restorative services in the case of dentists classified in the Patient cluster (i.e., rated patient preference highly), and with prosthodontic services for dentist classified in the Cost cluster, compared to the reference of the Oral health cluster.

Practice beliefs

Practice beliefs of dentists were significantly associated with service patterns. Information giving was positively associated with crown and bridge services and negatively associated with prosthodontic services. Preventive orientation was positively associated with restorative, crown and bridge, prosthodontic and total services per visit. Patient influence was positively associated with extraction, endodontic and prosthodontic services. A previous study of practice beliefs by Grembowski, Milgrom and Fiset (1990b) found that practice beliefs explained little variation in service rates, with Information giving associated with fewer diagnostic services. However, a later study which also controlled for treatment choice factors found a greater range of significant associations of services with practice beliefs (Grembowski, Milgrom and Fiset, 1991). These results are compared in Table 5.2 against the pattern of services found in this thesis.

Table 5.2: Comparison of associations of practice beliefs with services across studies

	Endodontic	Extraction	Prostho-dontic	Bridge	Crown build-up	Crown & bridge	Restorative	Total services
Preventive orientation	(-) USA		(+) AUS		(-) USA	(+) USA (+) AUS	(+) AUS	(+) AUS
Patient influence	(+) AUS	(-) USA (+) AUS	(+) AUS					
Information giving			(-) AUS	(-) USA		(+) AUS		

USA: United States of America - Grembowski, Milgrom and Fiset (1991)
AUS: Australia - current study

A greater number of significant effects were observed in the Australian data compared to the USA. Preventive orientation was consistently associated with higher rates of crown and bridge services but lower rates of crown buildups and endodontic services in the USA and higher rates of restorative, prosthodontic and total services in Australia. Patient influence was negatively associated with extraction in the USA but positively associated with extraction in Australia, with both endodontic and prosthodontic services also associated with Patient influence in Australia. Information giving was negatively associated with bridge work in the USA, and in Australia negatively associated with prosthodontic services and positively associated with crown and bridge services. Crown and bridge services in Australia are predominantly crowns (10.4% of restorative services in 1993-94) rather than bridges (1.4% of restorative services in 1993-94) (Australian Institute of Health and Welfare - Dental Statistics and Research Unit, 1998).

Practice beliefs of dentists appeared to be stable as the factor structure of Grembowski, Milgrom and Fiset (1991) was replicated, but the scales had low reliability. This may be because the factors were under-identified, and require more items to measure them with greater reliability (Short and Horn, 1984). The single item, 'controlling active disease', may warrant further development to better identify the construct which this item represents. While the measure of sampling adequacy was acceptable, the low reliability measures considered along with the similarity of some items (e.g., items 4 and 8) in the scales, and the need to better identify some of the constructs indicates scope for further development to improve the scales.

There is often a question as to correct naming of factors (e.g., does "Preventive orientation" really represent what the label suggests?). Reification of factors may occur, and researchers are cautioned against attributing reality and uniqueness to factors (i.e., giving a factor a name does not give it reality). However, factors that recur from different samples and conditions point to an underlying construct (Kerlinger, 1986).

While the factor structure was replicated in the Australian context, there may be some discrepancy between the factor names and service patterns, and hence the constructs they represent. Information giving comprises items mainly related to the cost of treatment and may reflect informing patients regarding cost, which is consistent with higher rates of crown and bridge services. Preventive orientation was not associated with higher preventive rates, with the scale comprising one preventive belief item ("plaque control"), but also one item related to professional authority in treatment planning ("convince to accept"). This aspect of the scale may be more related to higher provision of restorative, crown and bridge, and total services.

Despite some lack of overlap between studies in associations of beliefs with services (e.g., for Patient influence and extractions) there was also some convergence in the pattern of results (i.e., Preventive orientation with crown and bridge services). Other results may be consistent with an underlying construct. Information giving was associated with lower bridge rates in the USA, and while associated with higher crown and bridge rates in Australia this most likely reflects crowns rather than bridges, and there was a negative association with prosthodontic rates, which may point to a general negative association of Information giving with tooth replacement by dentures and bridges.

Dentist preferences for patients

A US study showed dentist perceptions of good patients involved dental sophistication, interpersonal responsiveness and compliance (O'Shea, Corah, Ayer, 1983). These dimensions were related to the perceptions of treatability, likability and manageability of patients which have been postulated as important in studies of other health professionals. Another US study found that dentists evaluated their patients using the three dimensions of compliance, tractability and interpersonal responsiveness (Rouse and Hamilton, 1991). Patient compliance involves regular, prompt, courteous attendance and maintenance of oral health, patient tractability involves conforming to the dentist's authority by being cooperative and manageable during treatment, and respectful and trusting of the dentist, and interpersonal responsiveness was seen as multifaceted and involved showing positive affect toward the dentist.

The pattern of dentist preferences for patients obtained from the factor analysis performed for this thesis differed from the empirical study of Rouse and Hamilton (1991). As outlined in Table 5.3 the Dental behaviour factor contained items spanning both Compliance and Tractability, the Personality factor contained items all from Interpersonal responsiveness, the General behaviour factor contained items from both Tractability and Interpersonal responsiveness, while the Finance factor contained mainly new items. This pattern involved a splitting of Tractability items between Dental behaviour (trust, manageability, acceptance of treatment plan) and General behaviour (cooperation, respect), and Interpersonal responsiveness items between General behaviour (polite, secure) and Personality (thankful, fun to work with). This is explicable in terms of splitting the aspects of Tractability into those which are more treatment related into Dental behaviour and those which are more general characteristics into General behaviour, while the aspects of Interpersonal responsiveness are split into security and appreciation (General behaviour) and positive affect (Personality).

Table 5.3: Conceptual grouping across empirical studies of dentist preferences for patients

O'Shea, Corah and Ayer (1983)	Rouse and Hamilton (1991)	Present study of dental services
Dental sophistication		**Dental behaviour**
Positive, appropriate & correct attitudes, beliefs & values regarding oral health		Value good dental care
		Appreciate need for prevention
Subscribes to appropriate self-care	**Compliance**	
Maintains oral health	Maintains oral health	Maintains oral health
	Gives 24-hr notice cancel appointment	Gives 24-hr notice cancel appointment
		Relaxed
Compliance	Be late; Not respect opinion; negative attitudes about oral health [-ve loadings]	
Follows advice; Accepts suggestions		Follows instructions
Come in at recall	Come in at recall	Come in at recall
On time for appointments	On time for appointments	On time for appointments
	Tractability	
	Trust me	Trust me
	Be manageable	Be manageable
Accept treatment plan	Accept treatment plan	Accept treatment plan
		Finance (part 1)
		Afford optimal treatment; Have insurance; Good dental knowledge
Willing to pay		Willing to pay
Pays bills		
		General behaviour
Cooperates	Cooperate with me	Cooperate with me
Interpersonal responsiveness		
Respect	Respect my opinion	Respect my opinion
	Interpersonal responsiveness	
Courteous	Polite	Polite
	Secure; Content; Patient	Secure; Content; Patient
		Personality
Thankful; Fun to work with	Thankful; Fun to work with	Thankful; Fun to work with
Attentive; Can communicate	Responsive; Sociable; Charming	Responsive; Sociable; Charming
Positive affect	Cheerful; Kind; Warm	Cheerful; Kind; Warm
	Self-confident	Self-confident
Mutual trust; Pleasant		
		Finance (part 2)
	Attractive	Attractive

While there is some inconsistency in classifying items into dimensions across the studies there is also a common element. Across the studies the dimensions of treatment adherence, personal adaptability, social interactiveness, and enabling characteristics emerge. These are outlined in Table 5.4. Treatment adherence corresponds to Dental behaviour and aspects of Dental sophistication and Compliance. This dimension reflects behaviour relevant to the treatment situation. Personal adaptability however, corresponds to General behaviour and aspects of Compliance, Tractability and Interpersonal responsiveness. These characteristics reflect flexibility or willingness to cooperate when reasonably expected to do so, but not necessarily conformance or obedience (Wills, 1978). Social interactiveness corresponds to Personality and aspects of Interpersonal responsiveness. This primarily reflects positive affect, communication and appreciativeness. Enabling characteristics correspond to the Finance factor, spanning aspects such as being willing and able to pay, and having good dental knowledge. Again, there is a need to be cautious regarding reification of factors, but also be aware that factors that recur from different samples and conditions suggest an underlying construct (Kerlinger, 1986).

Factors from a Finnish study of the dentist-patient relationship where all items pertained to aspects of dental treatment grouped the dental treatment items into Motivation and compliance, Allows disruptive behaviour and Punctual and active (Lahti et al., 1992). Items from these factors would relate to the dimension of Treatment adherence, suggesting that this dimension may comprise a number of components.

Table 5.4: Conceptual grouping of dentist preferences

Wills (1978)	O'Shea, Corah & Ayer (1983)	Rouse & Hamilton (1991)	Present study of dental services	Synthesis
Treatability	**Dental sophistication**	**Compliance**	**Dental behaviour**	**Treatment adherence**
• Motivation for treatment	• Positive, appropriate & correct attitudes, beliefs & values about oral health • Maintains oral health	• Comes in at recall • On time for appointments • Maintains oral health	• Comes in at recall • On time for appointments • Maintains oral health • Trust me • Be manageable • Accepts treatment plan	• Attendance • Self care • Trust • Manageability • Acceptance
Manageability	**Compliance**	**Tractability**	**General behaviour**	**Personal adaptability**
• Obedient • Conforming	• On time for appointments • Comes in at recall • Accepts treatment plan • Cooperates	• Trust me • Be manageable • Accepts treatment plan • Cooperates • Respect	• Polite • Secure • Cooperates • Respect	• Politeness • Security • Cooperation • Respect
Likability	**Interpersonal responsiveness**	**Interpersonal responsiveness**	**Personality**	**Social interactiveness**
• Agreeable • Likeable • Warm • Attractive	• Positive affect • Courteous • Thankful • Fun to work with • Can communicate	• Cheerful, kind • Polite • Thankful • Fun to work with • Sociable • Secure	• Cheerful, kind • Thankful • Fun to work with • Sociable	• Positive affect • Appreciative • Responsive • Communicative
			Finance	**Enabling**
			• Willing to pay • Have insurance • Dental knowledge	• Payment mechanism • Knowledge

Despite terminological differences between studies there was some consistency in ranking of factors. These were: compliance, followed by dental sophistication, and then responsiveness for O'Shea, Corah and Ayer (1983); the majority strongly preferred compliant patients, and about half strongly preferred tractable patients, but a minority had strong preferences for patients in regard to interpersonal responsiveness for Rouse and Hamilton (1991); while in this thesis Dental behaviour and General behaviour were preferred by most dentists, followed by Personality and then Finance. In general, the dimensions of Treatment adherence and Personal adaptability were ranked by dentists over Social interactiveness of patients.

In this thesis dentist preferences showed significant associations with services provided. The Dental behaviour sub-scale was positively associated with diagnostic, preventive, general and total services. The Personality sub-scale was positively associated with extraction and prosthodontic services. The General behaviour sub-scale was positively associated with periodontic services and negatively associated with endodontic services. The Finance sub-scale was positively associated with restorative services and negatively associated with diagnostic, prosthodontic and general services.

Dentist demographic characteristics

Dentist demographic characteristics showed a significant negative association for male dentists with preventive services. The paucity of associations by sex of dentist is consistent with reports of differences in service provision being small in terms of effect size (Kent, Carter, and Spencer, 1998), and the distribution of the ten main areas of service being similar in rank order between male and female dentists

(Brennan, 1997). There appears to be fewer gender-specific associations in dentistry compared to medicine which most likely reflects the lack of gender-specific types of oral health problems in dentistry as compared to medicine where some health issues are seen as masculine and some as feminine providing a source of differentiation (Bensing, Van den Brink-Muinen, and De Bakker, 1993).

Age of dentist showed significant associations with diagnostic, preventive, periodontic, extraction, endodontic, restorative, crown and bridge, prosthodontic, general and total services. Patterns of dental service provision in Australia, while associated with age of dentist, generally lack clear and consistent trends except for endodontic services which show a consistent pattern of higher rates among younger dentists (Brennan, 1997).

Synthesis: interpreting dentist factors

Overall, cost emerged as a major determinant of treatment choice in private general practice. In the private sector, resource constraints (i.e., the ability of the patient to pay) may be balanced with technical considerations such as oral health status. Patient preference was also highly ranked, but had a lower ranking than cost and oral health. Models of service rates in a homogeneous patient population have indicated that structural features of a practice and environmental characteristics, practice beliefs of dentists, and patient factors (i.e., cost and patient preferences) involved in decision making explained more of the variance than technical factors (i.e., tooth damage and periodontal status) in clinical decision making (Grembowski, Milgrom and Fiset, 1991). The sensitivity of dentists and patients to cost considerations may reflect that dentistry has been traditionally regarded as a discretionary service and provided according to market principles (Bader and Shugars, 1995b). Despite this, cost and finance factors have not been ranked highly as a preferred characteristic of patients (O'Shea, Corah and Ayer, 1983). Generally, while dentists may not be selective about ability to pay or insurance status, the fact that they take cost into consideration when choosing treatment suggests that dentists act in the role of patient advocate or agent (Maryniuk, 1990). However, selecting treatment alternatives primarily on the basis of price raises issues of appropriateness of care (Bader and Shugars, 1995b), and may result in conflict between the dentist's self-interest and the patient's (Maryniuk, 1990).

The association of beliefs of dentists with service patterns may reflect a process which matches dentist practice beliefs with expectations of patients (Grembowski, Milgrom and Fiset, 1991), although patients may have limited information on which to make such choices (Maryniuk, 1990). Regardless of whether dentists and patients have similar beliefs, service patterns may be constrained by enabling mechanisms such as income or insurance coverage to allow the desired service pattern to proceed. Such a view is consistent with the notion of negotiated treatment plans between dentist and patient (Albrecht, 1977).

The operation of dentist factors on variation in service provision can be assessed by looking at the pattern of associations for treatment choice, practice beliefs and dentist preferences for patients in combination. This is presented in Table 5.5. Periodontic and general services are not included as they represent low rate areas of services in private general practice. The variables have been grouped according to similarities in patterns of service provision.

Table 5.5: Patterns of associations: rate ratios for services by dentist factors

	Endodontic	Extraction	Prostho -dontic	Restorative	Crown & bridge	Diagnostic	Preventive	Total services
Type A								
Cost cluster	-	-	1.52	-	-	-	-	-
Patient influence	1.25	1.32	1.38	-	-	-	-	-
Personality	-	2.14	1.40	-	-	-	-	-
Type B								
Preventive orientation	-	-	1.47	1.16	1.33	-	-	1.05
Type C								
Dental behaviour	-	-	-	-	-	1.16	1.24	1.09
General behaviour	0.59	-	-	-	-	-	-	-
Type D								
Patient cluster	-	-	-	1.19	-	-	-	-
Finance	-	-	0.75	1.20	-	0.90	-	-
Information giving	-	-	0.74	-	1.45	-	-	-

Type A comprises the Cost cluster (indicating rating cost as an important factor in choosing treatment), Patient influence scale (a practice belief scale encompassing that patients should choose treatment with the dentist's advice and if they do not accept treatment recommended they are not dismissed from the practice) and Personality (a dentist preference for patients who are warm, sociable, charming, cheerful, kind, etc). This grouping of factors involves patients in treatment selection, and is associated with emergency care either through lower cost services (extraction) leading to tooth loss and replacement (prosthodontic services) or the higher cost alternative (endodontic services) favouring tooth retention. Type B comprises Preventive orientation (a practice belief encompassing plaque control as a prerequisite for treatment and dentists should convince patients to accept recommended treatment). This factor seems to imply professional autonomy in treatment planning rather than an orientation towards prevention, and is associated with higher service rates overall spanning both restorative and prosthodontic items. Type C comprises Dental behaviour (a dentist preference for patients who come in at recall, are on time, follow instructions, etc) and General behaviour (a dentist preference for patients who are cooperative, patient, polite, respectful, etc). This grouping of factors is associated with diagnostic and preventive services and routine scheduled maintenance care. Type D comprises the Patient cluster (indicating patient preference is an important consideration in choosing treatment alternatives), Finance sub-scale (dentist preference for patients who can afford care, are willing to pay, are insured), and Information giving (practice belief scale encompassing presenting all treatment options to patients and patients should know the cost of treatment). This grouping of factors involves consideration of the role of the patient, presenting treatment options and prices, and being able to pay for care, and was associated with restorative services.

5.1.3 Practice factors

Practice factors were only included in the dentist level models of service provision. The range of practice factors included type of practice, geographic location, number of dentists, waiting time, number of non-dentist staff and numbers of patients treated per year. Solo practice was positively associated with preventive services and negatively associated with diagnostic services. Capital city location was positively associated with preventive services and negatively associated with prosthodontic services. Number of dentists in the main private practice was negatively associated with extractions. Waiting time for an appointment was negatively associated with periodontic and general services and positively associated with prosthodontic services. Number of non-dentist staff was negatively associated with diagnostic, periodontic, general and total services. Numbers of patient visits per year were positively associated with diagnostic and periodontic services

A summary of the patterns of associations of services with practice factors is presented in Table 5.6. This table does not include periodontic or general services as these areas comprise only low rates of provision in private general practice. There were no significant associations between practice factors and either endodontic, restorative or crown and bridge services. The practice variables have been grouped into the categories of size, location, volume and busyness of practice. Overall, smaller practice size was associated with fewer diagnostic, extraction and total services, but more preventive service. Capital city location of a practice was also associated with more preventive services, as well as lower rates of prosthodontic services. Lower volume practices were associated with higher diagnostic rates. Less busy practices had higher prosthodontic rates.

Table 5.6: Patterns of associations of services by practice factors

	Diagnostic	Preventive	Extraction	Prosthodontic	Total service
Size of practice					
Solo practice	(-)	(+)	-	-	-
Lower number of dentists	-	-	(-)	-	-
Lower number non-dentist staff	(-)	-	-	-	(-)
Location of practice					
Capital city	-	(+)	-	(-)	-
Volume of practice					
Lower number patients per year	(+)	-	-	-	-
Busyness of practice					
Shorter waiting time	-	-	-	(+)	-

5.1.4 Oral health status

As for the range of other patient characteristics, oral health status was included in both the patient level and dentist level models. In the patient level models of service provision denture status, number of teeth and number of decayed teeth were entered as terms in the models.

Patient level models

Oral health status along with visit status had the highest number of associations. Denture wearing and number of teeth both had a strong effect on prosthodontic services. Denture wearing also had a weak negative effect for diagnostic, endodontic and restorative services, while number of teeth had a moderate association with extraction services. Decayed teeth had a strong association with restorative services and moderate negative effects for preventive and prosthodontic services.

Dentist level models

In the dentist level models the findings for the proportion of patients with dentures showed significant positive associations with extraction and prosthodontic services and a negative association with preventive services. Proportions of patients with decayed teeth were positively associated with extraction and restorative services and negatively associated with preventive, crown and bridge and prosthodontic services.

Summary: oral health factors

Table 5.7 presents a summary of the significant associations of oral health factors with service provision rates for the patient and dentist level models. Periodontic and general services are not included as they were provided at low rates in private general practice, and total services are not included as there were no significant associations with oral health factors. Taking the associations which were significant at both the patient and dentist level as the most robust effects, denture wearing was positively associated with further prosthodontic care among the dentate, while decayed teeth were positively associated with restorative services and negatively associated with preventive, crown and bridge, and prosthodontic services. Total number of teeth was only included in the patient level models where it was positively associated with extraction and prosthodontic services.

Table 5.7: Summary of service patterns by oral health factors

		Service areas						
	Model level	Diag -nostic	Prev -entive	Extract -ion	Endo -dontic	Restor -ative	Crown /bridge	Prostho -dontic
Denture wearing (present)	Patient:	(-)	-	-	(-)	(-)	-	(+)
	Dentist:	-	(-)	(+)	-	-	-	(+)
Number of teeth[a] (fewer)	Patient:	-	-	(+)	-	-	-	(+)
	Dentist:	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Decayed teeth (present)	Patient:	(-)	(-)	-	(+)	(+)	(-)	(-)
	Dentist:	-	(-)	(+)	-	(+)	(-)	(-)

(a) Not included in dentist level model

5.1.5 Patterns of service provision by main areas

In the previous section service patterns were summarised across a range of factors to address the research problem of whether variation by dentist, patient, practice and oral health status persists after controlling for all of these sets of variables. This form of summary while relevant to the research problem tends to ignore the richness of the data in describing patterns of associations which are specific to each service area. Having looked at the broad patterns of service provision across the range of dentist, practice, patient and oral health factors in the previous section, this section draws out these associations in relation to each specific area of service, drawing primarily on the dentist-level models as these included a wider range of explanatory variables.

Diagnostic services

Provision of diagnostic services was associated primarily with dentist and practice factors, with the proportion of new patients being the only significant patient-level factor. Among the dentist factors, preferences for patients with higher ratings on the Dental behaviour and lower ratings on the Finance sub-scales, and dentists aged 40-49 years were associated with higher diagnostic rates. Practice factors of solo practitioners and those with fewer non-dentist staff were associated with lower rates, while lower numbers of patient visits per year were associated with higher rates of diagnostic services.

A preference for patients with high dental behaviour ratings is consistent with provision of routine care such as diagnostic services (e.g., regular recall examinations). The negative association of diagnostic rates with a preference for patients with high ratings on finance measures suggests a tendency by such practitioners to favour higher cost services rather than those in the diagnostic area. While solo practitioners could represent older dentists there is an age term in the model to control for this factor. However, other potential correlates of solo practice which could explain the lower diagnostic rate include less diagnostic uncertainty associated with greater practice experience and an established clientele of patients. The lower diagnostic rate associated with lower numbers of non-dentist staff is consistent with lower total service rates overall. In general, lower numbers of patient visits per year tends to be associated with higher rates of total services per visit, but this results in numbers of annual services per dentist being similar due to a counter balancing of services per visit and number of patient visits (Australian Institute of Health and Welfare - Dental Statistics and Research Unit, 1996). This pattern of care may be operating here for diagnostic rates which were higher for dentists with lower numbers of patient visits per year. However, the number of total services was not significantly higher in the multivariate model, but was in the bivariate analysis. New patients were associated with higher diagnostic rates reflecting the necessity to gather background information on patients with no previous history.

Preventive services

There were a range of dentist, practice and patient factors associated with preventive services. A preference for patients with higher ratings on the Dental behaviour sub-scale is consistent with regular patients attending for routine care being provided a service package including higher rates of preventive care. Among dentist characteristics, male dentists had lower preventive rates, possible reflecting differences in treatment philosophy controlled for age differences, with younger dentists (i.e., those aged 20-29 years) also demonstrating a preventive-oriented treatment philosophy. Among practice factors, solo practitioners displayed higher preventive rates. While solo practitioners might be expected to have an older age distribution, this is controlled for in the model; but if they have an established clientele, they may more likely to be in a set pattern of routine maintenance care. Another practice factor, capital city location was associated with higher preventive rates. This is consistent with a trend for more favourable service patterns for capital city residents in general, reflecting greater availability of providers and improved access to care. Among the patient-level factors, emergency visits were associated with lower rates of preventive care, reflecting a less favourable service pattern overall for visits motivated by symptoms of relief of pain. New patients also had lower preventive rates, consistent with less favourable service patterns for irregular attenders. In contrast, insured patients had higher preventive rates reflecting a more favourable service pattern in general for the insured. Oral health status was associated with preventive rates with both decayed teeth and presence of dentures associated with lower rates of preventive services. Disadvantaged geographic areas were associated with preventive rates (i.e., patients from lower SES areas had lower preventive rates).

Periodontic services

Periodontic services were associated primarily with dentist and practice factors, with area-based SES being the only significant patient-level variable. Periodontic services represent mainly specialist services, and comprise only a small fraction of total services in general practice. The low rate of provision may lead to some idiosyncratic associations which may be difficult to interpret, possibly reflecting individual preferences of a small number of providers and patients. Hence, patterns of associations for periodontic services should be treated cautiously. Given these caveats, there may be a general tendency to refer periodontal cases to specialists for all practitioners except those with a special interest in periodontics. There may also be a tendency for both providers and patients to see periodontic problems as more of an elective treatment, which may tend to be ignored except where discomfort is involved. This may explain the lower periodontic rate for patients from low SES areas. An alternative explanation may lie in a sorting of patients with periodontic problems away from practitioners in these areas to specialists and those general practitioners in more affluent areas. Similarly, the lower periodontic rate for dentists with a preference for patients with higher Dental behaviour sub-scale ratings could indicate the positive effects of a regular preventive maintenance care schedule or be a selection effect away from these dentists who are more preventively oriented. The higher periodontic rate for dentists with a preference for patients with higher ratings on the General behaviour sub-scale suggests a role for patient compliance and co-operation in the provision of this treatment in general practice. In general, rate ratios were higher for dentists under 50 years of age, but were only statistically significant for those aged 30-39 years, possibly reflecting different emphases on periodontal diseases in dental education over time. Shorter waiting times were associated with lower periodontic rates, perhaps reflecting an greater emphasis on more basic treatment (e.g., prosthodontic care) than services considered either specialist or elective items such as periodontic treatment in less busy practices. Lower numbers of non-dentist staff were associated with lower periodontic rates, which is reflected in the pattern for total service per visit, and also for diagnostic and general services. As for diagnostic services, the higher rate of periodontic services among dentists with lower numbers of patients per year could be linked to a general trend toward higher rates of total services per visit (in this thesis, significant only in the bivariate analysis) which counterbalances the lower patient numbers. A study of the provision of periodontal services in Australia in 1983-84 found that patient age, dentist self-rated busyness, partnerships compared to solo practices, a fee index of five service items, gross practice revenue and metropolitan location were all positively associated with periodontal rates, while dentist age was negatively associated with periodontal rates (Spencer and Lewis, 1989b).

Extraction services

Patient-level factors and dentist factors were associated with provision of extraction services. The only significant practice factor was number of other dentists in the main private practice at which a dentist worked. Lower numbers of other dentists were associated with lower extraction rates. With age of dentist and practice type included as terms in the model, the term for lower numbers of other dentists would reflect solo practice without assistants, with most likely an established clientele of patients. The dentist factors of higher Patient influence practice beliefs and preference for patients with higher ratings on the Personality sub-scale being associated with higher extraction rates may seem surprising. However, it is likely that patient influence reflects the operation of cost considerations on treatment choice, with preferences for patient personality suggesting an encouragement for allowing the patient a role in the process. Together, these seem to point to negotiated treatment choices involving a lower cost alternative such as extraction. There was a trend toward lower extraction rates among dentists under 50 years of age, but this was only significant for those aged 40-49 years. Age-related service patterns could reflect differences in treatment philosophy stemming from dental education experiences and possible cohort differences. A range of patient-level factors were associated with extractions. Higher extraction rates were associated with emergency visits, uninsured patients and new patients, indicating adverse service patterns for those visiting for relief of pain, lacking enabling mechanisms via insurance, and being an irregular visitor. Patient age was also associated with extractions, with higher rates among adult patients aged 25-44 years. This is consistent with previous reports of extractions peaking among young adult age groups (e.g., Brennan, Spencer and Slade, 1997). The oral health status factors of decayed teeth and presence of dentures were both associated with higher extraction rates indicating poorer oral health status leads to poorer service provision and ultimately oral health outcomes. Area-based SES was also associated with extractions, with higher rates among patients from lower SES areas indicating an area driven SES effect after controlling for a range of visit and oral health factors, pointing to social inequalities in service provision which could stem from issues of access and cultural norms regarding standards of care.

Endodontic services

Provision of endodontic services was associated with both dentist and patient factors, but not any practice factors. Endodontic services provided some apparent anomalies in the service provision models. In relation to patient characteristics, apart from the reversal of direction in the association of new patient status between patient and dentist level models, there were a range of effects which were not straightforward in their interpretation. A significant positive association with emergency visits also occurred in the patient level model, while significant positive associations with insurance and lower socio-economic status occurred in the dentist level model. Endodontic services seem to be associated with disadvantage in terms of emergency treatment for relief of pain and lower socio-economic status on the one hand as well as with insurance which is usually correlated with advantageous service patterns. Some of the apparent inconsistencies may reflect the nature of endodontic treatment itself, which manifests itself typically through symptoms of pain which necessitate emergency visits, but also reflects a higher cost service which favours retention of teeth rather than the lower cost alternative of extraction. Among the dentist factors a higher belief in regard to the Patient influence scale was associated with higher endodontic rates, suggesting an orientation toward involving patients together with relief of pain visit patterns can lead to higher cost alternatives such endodontics which may favour tooth retention rather than just extraction as the only option. However, a higher preference rating for patients on the General behaviour sub-scale was associated with lower endodontic rates, indicating greater emphasis on attributes such as co-operation probably flows through to dental visiting patterns with less likelihood of visits for relief of pain. The age gradient observed with higher endodontic rates among younger practitioners could reflect a cohort effect related to dental education experience as well as a general trend towards increases in endodontic service rates over time (Brennan, 1997).

Restorative services

Restorative services were associated with both dentist and patient level factors, but not with any practice factors. A higher restorative rate was associated with the Patient treatment choice cluster, which primarily reflects a role for patient preference in treatment choice. This treatment choice cluster had a lower extraction rate in the bivariate analysis, but was not significant in the multivariate analysis. When considered along with higher restorative rates for higher practice belief ratings on Preventive orientation and the Finance sub-scale for patient preferences, it suggests that the role of dentist authority linked to the Preventive orientation scale and ability to pay associated with the Finance sub-scale may be matched by a patient-dentist selection where those interested in and positive about restorative care converge, with no conflict between patient preferences and dentist beliefs among this sub-group of patients and providers. The higher restorative rates for dentists aged 30-39 years could reflect treatment philosophy related to educational experiences or cumulative individual career experience resulting in increased knowledge and skills in restorative care over time. Among the patient level factors there were lower restorative rates associated with emergency visits, but higher rates for insured patients and those with decayed teeth, indicating restorations tended not to be placed for relief of pain, that enabling factors such as insurance facilitate restorative care, and oral health status is related to care provided.

Crown and bridge services

Provision of crown and bridge services was predominantly associated with dentist factors, with no practice factors and only one patient level factor being statistically significant in the multivariate model. Decayed teeth were negatively associated with rates of crown and bridge services, indicating these services may be more likely to reflect the sequelae of caries rather a direct response to it, and may even reflect a 'preventive' approach to the potential avoidance of conditions such as tooth fracture. Dentist practice belief scales of Information giving and Preventive orientation were positively associated, and Patient influence negatively associated, with the provision of crown and bridge services. Both Information giving and Patient influence most likely represent cost implications of treatment choice with the giving of information about cost of care associated with higher rates but the involvement of the patient in choosing treatment associated with lower rates of crown and bridge services. The higher rate of crown and bridge associated with higher ratings on the practice belief of Preventive orientation most likely reflects the professional authority aspect of this scale rather than prevention. Age of dentist showed lower rates of crown and bridge among 20-29 year old dentists, but higher rates among 40-49 year old dentists compared to those aged 50 years or more. This may reflect a process of individual cumulative experience which results in acquisition of knowledge and skills over a career with some tapering away as retirement approaches, or else the operation of differences in treatment philosophy associated with educational experiences.

Prosthodontic services

Provision of prosthodontic services was associated with a range of dentist, practice and patient factors. Prosthodontic services represent an area of service which may be seen as the final consequence of disease and failure of other treatment, resulting in tooth loss and replacement by dentures. In some sense, these services can be a high cost service, but may be preferred by some patients as a final solution to dental problems and possibly a means of avoiding future expenditure on endodontic or restorative care. Cost related factors are reflected in higher prosthodontic rates among dentists in the Cost treatment choice cluster where more emphasis is placed on cost as a factor when choosing treatment, and a lower rate of prosthodontic services for dentists with higher ratings on the Finance sub-scale for patient preferences. The Information giving practice belief scale was also associated with lower prosthodontic rates, reflecting the role of informing patients about costs of care provided. The Preventive orientation and Patient influence practice belief scales, and Personality dentist preference for patients sub-scale were all associated with higher prosthodontic rates. This may reflect the role of professional authority in treatment selection for the Preventive orientation practice belief, and a tendency for patient involvement to favour perceived long term lower cost solutions for the Patient influence practice belief and Personality preference sub-scale. In general, the role of cost in treatment choice seems to be working in opposite directions, being a dampening factor from the perspective of a dentist (Information giving practice belief and Finance dentist preference for patients sub-scale), but a facilitating factor from the perspective of patient (Cost treatment choice cluster, Patient influence practice belief, and Personality dentist preference for patients sub-scale). The rate of prosthodontic services was higher for dentists in the 40-49 year age group. Prosthodontic service patterns by age of dentist could reflect educational emphases in training and underlying trends in oral health away from edentulism over time. In general, more favourable service patterns were observed at capital city locations, reflecting differences in availability of dentists and associated access issues. The association with waiting time indicated that less busy practices had higher prosthodontic rates. These practices, which have a clientele more favourable to prosthodontic care, could possibly reflect a lower SES distribution, and cultural norms regarding tooth loss. The positive relationship with insurance status seems paradoxical, but like endodontics, while this may reflect an undesirable service pattern, they are still costly procedures and enabling mechanisms such as insurance may facilitate their occurrence. Also these patterns are for prosthodontic care among the dentate, which may differ from that observed among edentulous persons. In terms of oral health status, decayed teeth had an expected negative relationship and presence of dentures an expected positive relationship with prosthodontic services.

General/miscellaneous services

Provision of general/miscellaneous services was associated with dentist, practice and patient level factors. However, area-based SES was the only patient level factor which was statistically significant, with lower rates of general care associated with a lower SES distribution. In contrast, a higher rating on the Finance sub-scale for dentist preferences for patients was also associated with lower rates of general/miscellaneous services. Dentists aged 30-39 years, and the practice factors of shorter waiting times for an appointment and lower number of non-dentist staff were also associated with lower rates, while a higher rating on the Dental behaviour sub-scale for dentist preferences for patients was associated with higher rates of services in this area. This service area comprises one of the lower rate areas, being third lowest behind orthodontic and periodontic services out of the 10 main areas of service. The low provision of these services in private general practice makes it difficult to interpret patterns of associations with these services. Additionally, the nature of these services being an aggregation of general and miscellaneous service items which comprises a heterogeneous collection of services covering emergency care, drug therapy, professional visits, anaesthesia and sedation, anxiety therapy, electrotherapy, and occlusal therapy, also hinders interpretation of patterns of associations.

Total services

Rates of provision of total services per visit were associated with dentist, practice and patient level factors. However, the number of associations was limited and the effect sizes of the associations tended to be small. Higher preference ratings for patients on the Dental behaviour sub-scale were associated with higher rates of total services, consistent with more service among the dentally interested, which includes higher rates of diagnostic and preventive care. The other significant dentist factor was age, with those under 50 years having higher rates of service per visit, suggesting that older dentists may limit the range of services they provide as they approach retirement. Lower numbers of non-dentist staff were associated with lower total service rates, suggesting a trend toward less service among smaller practices, but patterns of rates per visit can be counter balanced by numbers of patients per year treated (Australian Institute of Health and Welfare - Dental Statistics and Research Unit, 1996). Insurance status was positively associated with rates of service per visit, indicating this enabling mechanism facilitates the provision of more services, which included preventive, endodontic, restorative and prosthodontic care. Area-based SES showed that a lower SES distribution was associated with fewer services, consistent with the financial barrier of being less able to pay for care providing a limiting effect on services provided in private general practice.

5.2 Limitations of approach and methods

Having looked at the main findings of the thesis in the previous section, this section considers methodological issues. Primarily, this section deals with some of the limitations of the approach and methods adopted in the thesis. This involves consideration of aspects of sampling and response, dependent variables, use of scales, statistical approach, data aggregation, service log approach and rationale for the study.

Sampling and response

The approach to sampling which was adopted consisted of the use of dental registers. This represents a comprehensive sampling frame which includes all dentists registered to practise dentistry in each State and Territory of Australia. Well maintained dental registers provide an ideal sampling frame, but may be compromised if they are not adequately maintained by the respective State/Territory dental boards. For example, if new dentists were not included on the register or if address details were not updated. Another potential source of bias may arise from response levels.

In this study some sampling and response problems were encountered through addresses which were not contactable and through difficulty in achieving an acceptable level of response. Efforts were made to minimise these problems by tracing addresses through telephone listings and by using multiple follow-up mailings. Potential response bias was assessed through comparison of the age and sex distribution of respondents with the population of registered dentists, and comparison of characteristics of respondents who supplied service log data with those which did not complete the service log. No evidence of response bias was detected through these comparisons.

The sampling approach of using a log to collect data on services and patients involved a two stage sampling approach. The dentists were sampled as a simple random sample (primary sampling unit), but the second stage of sampling used the service log of patients (secondary sampling unit). This second sampling stage treats dentist as clusters. The effect of clustering is minimised when clusters are numerous with few replicates within a cluster (Bennett et al., 1991), which is the case here where each dentist (i.e., cluster) was sampled for one day. The loss of sampling efficiency resulting from this complex sampling design was measured by an intraclass correlation for each area of service, and the design effect estimated was used to calculate a weight for the patient level models which adjusted the sample to the size of the simple equivalent sample size (Rosier, 1998).

Dependent variables

Measurement of dependent variables in this study has involved the use of a standard set of criteria to classify service items and group these items into main areas of service. *The Schedule of Dental Services* provided by the Australian Dental Association is a uniform set of guidelines for classifying services which is well known among practitioners as it is often used to allocate costs of treatment in billing patients either directly or through insurance agencies. This may also have some distorting effect if the use of the schedule reflects billing practices rather than service provision. However, the universal nature of the use of the schedule by practitioners would reinforce the utility of the schedule as a data collection instrument. Practitioners were instructed in the service log to record all services provided regardless of how or whether they were charged to the patient.

The service provision analysis refers to rates of service items classified into main areas. Therefore different types of services are treated the same, simply as counts of services converted to rates per patient visit. So a single surface filling is counted as one item of service as is a filling involving three or more surfaces. Dissimilar services can be converted into a common scales using relative value units (RVUs) based on work effort. One method of calculating RVUs involves multiplying estimates of time per service by a responsibility factor (Clappison, Pressey and Freeman, 1965). Other methods have been based on concepts of service times, costs and task mix (Schwarz, 1989; Council on Dental Health, 1968; Mackie and Lennon, 1984; Marcus et al., 1990). An analysis of RVUs in Australia showed that the distribution of services based on RVUs differs from that based on service item counts, with a more pronounced dominance of restorative services. Diagnostic and preventive services appear reduced relative to restorative services, while endodontic and crown and bridge services are more prominent when measured as RVUs (Brennan, Spencer and Szuster, 1994). Service rate counts were preferred in this thesis due to their more readily interpretable nature over the more specialised econometric concept of RVUs.

Use of scales

In this thesis scales were developed based on previous research into patient values (Weinstein et al., 1979), practice beliefs (Grembowski, Milgrom and Fiset, 1988; 1991), and preferences for patients (Rouse and Hamilton, 1991). Researchers tend to overestimate problems with existing measurement scales, and hastily develop new scales when they are not warranted (Streiner and Norman, 1995). While there is a general need to replicate research findings this may be particularly warranted in studies using factor analysis where the evidence for factors is more compelling when they are observed in a range of samples (Kerlinger, 1986). Replication need not be literal duplication, but can involve constructive replication based on the same problems or variables (Martin and Bateson, 1986). The approach adopted consisted of a constructive replication based on the previous studies of patient dental values, practice beliefs and preferences for patients.

A methodological question concerns the degree of sensitivity of scales to cut-off scores used. Means higher than the mid-point do not necessarily indicate an absolute cut-off for agreement/disagreement, as scores really just rank respondents (Davies and Ware, 1981). However, collapsed Likert scales correlate with dichotomous scales, but have greater internal consistency (Greenwald and O'Connell, 1970), and collapsed scales have been found to have no deleterious effects on reliability or validity (Matell and Jacoby, 1971). The median was used in this thesis as an empirically based cut-off which was interpretable in terms of the agree/disagree continuum of the scale. This was preferred in lieu of any compelling conceptually based alternatives. Likert scales have been found to be generalisable across different anchoring labels as long as the numerical scale is clearly defined (Chang, 1997). Labelling of the mid-point as neutral versus undecided has been found to make negligible difference (Armstrong, 1987), and excluding the mid-point no significant difference, on total scores (Guy and Norvell, 1977). Variability of responses to mid-points has been found to be similar to other response categories, supporting the treatment of it as an indicator of a middle position along a continuum rather than an indicator of ambivalence or indifference (DuBois and Burns, 1975). While the mid-point value of the scale (i.e., using the value "3" on a scale ranging from "1" to "5") may be considered the middle of the response continuum, an advantage of using the median is that it adjusts for any skew present in the responses on the scale. Where there is a high degree of skew towards one end of a scale, using the median as a cut-off may provide greater statistical power by dividing the respondents into nearly equal sized groups. However, this needs to be considered when interpreting the results, as both groups may have, on average, a high degree of agreement on the dimension being measured.

The dentist preferences for patients and patient evaluation sub-scales each had adequate reliability measures, within the range of Cronbach's $\alpha = 0.70$ - 0.90 (Streiner and Norman, 1995). Reliability measures of $\alpha = 0.50$ may be used as a good minimum standard for group comparisons, while 0.90 is required for comparisons at the individual level (Davies and Ware, 1981). The practice belief scale of Information giving had an α of 0.65, however, the practice belief scales of Preventive orientation and Patient influence were both below the $\alpha = 0.50$ level.

Statistical approach

Throughout the thesis a range of bivariate tests are presented. When using multiple testing some statisticians suggest that more stringent tests of significance be adopted (e.g., using 1% rather than 5% as the alpha level). However, such an approach may simply reduce the false positive results at the expense of false negatives (Rothman, 1986). The problem with multiple comparisons mainly stems from performing many tests and selectively reporting only those which were significant. No adjustment for multiple comparisons is needed if the total number of tests is clearly reported and non-significant results are reported along with the significant ones (Rothman, 1986). This approach was adopted in this thesis, with all tests both positive and negative being presented.

Collinearity refers to relationships among the independent variables and is used to indicate that one predictor is an exact linear combination of the others. Near collinearity arises when there is a high degree of association between independent variables and may result in inaccurate estimates of regression coefficients, standard errors and hypothesis test statistics (Kleinbaum et al., 1998). Ideally collinearity problems can be avoided through eliminating one or more of the variables. In general, this approach was adopted in the thesis with derived variables such as numbers of patient visits per year used instead of the components of the derived variable such as hours per year worked and numbers of patients per hour. Among the dentist factors some of the scales were correlated, with the Dental behaviour and

General behaviour preference for patient sub-scales in particular having a high correlation (r > 0.7). The dentist level models were run eliminating the General behaviour sub-scale and comparing the results to the full models. As only minor differences occurred between the two model types across the 10 service areas the full models containing the General behaviour sub-scale were retained.

Selection of variables for inclusion in the models was motivated by the aim of developing a comprehensive model of service provision which included as many elements as possible from among the groups of provider, practice and patient factors. While parsimonious models are often preferred, when inference is the goal, concerns about confounding and aptness of the model should dominate any competing concerns for simplicity (Rothman, 1986). The analytic aim in this thesis was to include as many factors of potential influence as practical tempered by the desire to avoid redundancy and collinearity. While step-wise approaches are often used in cases where the goal of an analysis is purely predictive, when the goal is explanation step-wise approaches are undesirable to the extent that they may omit non-significant terms which combined can account for substantial confounding, and there is no compelling reason to reduce the model to a small set of terms providing that there are not too many terms (e.g., 20-30%) relative to the number of observations (Rothman, 1986). Hence the approach in this thesis was include a full set of independent variables across the range of service areas in each model.

Previous analyses of dental services have outlined the difficulties of analysing service rates which in general tend to have distributions which are skewed and hence not amenable to parametric analytic approaches (Bailit and Clive, 1981; Grembowski, Milgrom and Fiset, 1990a). While non-parametric techniques are available (Seigel and Castellan, 1988), they are limited in their applicability to analysis of multiple independent variables. Data transformations may be used in parametric analyses of skewed data, with rank transformations suggested as a bridge between parametric and non-parametric statistics (Conover and Iman, 1976; 1981; Iman and Conover, 1979), but are clumsy to apply and present difficulties in interpretation. The main approach in this thesis consisted of using Poisson regression, as this analytic technique is compatible with the distribution of the data and is readily applied to analysis of multiple independent variables in a modelling framework. This approach was compared to ordinary least squares regression and, in the patient level models, logistic regression. Linear regression provides a readily interpretable measure of goodness of fit. Logistic regression looks at initiation of contact as a separate problem to repeated contacts (Korten et al., 1998).

The percent of variance explained by the models ranged from 0.5 to 19.6% for the patient level models, with four models greater than 12.0%, and from 0.7 to 15.5% for the dentist level models, with four models greater than 9.0%. Interpretation of a given R-squared value may depend on the context of the study, where a value of 0.30 might be considered high by a social scientist while a value of 0.98 might be considered small by a physicist (SAS, 1988). The lower psychosocial and organisational effects found in models from large-scale surveys have been attributed to the use of proxy measures of morbidity which due to their correlation with socio-demographic, attitudinal and behavioural variables leads to a reduction of their effects when simultaneously entered into a model, the use of measures such as presence of insurance rather than extent of coverage or out-of-pocket expense, the difficulties of capturing details of small sub-groups of a population from aggregated data such as population-to-provider ratios, and a lack of sensitivity resulting from general measures of persons and environment which are unable to describe cross-sectionally how those with identical symptoms might behave differently according to what is going on in their lives and on situational factors (Mechanic, 1979).

Data aggregation

Area-based measures of socio-economic status were used in this thesis to measure the effect that this had on the service provision patterns. This was performed by collecting residential postcode of patients and linking this to an area-based index of disadvantage derived from census data. The use of an area-based measure primarily reflects pragmatic methodological issues of subject burden, ease of collection, and feasibility of collecting alternative measures. However, area-based measures may be better predictors of health status of population subgroups than conventional measures based on the characteristics of individuals or households (Locker, 1993). Conventional measures of social inequality such as occupation, income and education have limitations such as being difficult to collect, having high refusal rates, the groups identified are not homogeneous, lacking a spatial dimension, and ignoring the broader social environments in which people live (Locker, 1993). Area-based measures have some advantages in terms of having less missing data, less social desirability bias and enabling identification of areas which can be targeted for direction of resources (Locker and Ford, 1994). A comparison of an area-based measure with a conventional measure found that household income was a better predictor of inequalities in oral health than the area classification in terms of stronger effect sizes and more consistent rankings, but the differences between the performance of the two measures were not great, with the area-based measure performing almost as well as the conventional measure (Locker and Ford, 1994). Some limitations of area-based measures include that they tend to be produced periodically and may be out of date, and could potentially lead to the ecological fallacy of drawing erroneous inferences about associations between two variables when using grouped data (Locker, 1993; Locker and Ford, 1994).

The dentist level models presented in this thesis include dentist and practice factors in addition to a range of patient factors, but patient factors are aggregated to the dentist level. This aggregation of data could lead to potential methodological issues related to the ecological nature of this grouped data. Data averaged over groups may result in associations which are more tenuous than when derived from individual level data, and suffer from an inability to control for confounding in the grouped data (Rothman, 1986). However, despite the problems associated with the use of aggregated data, the findings can be useful even if confounded by unknown and uncontrollable factors by identifying effects worthy of further investigation (Rothman, 1986).

Service log approach

The technique of sampling service provision through a log of a typical day has been examined through a study of a sub-sample of respondents to the 1993-94 wave of the Longitudinal Study of Dentists' Practice Activity (Brennan, 1997). Dentists in the sub-sample were asked to record a total of 10 days of service provision and to nominate their self-selected typical day of practice. Similar estimates of rates of service provision from each of the 10 main areas of service from the *Schedule of Dental*

Services were obtained for the self-selected typical day and the remaining 9 days of data from the log. However, the variability was greater for the nominated typical day estimates compared to the remaining sampled days. This greater variability may be accounted for by sample size (i.e., the typical day estimates were based on 1 day by 30 dentists giving 30 days in total while the remaining sample was based on 9 days by 30 dentists giving 270 days in total). When rates and standard errors were compared by cumulative sampling days (e.g., day 1, days 1-2, days 1-5, and days 1-10) there was generally only small variation even between 1 day and 2 days cumulative sampling. However, the variability in the estimates tended to decrease as the sampling effort increased. Therefore sampling effort can be used to increase the precision of the estimates. One way is to increase the number of days sampled per dentist, another is to increase the number of dentists sampled. If estimates are only required at an aggregate level (e.g., by dentist age) rather than for individual practitioners, then a 1 day sampling period is sufficient given that a large enough number of dentists is sampled.

Visit was the unit of analysis recorded in the service log. This was a consequence of the sampling procedure which collected data over a 1 day period. Patients were not uniquely identified and followed through a course of care. Instead a cross-section of visits was obtained, and due to the short duration of the sampling it was unlikely that patients were included in the sample more than once. The rate of service provision is expected to be lower per visit than per course of care, which may span a number of visits. However, due to the cross-sectional nature of sampling, which includes all types of visits in a sampling day such as first visits, intermediate visits and final visits from a course of care, the service data obtained will be representative of the full range of services provided.

The oral health variables recorded in the service log (i.e., numbers of teeth, decayed teeth, wearing of dentures) related only to status at the beginning of the current visit. Therefore measures such as decayed teeth are not considered valid prevalence or severity measures in the usual sense of an oral health survey, as they may have already been treated in previous visits during the current course of care; but the oral health measures are relevant to the provision of service at the current visit.

Rationale for study

An influential definition of science was proposed by Popper who saw scientific progress not as passive observation but as active investigation of a series of conjectures and refutations based on the testing of ideas which were open to falsification (Magee, 1973). While this view was supported by some (e.g., Medawar, 1979) it seemed not to fit the actual practice of science (Charlesworth, 1982). Hence the development of Kuhn's ideas of a history and sociology of science where epochs of normal science are punctuated by revolutions or paradigm shifts, and Feyerabend's view that there is no scientific method but that scientists use whatever methods are available. This seems to link with notions of science as the 'art of the soluble' (Medawar, 1982). Success in science has been attributed to two separate routes, syntheses and breakthroughs (Wilson, 1994), paralleling the notions of normal and revolutionary science. The approach of this thesis has been to attempt a constructive replication of aspects of treatment choice, practice beliefs, and preferences for patients and combine these elements in a synthesis of explaining variation in service rates which incorporates control for practice, patient and oral health factors.

The central implication of this thesis is the impact that variation in dental service provision has in terms of appropriateness of care. Randomised clinical trials (RCTs) may be used as an objective measure of appropriateness of alternative treatment methods, and should be performed regardless of model studies such as that presented in this thesis. However, the value of model studies is their ability to explain, and therefore improve the understanding of the multiple sources of potential influence. This contrasts with the black-box approach of a RCT which can determine an outcome between two alternatives but doesn't really explain the dynamics behind the process. There are parallels here with the goals of analysis (i.e., explanation and prediction) where studies tend to emphasise one aspect more than the other. The importance of explanation lies not only with academic and intellectual curiosity, but with the ability of the profession to project to the public a credible account of the services they provide. This may be particularly important in an age of rising consumerism and for a profession such as dentistry where there is a knowledge gap between lay and professional judgements of quality of care. The public health implications of the findings of this thesis are discussed in the next section.

5.3 Public health implications

This section deals with the public health implications of the findings. These are discussed in relation to appropriateness of care and the development of parameters and guidelines.

5.3.1 Appropriateness of care

The central public health implication of this thesis is that appropriateness of care may be compromised when factors other than oral health status are influencing the patterns of services provided. The assumption is that as a result of these other sources of variation a range of treatment patterns are being provided which are not all of equal effectiveness. Understanding the sources of this variation provides avenues to explore in the pursuit of improved quality of care.

Background

With much of dentistry being described as lore and many common treatment practices being unsupported by scientific evidence, there is scope for improving the understanding of the service provision process (Bader, 1992). In places such as Australia and the USA where private dental care dominates, economic markets are the cornerstone of the delivery system and the challenge is to understand the dynamics of the transactions between patient and provider which largely determine who is treated, for what type of dental problem, by whom the service is given, and how much the service provider is paid (Grembowski et al., 1988). Choice of treatment is described as an art with many factors involved (e.g., economic, psychological, physiological) with few objective rules guiding what is seen as professional judgement (Kress, 1980). The widespread variation in dental decision-making arises from variation in identification of conditions, decisions to treat, and selection of treatment which is influenced by differences in dentists' beliefs or knowledge (Bader and Shugars, 1995b).

Common factors which influence treatment planning include patient attendance patterns, dentist-patient relationships, treatment prognosis, attitudes to risk, values of both dentist and patient in relation to dental care, treatment thresholds of dentists, and financial constraints on patients (Kay and Nuttall, 1995a). Understanding clinical decision-making is necessary if the profession is to able to defend its own judgements through offering explanations about the reasoning behind clinical decisions to prevent the profession from being labelled as inaccurate, unethical or unscientific (Kay and Nuttall, 1995b).

Sources of variation

Existing diagnostic tools have been criticised for their reliance on subjective judgements, provision of only semi-quantitative measures and insensitivity to small lesions, which can impact on individuals through either false negative diagnoses of hidden occlusal dentine lesions and approximal cavities or false positive diagnoses for sound surfaces resulting in inappropriate decisions to intervene (Pitts, 1997). Caries-related treatment decisions have been described as a pattern recognition process or non-analytical processing using scripts based on summarised versions of the cumulative experience of a provider with similar clinical presentations (Bader and Shugars, 1997). Use of scripts involves a matching of salient features leading to an automatic decision, usually to intervene. Scripts are thought to be highly individualistic and to contribute to substantial variation in treatment decisions. Tooth and mouth factors are likely to be included in caries scripts, with patient level factors likely to be involved in treatment selection, and dentist factors influencing which salient features are incorporated into individual caries scripts. Investigation of restorative treatment thresholds has indicated that the individual experiences of a dentist may be more important in forming views on when to intervene than other factors such as payment mechanisms, practice location or training experiences (Nuttall and Pitts, 1990).

The minimum point at which to intervene with a filling has been found to vary by age of patient and type of tooth, and was modified for reasons of being an irregular attender or having poor oral hygiene (Nuttall and Pitts, 1990). Other studies have found that attendance patterns have an influence on treatment provided. A higher amount of treatment with more restorations was received by new patients (Davies, 1984), and comparison of frequent and infrequent attenders found that frequent attenders received more restorations while infrequent attenders had more extractions (Nuttall, 1984). Another study of attendance patterns found that individuals who visited a dentist infrequently had a lower prevalence of restorations, with a higher percentage of unsatisfactory restorations compared to those who visited more frequently (Kroeze et al., 1990). Periodontal disease has also been related to visit patterns, with severity correlated with time since last dental visit and receipt of extractions, and with attitudes regarding the importance of regular visits (Eddie and Davies, 1984).

Insurance is another factor which can influence visit patterns and services provided. While there is evidence of improvements in oral health as reflected in changes in service patterns over time within a population of insured patients (Eklund, Pittman and Smith, 1997), simulation models show that reductions in coverage would have adverse effects on oral health status with increases in percentages of decayed teeth and untreated decay compared to baseline (Brown, Caldwell and Eklund, 1995).

Variation in service rates has been related to practice characteristics, patient exposure to fluoridated water and non-price competition in the dental market (Grembowski, Milgrom and Fiset, 1990b). Higher rates occurred in large, busy practices in markets with high fees. An inverse relationship has been found between practice age and rate of services provided, while dental market has been found to have both positive and negative effects on service rates indicating both non-price and price competition in the marketplace (Grembowski, Milgrom and Fiset, 1991). A study of fluoridation and use of dental services among insured adults found that fluoridation reduced oral disease but may or may not reduce use of restorative services depending on clinical decisions of dentists (Grembowski et al., 1997b). While clinical needs were the primary determinant of restorative demand, there was a market effect where over-treatment in the form of supplier-induced restorative demand may have occurred in fluoridated markets with a large supply of dentists as a result of less decay and competition for patients.

The effects of variation in both dentists' decisions to treat and also choice of treatment can lead to substantial variation in cost of treatment, reflecting disagreement among dentists in the perception of the need to intervene (Shugars and

Bader, 1996). Similarly, a substantial lack of agreement was found to occur between dentists on which teeth are at risk of fracture and require treatment by a crown (Bader, Shugars and Roberson, 1996). Investigation of the use of crown versus the alternatives of complex amalgam or composite restorations found variation in crown use beyond that explained by patient and practice factors which raised concerns regarding the appropriateness of care provided (Shugars et al., 1997). Treatment selection has often relied on cost as a primary consideration, but investigation of outcomes should include not only restoration survival, but survival of tooth and pulp, and any related maintenance requirements (Martin and Bader, 1997). Sources of disagreement leading to cost variation could include diagnostic criteria, risk assessment, interpretation of non-clinical patient factors and interactions between dentists and patients (Shugars and Bader, 1996).

The lack of a theory of communication in the dental context has hindered the development of an empirical model of the dentist-patient relationship which can predict and prevent adverse outcomes (Sondell and Soderfeldt, 1997). Dental consultations include the same functions of a medical consultation, namely to interview, investigate, diagnose, prescribe, review and advise, but additionally includes the function of delivering treatment. The element of treatment may put dentists under stress to perform and patients under stress expecting a potentially unpleasant experience. The location of the dental consultation in a dental chair surrounded by equipment with treatment occurring in the mouth may be barriers to communication, although treatment provided through a series of visits may foster a more communicative relationship (Sondell and Soderfeldt, 1997).

A qualitative study of dentist-patient interactions found that dentists view the current condition of the mouth as a sign of a range of personal characteristics of patients (Redford and Gift, 1997). The responsibility for poor existing treatments is attributed primarily to the patient, with those who have poor oral health status being viewed as non-compliant and thus less likely to be offered treatment involving extensive home care or multiple visits, while those presenting with previous low cost treatment generally being offered more limited treatment options. Patients perceived as bright, co-operative and not apprehensive were offered the greatest range of options and maximum opportunity for interaction. Patients were also found to bring their own biases to the treatment process, being more likely to interact when they have a more favourable impression of a dentist in terms of examination style, personality and ability to relate to patients as individuals (Redford and Gift, 1997). Variability between treatment planned for similar conditions may be acceptable providing there is a rational basis for the choices that have been made (Kay and Nuttall, 1995c). The optimal treatment plan should be dictated by what outcome can be achieved and how valuable this is to the patient, therefore patient preferences are an important part of clinical decision-making (Kay and Nuttall, 1995d).

Overview

Figure 5.1 presents an overview of the factors which influence variation in service provision. This schematic model outlines major sources of influence and their interrelations during the service provision process. This is intended to illustrate major pathways and interactions, but is not intended to comprehensively model all possible connections. The model shows the service provision process occurring at a dental visit through the intersection of patient and provider at a clinic or practice, embedded within a payment mechanism which in turn is set within the broad span of a society or culture. Within the confines of the visit, shown in the middle of the chart, is the typical sequence of events involved in the service provision process. A dental problem is converted to a diagnosis leading to a decision to intervene, followed by treatment choice and provision of services. The dentist-patient interaction overlays the visit at the intersection of the patient and provider. The attitudes and behaviours of both patients and providers sets the tone of the relationship which may or may not encourage a patient role in the treatment choice process. The knowledge and attitudes of patients will impact on their oral health status, leading to the dental problem that motivates a visit and the symptoms which may dictate whether a visit involved relief of pain, other dental problems not requiring relief of pain, or routine preventive and maintenance care. The visit takes place within a clinic or practice which through various access issues (e.g., distance, hours of business) can inhibit or facilitate visiting on the part of the patient, and provide a constraining force on the provider (e.g., if located in a low SES area, or rural or remote geographic location). The payment mechanism within which a visit occurs may be an enabling factor for the visit (e.g., in the case of insurance coverage) or may constrain options available at the point of treatment choice (e.g., through cost differentials in fee-for-service treatment alternatives). The provider brings abilities to identify at the diagnosis or detection phase, knowledge which can shape beliefs which facilitates the decision to intervene with treatment, and clinical skills which influence the success rate of the services provided in the treatment phase. Technical evidence drawn from research on treatment outcomes provides data which can inform the knowledge base of the provider and flow on to refine the practice beliefs of a provider.

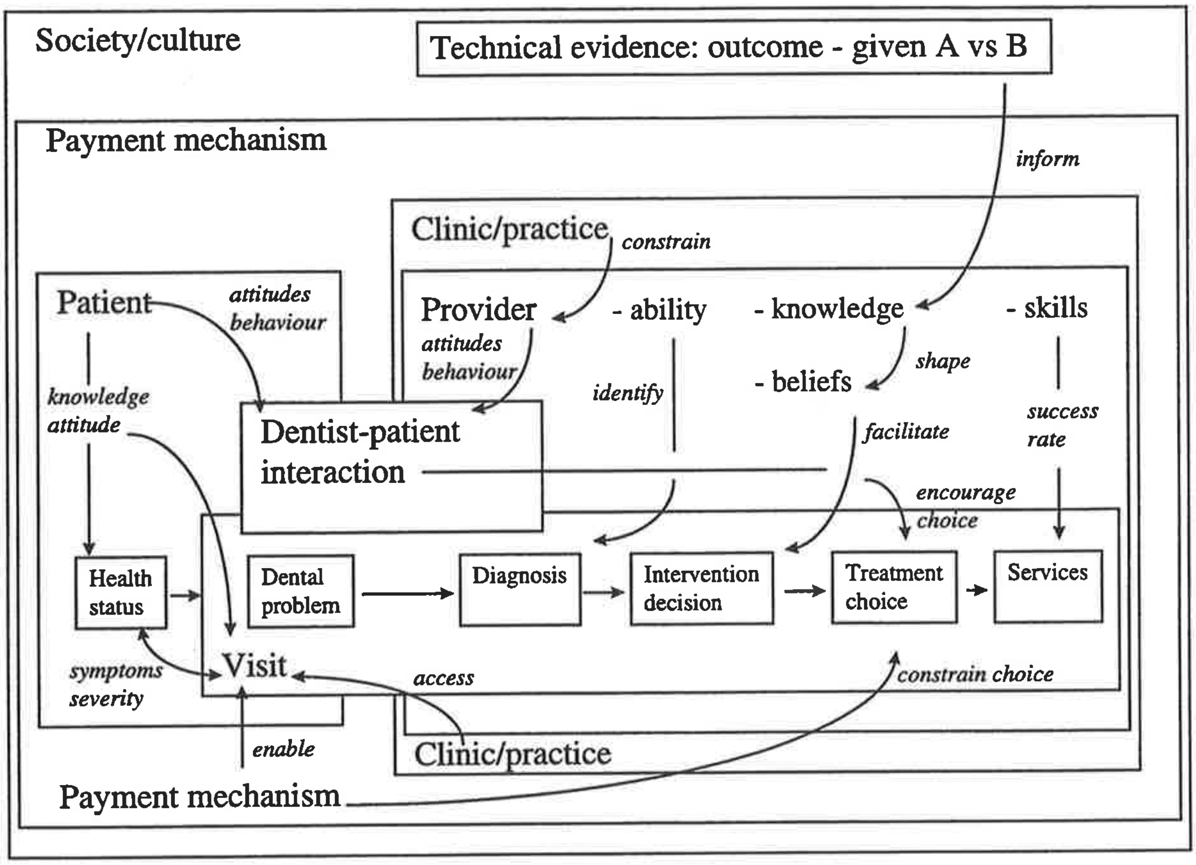


Fig. 5.1: Sources of influence on service provision and their interrelationships

This overview of the service provision process schematically models some of the main sources of influence on variation in treatment provided and their likely effects and interactions drawing on findings from this thesis and the literature. The literature in general has shown that variation is widespread and may occur at any of the various points or phases in the service provision process. The findings of this thesis have shown that after controlling for oral health status, a range of dentist, practice and patient level factors persist as significant sources of variation in service patterns. This variation points to problems in relation to appropriateness of care. While the existence of variation is not definitive proof of inappropriate care, the implications are that further research is needed to document the discrepancy between need and treatment and to provide data on outcomes which can build the knowledge base upon which the service provision process rests. This knowledge should form the foundation of practice parameters and guidelines.

5.3.2 Parameters and guidelines

Guidelines are systematically developed statements designed to assist practitioners and patients in making decisions about appropriate health care for specific clinical circumstances, while practice parameters is a term used to refer to descriptive rather than prescriptive recommendations (Shugars and Bader, 1995). Guidelines should reflect what is known about a clinical condition in terms of risk factors, course of disease, diagnosis, relative effectiveness of treatment alternatives and their outcomes (Shugars and Bader, 1995). In other words they should be decision aids based on scientific evidence of outcomes, designed for use prospectively.

In recognising a gap between best practice and current practice, the pursuit of best practice does not necessarily mean a state of perfection (Leeder, 1998). Instead best practice is what the pooled evidence suggests would usually confer the most benefit, with the practitioner and consumer having scope to negotiate an approach which weighs the facts about treatment outcomes along with others relating to patient, community and setting.

Guidelines in dentistry generally are lacking in terms of detailed analysis of the literature, failure to include patient preferences, and a reliance on expert opinion rather than scientific data from outcomes studies (Shugars and Bader, 1995). The paucity of clinical guidelines in dentistry has been linked to the lack of outcomes information. The paucity of outcomes information and related guidelines has meant that until recently the bulk of activities performed by general practice dentists has remained unaddressed by any guideline development activity (Bader and Shugars, 1995b). With outcomes data and guidelines being generally lacking in dentistry, the extent to which they can alter practitioner behaviour and the effect this has on patient well-being remains poorly understood (Shugars and Bader, 1995).

While guidelines build upon previous efforts in the area of quality assurance they differ in their focus on long-term outcomes rather than immediate and intermediate technical measures primarily of structural and procedural aspects of care (Shugars and Bader, 1995). While guideline development may not be a panacea which can guarantee appropriate care is provided it represents an approach which recognises that appropriateness of care is an issue and which encourages investigation of outcomes and an evidence-based focus on treatment selection. Further research is needed on developing risk assessments for different age groups, determining present caries activity and monitoring of lesions over time, and implementing improved diagnostic tools into clinical and research practice (Pitts, 1997), along with ongoing research into determining how market forces influence practice patterns as guidelines are developed and adopted (Grembowski, 1997).

6. Summary and conclusions

This section summarises the associations of patient, dentist, practice, and oral health factors with services provided, and assesses the importance of these sets of variables as explanatory factors in multivariate models of service provision. The influence of these factors on variation in service provision is discussed in relation to the issue of appropriateness of care, and the implications for policy development.

6.1 Summary: patient characteristics

Patient characteristics were included in both patient-level analyses and dentist-level analyses of service provision. At the patient level, demographics had few associations, none with sex of patient, but some with age of patient (i.e., middle-aged patients had more prosthodontic and crown and bridge, but less restorative services). Visit characteristics had more associations for variables such as insurance status and new patient status, but particularly for visit type with emergency visits having strong negative associations with preventive and crown and bridge services, and positive associations with extraction, endodontic and general/miscellaneous services. Higher patient finance ratings were positively associated with crown and bridge services, while area-based SES had a negative association with extractions.

In the dentist-level models, patient demographics had few significant associations, with patient age having a weak negative association with endodontic services and a positive association with extractions. Visit factors had widespread associations with service provision. Emergency visits had a weak positive association with extractions and negative association with preventive services, new patient status was weakly positively associated with extraction and endodontic services but negatively associated with preventive services, while insurance was weakly positively associated with endodontic and preventive services, had a moderate positive association with prosthodontic services and negative association with extraction. Area-based SES had widespread associations with services, including a weak positive association with endodontic services and negative association with preventive and general services, a moderate positive association with extraction, and a strong negative association with periodontic services.

6.2 Summary: dentist characteristics

There were few differences in services by sex of dentist, but there were more extensive associations of services with age of dentist, which could indicate developmental or practice experience factors or the operation of period or cohort effects among practitioners. Other dentist characteristics such as practice beliefs, preferences for patients, and treatment choice factors showed associations with a range of services. Involvement of patients and consideration of cost factors by dentists had polar effects on prosthodontic rates, with an orientation to patient influence practice beliefs and preferences for patient personality associated with higher prosthodontic rates and also extraction and endodontic services, while an orientation toward information giving practice beliefs, patient preferences in treatment choice and preferences relating to the financial status of patients associated with lower prosthodontic rates and higher restorative and crown and bridge rates. Professional autonomy practice beliefs were also associated with higher rates of prosthodontic services, as well as restorative and crown and bridge services, while an orientation toward the preference for patients with positive dental behaviour was associated with routine scheduled care in the form of higher diagnostic and preventive rates. While these effects were generally small to moderate in size, their presence indicates that the practitioner exerts an influence on the patterns of services provided.

6.3 Summary: practice factors

Practice factors were associated with all service areas except for endodontic, restorative and crown and bridge. Geographic location, while showing significant associations with only a few service areas was important in that it was consistently associated with disparities in preventive and prosthodontic care, pointing to geographic barriers to care. Other practice factors such as practice type while exhibiting a wide range of associations showed few consistent trends with service provision. Lower annual patient volume was positively associated with diagnostic rates, less busy practices had higher prosthodontic rates, while smaller practices had lower diagnostic and extraction rates and higher preventive rates.

6.4 Summary: oral health status

Oral health status variables were included in both the patient-level and dentist-level models of service provision. At the patient-level, there were a wide range of associations between services and oral health status. Denture status showed a strong positive association with prosthodontic rates, but also negative associations with diagnostic, endodontic and restorative services. Decayed teeth showed strong positive associations with restorative services and moderate negative associations with preventive and prosthodontic services, as well as weak negative associations with diagnostic and crown and bridge rates and a positive association with endodontic rates. Fewer numbers of teeth were strongly positively associated with prosthodontic care, and had a moderate positive association with extraction rates.

At the dentist-level, oral health was also associated with a wide range of services. Denture wearing had a weak positive association with extractions and a negative association with preventive services, and a strong positive association with prosthodontic care. Decayed teeth had a weak negative association with prosthodontic, preventive and crown and bridge rates, and weak positive associations with extraction and restorative rates. Overall, while an important explanatory variable, oral health status did not fully explain the pattern of service provision, as evidenced by the range of patient, dentist and practice factors which were also significantly associated with variation in provision of services.

6.5 Synthesis: factors influencing service provision

In general, patient, dentist and practice factors were significant explanatory variables in models of service provision which included oral health status factors. This indicates that service provision is not a simple deterministic pathway involving technical considerations of oral health status which are converted into a treatment plan and provision of services. Patient, dentist and practice factors play an important mediating role in determining the patterns of services provided. Among the set of explanatory variables there was no single dominant variable or subset of variables which could be ranked as most important. Overall, service provision was influenced by a large number of small effects from a wide range of factors spanning dentist, practice, patient and oral health status.

6.6 Conclusions: factors influencing service provision

While oral health status has an influence on the provision of services it is not the sole determinant. A range of patient, dentist, and practice factors also influence the service provision process. The findings of this study indicated dentist characteristics such as practice beliefs and preferences for patients had an influence on service patterns. Such findings indicate that further understanding of the dentist-patient relationship, the development of practice beliefs, and the dynamics of treatment planning and decision-making could be beneficial to improving service outcomes. However, other factors such as insurance status and visit type were also associated with service patterns and have the potential to be manipulated to achieve better service outcomes. The persistence of some geographic and area-based gradients in services indicates the operation of socio-economic and geographic barriers on service patterns. While socio-economic and geographic barriers may require broad policy innovations to address their effects on service provision, there is scope for research into clinical outcomes in general practice to improve the knowledge base upon which treatment decisions are made, and such information could provide the basis for the development of practice parameters and guidelines for care to address potential problems with appropriateness of care which stem from the observed variation in service provision.

7. Appendices

7.1 Appendix A: cover letters mailed to dentists

Primary approach letter

AIHW DENTAL STATISTICS AND RESEARCH UNIT
at The University of Adelaide

THE UNIVERSITY OF ADELAIDE

AIHW
AUSTRALIAN INSTITUTE OF HEALTH & WELFARE

22 September 1997

«Title» «FirstName» «LastName»
«Address1»
«Address2»
«State» «PostalCode»

Dear «Title» «LastName»

A study of dentists; dental practice; and dental services in the 1990's
Conducted for the Australian Institute of Health & Welfare's Dental Statistics & Research Unit
by Mr D.S. Brennan and Prof A.J. Spencer

Within the next few days you will receive a request in the mail to complete a brief questionnaire. We are mailing it to you in order to gain knowledge of the opinions and information of dentists in Australia in relation to dental practice and delivery of services.

This survey is being conducted to gain an accurate and up-to-date picture of dental practice, especially the services being delivered, which may be of benefit to a range of groups including professional organisations such as the Australian Dental Association, as well as key groups which would benefit from an improved knowledge of dental practice such as government departments.

We would greatly appreciate your taking the time necessary to complete and return the questionnaire when it arrives.

Thank you in advance for your help.

Yours sincerely

David Brennan
NHMRC Research Scholar

Correspondence
AIHW Dental Statistics and Research Unit
Dental School
The University of Adelaide
South Australia 5005

Website: http://www.adelaide.edu.au/socprev-dent/dsru

General enquiries
Telephone + 61 8/(08) 8303 5438
+ 61 8/(08) 8303 4051
Facsimile + 61 8/(08) 8303 4858
E-mail: aihw.dsru@dentistry.adelaide.edu.au

Letter of support from ADA president

AUSTRALIAN DENTAL ASSOCIATION INC.

75 Lithgow Street, St. Leonards, NSW 2065.
Postal Address:
P.O. Box 520, St. Leonards, NSW 2065.
Telephone: (02) 9906 4412
Facsimile: Administration (02) 9906 4676
Publications (02) 9906 4917
E-mail:adainc@ozemail.com.au

Our Reference

4 August 1997

Dear Colleague

I am writing to urge your active co-operation with the comprehensive Study of Dental Services in Australia now being undertaken by the Australian Institute of Health and Welfare's Dental Statistics and Research Unit under the direction of Professor John Spencer.

The study complements previous work in this field which has produced valuable information for the planning of the dental labour force throughout Australia. The data gathering is now under way and will take a year to complete.

The Australian Dental Association has had an ongoing involvement in previous related studies and supports the present study being undertaken by the AIHW Dental Statistics and Research Unit.

Individual confidentially has been assured. Your name is not required. The study has clearance from the Ethics Committee of the Australian Institute of Health and Welfare. The basic data will be used only to calculate statistical averages and group profiles and will not be available to any individuals or agencies other than Professor John Spencer and his research unit.

Thank you for your co-operation

Yours sincerely

Dr Herb Hammer
Federal President

Initial mailing of questionnaire

THE UNIVERSITY OF ADELAIDE

AIHW DENTAL STATISTICS AND RESEARCH UNIT
at The University of Adelaide

AIHW
AUSTRALIAN INSTITUTE OF HEALTH & WELFARE

29 September 1997

«Title» «FirstName» «LastName»
«Address1»
«Address2»
«State» «PostalCode»

Dear «Title» «LastName»

A study of dentists; dental practice; and dental services in the 1990's
Conducted for the Australian Institute of Health & Welfare's Dental Statistics & Research Unit
by Mr D.S. Brennan and Prof. A.J. Spencer

While oral health in Australia has generally improved in recent times, both the pool of teeth at risk of disease and the use of services has increased. Yet little is known of the factors which influence the provision of dental services. The importance of understanding dental service provision needs to be considered in the context that Australians spend some $1.8 billion per annum on dental services (5.4% of recurrent health expenditure in 1993-94), and while dental diseases are not usually life-threatening, the importance of delivering services needs to be viewed from the perspective that the repetitive and widespread nature of dental problems results in a large burden. Hence the need to know more about the delivery of dental services.

You are one of a small number of dentists who are being asked to give their views and information relating to dental services and dental practice. Dentists have been selected as part of a random sample of all Australian States and Territories. Participation involves the completion of the attached questionnaire. In order to gain a representative view it is important that each questionnaire is completed and returned.

Individual confidentiality has been assured. The information will be used to calculate statistical averages and group profiles, which will be reported in aggregate form such that no individual can be identified. Please assist this research effort by completing the questionnaire as soon as possible and returning it in the prepaid envelope enclosed.

The results of this research will be disseminated widely through a range of reports and publications. These will be available to interested groups including professional groups such as the Australian Dental Association and other organisations with an interest in dental practice and service delivery.

If you have any queries on this study, please don't hesitate to contact the research team. You can contact us by letter, fax, email, or call either Mr David Brennan on (08) 8303 4046 or Professor John Spencer on (08) 8303 5438.

Thank you for your cooperation.

Yours sincerely

David Brennan
NHMRC Research Scholar

Correspondence
AIHW Dental Statistics and Research Unit
Dental School
The University of Adelaide
South Australia 5005

Website: http://www.adelaide.edu.au/socprev-dent/dsru

General enquiries
Telephone + 61 8/(08) 8303 5438
+ 61 8/(08) 8303 4051
Facsimile + 61 8/(08) 8303 4858
E-mail: aihw.dsru@dentistry.adelaide.edu.au

Reminder card

Recently a questionnaire, **"A study of dentists; dental practice; and dental services in the 1990's"**, seeking your views and information relating to dental practice and dental services in Australia was mailed to you. Your name was drawn in a random sample of dentists in Australia.

If you have already completed and returned it to us please accept our sincere thanks. If not, please do so today. Because it has been sent to a small, but representative sample of dentists it is extremely important that your response also be included in the study if the results are to accurately represent the opinions and practice of all Australian dentists.

If you are unable to participate in the study for one of the following reasons please tick the appropriate box and return this card to us in the reply-paid envelope previously supplied with the questionnaire.

☐ I am retired / not currently in practice
☐ I am in specialist / restricted practice
☐ I am not in private general practice (e.g., in administrative, or public practice)

If by some chance you did not receive the questionnaire, or it got misplaced, please call me now (08-8303-4046) and I will get another one to you today.

Yours sincerely

David Brennan. NHMRC Research Scholar. (Project coordinator)

Follow-up mailing 1

AIHW DENTAL STATISTICS AND RESEARCH UNIT
at The University of Adelaide

THE UNIVERSITY OF ADELAIDE

AIHW
AUSTRALIAN INSTITUTE OF HEALTH & WELFARE

27 October 1997

«Title» «FirstName» «LastName»
«Address1»
«Address2»
«State» «PostalCode»

Dear «Title» «LastName»

A study of dentists; dental practice; and dental services in the 1990's
Conducted for the Australian Institute of Health & Welfare's Dental Statistics & Research Unit
by Mr D.S. Brennan and Prof. A.J. Spencer

I recently wrote to you seeking your views and information on a range of issues related to the topics of dental practice and dental services in Australia as part of a research project to obtain a picture of what dental services are currently being provided and what factors are influencing dental practice. As of today we have not yet received your completed questionnaire. We realise that you may not have had time to complete it. However, we would genuinely appreciate hearing from you.

The Australian Institute of Health and Welfare's Dental Statistics and Research Unit has undertaken this study because of the need to obtain an accurate and up to date view of dental service delivery which incorporates a range of measures from practising dentists in Australia which can be used to assess the current scene and plan for the future.

I am writing to you again because of the significance each questionnaire has to the usefulness of this study. Your name was drawn through a scientific sampling process in which each registered dentist in Australia had an equal chance of being selected. This means that about 13 dentists in every 100 are being asked to give their views and information relating to dental services and dental practice. In order for the results to give a truly representative view of dental practice it is important that each dentist in the sample return their questionnaire.

The study is mainly directed at dentists in private general practice, however if you are retired or not currently treating patients, or in specialist or restricted practice then please indicate this on the questionnaire and return it to us.

In the event that your questionnaire has been misplaced, a replacement is enclosed.

Your cooperation is greatly appreciated.

Yours sincerely

David Brennan
NHMRC Research Scholar

Correspondence
AIHW Dental Statistics and Research Unit
Dental School
The University of Adelaide
South Australia 5005

Website: http://www.adelaide.edu.au/socprev-dent/dsru

General enquiries
Telephone + 61 8/(08) 8303 5438
+ 61 8/(08) 8303 4051
Facsimile + 61 8/(08) 8303 4858
E-mail: aihw.dsru@dentistry.adelaide.edu.au

Follow-up mailing 2

THE UNIVERSITY OF ADELAIDE

AIHW DENTAL STATISTICS AND RESEARCH UNIT
at The University of Adelaide

AIHW
AUSTRALIAN INSTITUTE OF HEALTH & WELFARE

24 November 1997

«Title» «FirstName» «LastName»
«Address1»
«Address2»
«State» «PostalCode»

Dear «Title» «LastName»

A study of dentists; dental practice; and dental services in the 1990's
Conducted for the Australian Institute of Health & Welfare's Dental Statistics & Research Unit
by Mr D.S. Brennan and Prof. A.J. Spencer

I am writing to you about our study of dental practice and dental services in Australia. We have not yet received your completed questionnaire. We understand that you may not have had time to complete it. However, it is not too late to participate in the study and we would genuinely appreciate hearing from you.

The large number of questionnaires returned is very encouraging. But, whether we will be able to describe accurately the current state of dental service delivery depends upon you and the other dentists who have not yet responded. This is because our past experiences have suggested that those of you who have not yet sent in your questionnaire may have different views and practice experience than those who have. For example, you may be from busier practices where it is difficult to find time to complete questionnaires, but because of this it is important that we receive your view of dental practice.

This is a nation-wide study of dental services, seeking information on dentists and dental practice. The results are of importance to the profession. The usefulness of our results depend on how accurately we are able to describe what actual services dentists are currently providing, and what other factors are influencing dental practice.

In the event that our previous correspondence did not reach you, or the questionnaire was misplaced, a replacement is enclosed. May I urge you to complete and return it as soon as possible.

Why is this study worth doing? Some members of the study sample have asked why they should give up some of their valuable time to complete this survey. The study provides an opportunity for the profession to present a scientifically credible account of factors influencing service provision, as a response to some of the widely publicised media reports of recent times which have propagated a distorted and sensationalist view of dentistry through some popular magazine and television programs. We are conducting this study in order to provide a balanced and factual picture of dental practice and service provision.

Your contribution to the success of this study will be appreciated greatly.

Yours sincerely

David Brennan
NHMRC Research Scholar

Correspondence
AIHW Dental Statistics and Research Unit
Dental School
The University of Adelaide
South Australia 5005

Website: http://www.adelaide.edu.au/socprev-dent/dsru

General enquiries
Telephone + 61 8/(08) 8303 5438
+ 61 8/(08) 8303 4051
Facsimile + 61 8/(08) 8303 4858
E-mail: aihw.dsru@dentistry.adelaide.edu.au

Follow-up mailing 3

AIHW DENTAL STATISTICS AND RESEARCH UNIT
at The University of Adelaide

THE UNIVERSITY OF ADELAIDE

AIHW
AUSTRALIAN INSTITUTE OF HEALTH & WELFARE

19 January 1998

«Title» «FirstName» «LastName»
«Address1»
«Address2»
«State» «PostalCode»

Dear «Title» «LastName»

A study of dentists; dental practice; and dental services in the 1990's
Conducted for the Australian Institute of Health & Welfare's Dental Statistics & Research Unit
by Mr D.S. Brennan and Prof. A.J. Spencer

Why am I writing to you? I am writing to you about our study of dental practice and dental services as we have not yet received a reply. We understand that you may not have had time to complete your questionnaire. However, it is not too late to participate in the study and we would genuinely appreciate hearing from you.

Why is this study worth doing? Some members of the study sample have wanted to know why they should give up some of their valuable time to complete this survey. The study provides an opportunity for the profession to present a scientifically credible account of factors influencing service provision, as a response to some of the widely publicised media reports of recent times which have propagated a distorted and sensationalist view of dentistry through some popular magazine and television programs. We are conducting this study in order to provide a balanced and factual picture of dental practice and service provision.

Why do we need your response? The large number of questionnaires returned is very encouraging. But, to be able to describe accurately the current state of dental service delivery depends upon you and the other dentists in the sample who have not yet responded. This is because our past experiences have suggested that those of you who have not yet sent in your questionnaire may have different views and practice experience than those who have. For example, you may be from busier practices where it is difficult to find time to complete questionnaires, but because of this it is important that we receive your view of dental practice.

Why are we sending you this questionnaire? As we believe this study is important to the profession for the reasons outlined above, and in the event that our previous correspondence did not reach you, or the questionnaire was misplaced, a replacement is enclosed. May I urge you to complete and return it as soon as possible.

Comments? If you have any further comments about matters covered in the questionnaire we invite you to write them on the back page of the questionnaire.

Your contribution to the success of this study will be appreciated greatly.

Yours sincerely

David Brennan
NHMRC Research Scholar

Correspondence
AIHW Dental Statistics and Research Unit
Dental School
The University of Adelaide
South Australia 5005

Website: http://www.adelaide.edu.au/socprev-dent/dsru

General enquiries
Telephone + 61 8/(08) 8303 5438
+ 61 8/(08) 8303 4051
Facsimile + 61 8/(08) 8303 4858
E-mail: aihw.dsru@dentistry.adelaide.edu.au

Explanatory notes included with follow-up mailing 3

Study of Dental Services in Australia

Conducted for the Australian Institute of Health & Welfare's Dental Statistics & Research Unit

by Mr D.S. Brennan and Prof. A.J. Spencer

Explanatory notes: comments and queries about this study

A number of dentists who have responded to this survey have made comments and queries. Some of the main comments and commonly asked questions are outlined below as explanatory notes to make the questionnaire easier to understand.

This study is mainly aimed at dentists who are currently treating patients in private general practice. If you are not in this situation it would still be valuable to the study to receive a reply from you.

If retired or not currently treating patients: Please indicate that you are not treating patients on page 2 and return it to us along with any comments you wish to make on the back page of the form.

If in specialist or restricted practice: Please indicate this on page 2 and return it to us along with any comments you wish to make on the back page of the form.

If treating patients in the public sector only: Please fill out page 2 of the form only and return it to us along with any comments you wish to make on the back page of the form.

Practice beliefs: Question 1 assesses practice beliefs of practitioners. This set of questions is derived from studies of service provision conducted in the USA (Grembowski et al., Dental decision-making and variation in dentist service rates. *Soc Sci Med* 1991;32:287-94). While some of these questions may be difficult to answer in the Australian context they will provide valuable comparative data, and enable the assessment of their usefulness in the Australian situation.

Factors influencing choice of treatment: Question 13 attempts to gauge which factors are important in selecting among alternative treatment choices. This has been modified from previous studies of dental services (Grembowski et al., Factors influencing dental decision making. *J Public Health Dent* 1988;48:159-67).

Some respondents have commented that for some of these pairs of alternative treatments they would always do one over the other, while others have commented that they would do neither of the listed alternative treatments but instead do a treatment not listed in the pair. These are valid responses which may also apply to you for some of these treatment pair choices. In this question we are interested in your opinion, based on your clinical experience and judgement.

Some responding dentists have cautioned that it is difficult to capture the full detail of treatment decisions through the hypothetical selection among pairs which is attempted in this exercise. We appreciate this comment and it will be considered when interpreting these results.

General evaluation of dental patients: Question 14 assesses the preferences that you as a practitioner may have for dental patients. This has been used in previous studies which have been aimed at understanding the dentist-patient relationship, in this case from the perspective of the dentist (Rouse & Hamilton, Dentists evaluate their patients: an empirical investigation of preferences. *J Behav Med* 1991;14:637-48.).

Some study members have pointed out that although they may prefer patients to possess certain characteristics that this does not affect the way they treat patients (i.e., all patients are given the best possible care).

Day log of one typical clinical working day: Question 15 collects information on services provided to patients during a typical clinical working day. While this part of the questionnaire is time consuming the information from one day when collected across a wide range of dentists provides a detailed picture of dental practice.

By collecting information on both the characteristics of patients and also their presenting oral health status it is possible to control for these factors when trying to understand patterns of services provided. While this adds to the complexity of the information collected it is important as previous studies have tended to control for only some of these factors.

Evaluation of patients treated during the typical working day: Question 16 looks specifically at the patients you treated during the log of one typical working day. These items were derived from previous investigations of dentists' perceptions of patients (Weinstein et al., Patient dental values and their relationship to oral health status, dentist perceptions and quality of care. *Community Dent Oral Epidemiol* 1979;7:121-7.)

While these are worded as questions we ask you to treat them as statements and indicate your level of agreement with them. Some responding dentists have pointed out that these judgements are hard to make for some patients, particularly for new patients. In such cases marking the mid-point (3) can indicate that you neither strongly agree nor strongly disagree.

Comments: The final page of the questionnaire provides space for you to make comments. Your views can provide valuable input into interpreting the quantitative information collected. These comments can guide the analysis and help us to improve our methods.

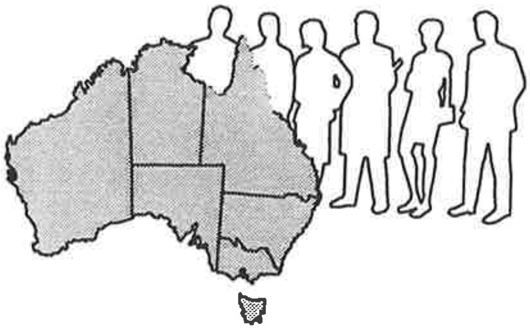
7.2 Appendix B: survey instrument

AUSTRALIAN INSTITUTE OF HEALTH & WELFARE

THE UNIVERSITY OF ADELAIDE

Study of Dental Services in Australia

A study of: dentists; dental practice; and dental services in the 1990's



Conducted by: Australian Institute of Health & Welfare's Dental Statistics and Research Unit
Department of Dentistry, University of Adelaide
South Australia 5005

Study of Dental Services in Australia

CONFIDENTIALITY
This study is being conducted by the Australian Institute of Health and Welfare's Dental Statistics and Research Unit. Responses are STRICTLY CONFIDENTIAL and will be reported in statistical form only such that individual identity is not revealed. The serial number allows your response to be recorded against our mailing list.

HOW TO ANSWER QUESTIONS
- Answer in terms of your CURRENT, ACTUAL situation (e.g., if your professional activities have recently changed).
- Good estimates are acceptable if exact answers cannot be given.
- Each dentist receiving a questionnaire in a group practice or partnership should complete a separate questionnaire.

1. **PRACTICE BELIEFS:** Please read each of the following statements then circle one of the numbers from: **1 - strong agreement** to **5 - strong disagreement** which best indicates your agreement with that statement.

	Strongly agree				Strongly disagree
Plaque control programs are a prerequisite for dental treatment	1	2	3	4	5
The primary focus of dentistry should be directed at controlling active disease rather than developing better preventive advice	1	2	3	4	5
If a patient disagrees with the dentist's recommended treatment, the dentist should try to convince the patient to accept it	1	2	3	4	5
Dentists should usually inform patients about the cost of their dental treatment before the treatment begins	1	2	3	4	5
With the dentist's advice the patient should choose the service	1	2	3	4	5
If a patient does not accept the dentist's recommended treatment, the patient is dismissed from the practice	1	2	3	4	5
Dentists should present all treatment options to patients	1	2	3	4	5
Excluding diagnostic and preventive services, all patients should usually know how much their dental treatment will cost them, out-of-pocket, before treatment begins	1	2	3	4	5

2. **YEAR OF BDS / BDSc GRADUATION:**____________________

3. **SEX:** ☐ Male ☐ Female

4. **MONTH AND YEAR OF BIRTH:**____________________

5. **(a). DO YOU DO ANY WORK IN GENERAL PRACTICE** (tick either Yes or No)
☐ Yes: (General Practice) ⇒ (Please go to Question 5(b) below)
☐ No: (Not in General Practice) ⇒ (Please go to Question 6)

(b). PRIVATE PRACTICE: Are you in Private Practice?
☐ No ⇒ (Please go to Question 6)
☐ Yes: (full-time) ⇒ (Please go to Question 5(c) below)
☐ Yes: (part-time) ⇒ (Please go to Question 5(c) below)

(c). IF YES, ARE YOU CURRENTLY TREATING PATIENTS IN PRIVATE GENERAL PRACTICE?
☐ Yes ⇒ (Please go to Question 7)
☐ No ⇒ (Please go to Question 6)

6. The focus of the remainder of this study is on private general practice, hence **if you are not working in private general practice then we do not need your answers to the remainder of the questions.** However, we would appreciate any comments you might like to make on dental practice and service delivery (see back page). Above all, please return the questionnaire to us so we know that you are not working as a private general practitioner.

---

7. **(a) MAIN TYPE OF PRIVATE PRACTICE** (tick one category which best describes your main practice situation)
   - ☐ Solo practitioner with no sharing of costs (includes a practitioner who employs an assistant or locum)
   - ☐ A partner in a complete partnership
   - ☐ Without partners, but with sharing of costs and/or employees (i.e., associateship)
   - ☐ Employed as an assistant
   - ☐ Other (please specify):______________________________

   (b) With how many other dentists **IN THIS PRACTICE?** (exclude yourself): _________ dentists
   (c) What percentage of your dental work time is **IN THIS PRACTICE?** _________ percent
   (d) What percentage of your dental work time is in **ANOTHER PRIVATE PRACTICE(S)?** _______ percent

---

8. **DO YOU ALSO TREAT ANY PATIENTS WHILE IN A PUBLIC OR NON-PRIVATE SALARIED POSITION?**
   - ☐ No ⇒ (Please go to Question 9)
   - ☐ Yes ⇒What percentage of your dental **WORK TIME?**__________ percent

---

9. **POSTCODE(S) OF PLACE(S) OF WORK:** (if unknown, fill in name of city or town)
   Main place in private practice: ______________
   Other private practice place(s): ______________
   Public sector place(s), if applicable: ______________

---

10. **CURRENT PRACTICE EXPERIENCE (IN YOUR MAIN PRIVATE GENERAL PRACTICE)** (Answer in terms of your practice experience using a typical or average day or week as indicated. Use decimals or fractions as needed)

(a) How many **PATIENTS PER DAY**, on average, do you treat? ___________ patients per day
(do not include patients whose treatment you supervised, but who are treated by other staff)

(b) What is the average **TOTAL NUMBER OF HOURS PER DAY** worked by you? ___________ hours per day
(exclude free time, but include administration, lab. work, etc.)

(c) How many **HOURS PER DAY** do you spend **CHAIRSIDE** with patients? __________ hours per day

(d) How many **DAYS PER WEEK** do you practise? ________ days per week

(e) How many **WEEKS** did you work in the last 12 months? ________ weeks per year

---

11. **APPOINTMENT TIME (IN YOUR MAIN PRIVATE GENERAL PRACTICE):** Approximately how long does a regular patient have to wait between the date of making an appointment and the actual appointment date? (exclude patients with emergencies and those scheduled for a series of treatments)

Please specify: _______ (days); or _______ (weeks); or _______ (months)

---

12. **AUXILIARIES WORKING WITH YOU (IN YOUR MAIN PRIVATE GENERAL PRACTICE).** Please state the number of auxiliaries and the hours per week they work with you in your main private practice location.

NUMBER	TYPE OF AUXILIARY	HOURS PER WEEK (working with you)
______	Chairside Dental Assistant(s)	_____ hours per week
______	Dental Hygienist(s)	_____ hours per week
______	Practice manager(s)	_____ hours per week
______	Secretary/Receptionist(s)	_____ hours per week
______	Other (please specify: __________________)	_____ hours per week

---

13. **FACTORS INFLUENCING CHOICE OF TREATMENT**: For each of the six pairs of alternative treatments listed below please select, in order, up to five factors important in choosing the first treatment over the second alternative for each pair by writing each factor in the boxes underneath each treatment pair. An example is given below, however these examples are not necessarily a complete list. Please provide your own responses based on your clinical experience and judgement. If necessary repeat the same factors for different pairs of treatment, or leave blank when you feel less than five factors are needed.

Example:

	Alternative treatment pairs					
	Visual exam only *vs* **X-rays as a diagnostic aid for a posterior tooth**	**Preventive intervention** *vs* **Restoration for an initial carious lesion in an occlusal surface of a posterior tooth**	**Crown** *vs* **Amalgam or composite build-up on a posterior tooth**	**Root canal therapy** *vs* **Extraction of a posterior tooth**	**Fixed bridge** *vs* **Removable partial denture for a missing anterior tooth**	**Prophylaxis (mechanical cleaning)** *vs* **Subgingival curettage or periodontal scaling**
Most important factor:	Caries rate	Age of patient	Extent of tooth damage	Caries rate	Periodontal status	Gingival status
2nd most important factor:	Medical history	Pain control	Future plans for tooth	Ability of dentist	Abutment strength	Extent of calculus
3rd most important factor:	Convenience to patient	Number of missing teeth	Preparation for other procedures	Number of appointments	Length of edentulous span	Oral hygiene status
4th most important factor:	Root caries	Cost to Patient	Alignment / tooth anatomy	Pulp status / sensitivity	Existing partial denture	Duration of infection
5th most important factor:	—	Patient preference	Cost to Patient	Difficulty of canals	Abutment contours/tipping	Tooth mobility

	Alternative treatment pairs					
	Visual exam only *vs* **X-rays as a diagnostic aid for a posterior tooth**	**Preventive intervention** *vs* **Restoration for an initial carious lesion in an occlusal surface of a posterior tooth**	**Crown** *vs* **Amalgam or composite build-up on a posterior tooth**	**Root canal therapy** *vs* **Extraction of a posterior tooth**	**Fixed bridge** *vs* **Removable partial denture for a missing anterior tooth**	**Prophylaxis (mechanical cleaning)** *vs* **Subgingival curettage or periodontal scaling**
Most important factor:						
2nd most important factor:						
3rd most important factor:						
4th most important factor:						
5th most important factor:						

14. **GENERAL EVALUATION OF DENTAL PATIENTS**: Read each of the following statements then circle one of the numbers from: **1 - strong agreement** to **5 - strong disagreement** which best indicates your agreement with the statement.

	Strongly agree				Strongly disagree
I prefer patients who come in at recall	1	2	3	4	5
I prefer patients who are emotionally secure	1	2	3	4	5
I prefer patients who co-operate with me	1	2	3	4	5
I prefer patients who are content with the service provided	1	2	3	4	5
I prefer patients who are patient	1	2	3	4	5
I prefer patients who are polite	1	2	3	4	5
I prefer patients who are on time for appointments	1	2	3	4	5
I prefer patients who are warm	1	2	3	4	5
I prefer patients who respect my opinion	1	2	3	4	5
I prefer patients who are sociable	1	2	3	4	5
I prefer patients who maintain their oral health	1	2	3	4	5
I prefer patients who are charming	1	2	3	4	5
I prefer patients who accept my treatment plans	1	2	3	4	5
I prefer patients to be late for appointments	1	2	3	4	5
I prefer patients who are thankful for care provided	1	2	3	4	5
I prefer patients who trust me	1	2	3	4	5
I prefer patients to not respect my opinion	1	2	3	4	5
I prefer patients who are attractive	1	2	3	4	5
I prefer patients to be manageable in the dental surgery	1	2	3	4	5
I prefer patients to be cheerful	1	2	3	4	5
I prefer patients who have negative attitudes about oral health	1	2	3	4	5
I prefer patients who are kind	1	2	3	4	5
I prefer patients who give 24-hour notice when cancelling an appointment	1	2	3	4	5
I prefer patients who are self-confident	1	2	3	4	5
I prefer patients who are fun to work with	1	2	3	4	5
I prefer patients not to come in at recall	1	2	3	4	5
I prefer patients who are interpersonally responsive	1	2	3	4	5
I prefer patients who are able to afford optimal treatment	1	2	3	4	5
I prefer patients who have private insurance	1	2	3	4	5
I prefer patients who have a good dental knowledge	1	2	3	4	5
I prefer patients who follow instructions (e.g., for home care, other procedures)	1	2	3	4	5
I prefer patients who are willing to pay for recommended optimal care	1	2	3	4	5
I prefer patients who present significant problems to providing good dental care	1	2	3	4	5
I prefer patients who value good dental care	1	2	3	4	5
I prefer patients who are anxious	1	2	3	4	5
I prefer patients who appreciate the need for preventive care	1	2	3	4	5
I prefer patients who are relaxed	1	2	3	4	5

15. Day Log: Typical clinical working day - Private General Practice Date:____ / ____ / ____

See "*Coding guide & examples*" on the separate inserted sheet

Service information			Patient & Visit information						Oral health at start of visit today:			
Patient number	Item Code (ADA)	Dentist Time (mins)	Sex of patient (M/F)	Age of patient (Years)	Insured status (Y/N)	Reason for course of care (Ex,Rop Oth)	Post-code of patient	Last visit -New or approx. mm/yy	Number of Natural teeth (0 - 32)	Number of Decayed teeth: -may be filled	Number of Filled teeth: - not decayed	Denture wearing as upp./low (N,P,F)

16. EVALUATION OF DENTAL PATIENTS: This section invites you to evaluate the patients you treated in your log of one typical day of clinical practice. Up to 18 patients are listed below, if you saw more than 18 patients please fill out the evaluation for the first 18 you saw, or up to the maximum number you saw if less than 18 patients were treated.

Please read each of the following statements then circle one number (1 - 5) which best indicates your agreement with that statement [the numbers range from 1 - **strong agreement** to 5 **strong disagreement** with a statement] for each patient (up to a maximum of 18 patients).

Patient number from your typical day log

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Does this patient have a good dental knowledge?		*Please circle one number (1-5) for each patient*																	
Strongly agree	1:	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	2:	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	3:	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	4:	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Strongly disagree	5:	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Does this patient follow your instructions? (e.g., concerning home care or other recommended procedures)		*Please circle one number (1-5) for each patient*																	
Strongly agree	1:	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	2:	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	3:	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	4:	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Strongly disagree	5:	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Does this patient present any significant problems that create obstacles to providing good dental care?		*Please circle one number (1-5) for each patient*																	
Strongly agree	1:	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	2:	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	3:	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	4:	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Strongly disagree	5:	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Is this patient willing to pay for recommended optimal care?		*Please circle one number (1-5) for each patient*																	
Strongly agree	1:	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	2:	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	3:	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	4:	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Strongly disagree	5:	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Is this patient financially able to pay for recommended optimal care?		*Please circle one number (1-5) for each patient*																	
Strongly agree	1:	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	2:	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	3:	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	4:	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Strongly disagree	5:	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5

Thank you for your co-operation and time in answering this questionnaire.

Please return the completed questionnaire as soon as possible in the reply-paid envelope provided.
If you have any queries please don't hesitate to contact the research team.

Comments (Your comments are invited - is there anything else you would like to tell us about dental practice and services?)

Patient preferences (is there anything else you would like to tell us about patients?)

Factors influencing choice of treatment (is there anything else you would like to tell us about treatment decisions?)

Trends in service delivery (is there anything else you would like to tell us about service patterns?)

Other issues (are there any other issues you would like to tell us about?)

CONFIDENTIALITY
This study is being conducted by the Australian Institute of Health and Welfare's Dental Statistics and Research Unit. Responses are STRICTLY CONFIDENTIAL and will be reported in statistical form only such that individual identity is not revealed.

Coding instructions included with questionnaire

CODING GUIDE & EXAMPLES:
15. LOG OF SERVICES PERFORMED ON A TYPICAL DAY - PRIVATE GENERAL PRACTICE

Please provide on page 6 information on the services YOU performed on a typical day, by completing the day log over one typical clinical day in your MAIN private general practice location.

The log provides space to record the following (See example below):

Record patient number, item code and dentist time on each line of the service log.

Column A **Patient Number**: Write in "01" for the first patient seen during the day, "02" for the second, etc.

Column B **Item Code**: Record the dental service code, ONE PER LINE, for each item of service, until all of the items performed on that one day for any one patient have been listed. It does not matter if particular items are not completed. Multiple services of the same type (e.g., two 1-surface amalgams) should be recorded as two separate items. Please use a copy of the A.D.A. Inc. *Schedule of Services* for the item codes.
Note: Please include all items, even if the patient was not charged for the procedure.

Column C **Dentist Time**: Estimate the time (in minutes) spent by YOU for each procedure performed for the patient.

Record sex, age, insurance status, reason for care, postcode, last visit date and oral health on the first line of each patient.

Column D **Sex of patient**: (M or F)

Column E **Age of patient**: (Years). Estimate if not known.

Column F **Insurance status**: Indicate whether the patient has DENTAL insurance. (Y for Yes or N for No).

Column G **Reason for course of care**: Indicate the INITIAL reason for the course of care by one of the following codes.
Ex - Exam (check-up)
Rop - Relief of pain (emergency)
Oth - Other dental problem (e.g., a dental problem not involving relief of pain)

Column H **Residential postcode of patient**: Indicate 4-digit postcode for the residential address of each patient.

Column I **Last visit (date)**: 'New' or approximate date (month/year) of last visit to this practice.

Column J **Number of natural teeth**: Number of natural permanent teeth at the beginning of the current visit (0 - 32).

Column K **Number of decayed teeth**: Number of decayed teeth (may also be filled) at the beginning of the current visit. Decayed teeth includes recurrent decay (i.e., may be decayed and filled).

Column L **Number of filled teeth**: Number of filled teeth (but not decayed) at the beginning of the current visit. These should be filled satisfactory, (i.e., if also decayed then should only be counted as decayed).

Column M **Denture wearing**: Indicate none (N), Partial denture or fixed bridge (P), or Full denture (F) as upper / lower. (E.g., F/F for full upper & lower denture, N/N for none, F/N for full upper, P/N for partial upper)

Example: Log of services
The example shows a sample entry for the first two patients seen during the typical day. The entry for the first patient (a 20 year old female) shows the following work performed: a pair of bitewing radiographs and two two-surface amalgam fillings. The patient does not have insurance, the reason for the course of care was an emergency/relief of pain, the residential post-code was 5067, she is a new patient, she had 28 natural teeth in total, with 2 decayed, 2 filled, and she had no dentures.
The entry for the second patient (a 73 year old male) shows the following work being performed: an initial examination and removal of plaque and calculus. The patient has dental insurance, the reason for the course of care was a check-up/exam, the residential post-code was 5012, his last visit was in August 1992, and he had 20 natural teeth in total, with 0 decayed, 8 filled, and he had a partial upper denture.

Column: A	B	C	D	E	F	G	H	I	J	K	L	M
Patient number	Item Code (ADA)	Dentist Time (mins)	Sex of patient (M/F)	Age of patient (Years)	Insured status (Y/N)	Reason for course of care (Ex,Rop Oth)	Post-code of patient	Last visit -New or approx. mm/yy	Number of Natural teeth (0 - 32)	Number of Decayed teeth: -may be filled	Number of Filled teeth: - not decayed	Denture wearing as upp./low (N,P,F)
01	023	06	F	20	N	Rop	5067	New	28	2	2	N / N
01	512	18										
01	512	18										
02	011	12	M	73	Y	Ex	5012	08 / 92	20	0	8	P / N
02	112	20										

7.3 Appendix C: Responses to choice of treatment pairs

Table C1: Original ordering of responses to choice of alternative treatment pairs

01. Age of patient	26. Patient previous experience with similar procedures	51. Rest of dentition/ proximal teeth	76. Need for specialist
02. Caries rate/ risk	27. Convenience to patient	52.Which tooth/ tooth position	77. Whether abutment for partial denture
03. Medical history/ general health	28. Number of appointments	53. Tooth prognosis/ serviceability in the long term	78. Practice profit/ time-money ratio/ convenience to dentist
04. Number of missing teeth	29. Cost to patient/ affordability	54. Interproximal caries, restorations	79. Gagging
05. Alignment/tooth anatomy	30. Pain control/ comfort	55. Recurrent caries	80. Root sensitivity
06. Extent of tooth damage	31. Patients ability to tolerate prosthesis/ type of partial	56. Longevity of restoration	81. No need for panoramic of other teeth
07. Future plans for tooth/ treatment plan	32. Need for anaesthesia	57. Future plans (partial or bridge)	82. Access to equipment (e.g., micro-abrasive)
08. Ability of dentist/ philosophy of dentist	33. Dental fear/ anxiety	58. Duration of root canal	83. Too heavy for temporary bridge
09. Root caries/ condition	34. Aesthetics	59. Probability of root canal success	84. Arrested caries
10. Pulp status/sensitivity	35. My records/ availability of x-ray/ legal record	60. Symptoms/ pain	85. Need for strength
11. Anatomy/ difficulty of canals	36. Toothache	61. Dental treatment history	86. Fluoride history
12. Duration/ type of infection	37. Time since last x-ray/ check-up/ visit	62. Time since last perio treatment/ exam	87. Access/ ease of treatment
13. Existing partial denture	38. Pregnancy	63. Diet/ lifestyle	88. Occupation/ sport
14. Abutment contours/ tipping	39. Colour change/ staining	64. Root filled/ treated	89. Radiation to dentist
15. Length of edentulous span	40. X-ray evidence	65. Patient motivation/ dental IQ/ recall compliance	90. None/ always do the latter alternative
16. Abutment strength/ condition	41. Probe/ penetration/ sticking	66. Time/ urgency	91. Family history
17. Soft tissue contours/ damage	42. Previous endo treatment	67. Number of proximal contacts	92. None/ always do first alternative
18. Extent of calculus	43. Heavy bite	68. Longer lasting	93. Do neither alternative/ both
19. Periodontal status/ pocket depth	44. Suitability for restoration/ pre-existing filling/ fracture	69. Fluoride applications	94. Salivary flow
20. Tooth mobility	45. Role in occlusion/ function/ avoiding dentures	70. Density of enamel/ presence of fillings	95. Vitality test
21. Gingival status/ bleeding	46. Bite/ occlusal force/ abrasion problems/ retained food particles	71. Potential problems/ difficulty with alternatives	96. Fissure seals present
22. Preparation for other procedures/ need for other treatment	47. Abutment length	72. Nerve prognosis	97. Public or private patient
23. Patient preference/ approval/ acceptance of potential difficulties	48. Number of fillings, crowns, implants/ age of fillings	73. Ability to view/ accuracy of diagnosis	
24. Oral hygiene status	49. Visible caries/ clinical appearance	74. Overall status of mouth/ extent of other treatment needed	
25. Patients ability to tolerate procedure/ co-operate	50. Size of lesion/ amount of healthy tooth/ vitality	75. Future/ past need for root canal treatment	

7.4 Appendix D: Design effects

The sampling of services by the use of service logs can be considered as a two-stage (cluster) sampling approach where dentists are the primary sampling units and patients the secondary sampling units. Cluster sampling has advantages such as reduced costs but has higher sampling error than simple random sampling with the same sample size. Cluster sampling is less efficient than a simple random sample of the same size, and this difference in efficiency can be measured as the design effect. It is considered desirable to estimate and adjust for design effects due to clustering as inaccurate estimates will be obtained if statistics appropriate to simple random samples are applied without adjustment to more complex samples such as two-stage (cluster) designs (Rosier, 1998).

The design effect compares variance errors of sampling for a complex sample and a simple random sample of the same size. Calculation of the design effect requires knowledge of the extent to which clusters are likely to display homogeneity with respect to the variables studies. This is measured using the intraclass correlation and mean cluster size. The intraclass correlation is estimated by analysis of variance of the dependent variable using the cluster variable as the independent variable (Rosier, 1998). The standard error of sampling for a given cluster sample can then be estimated by calculating the size of the simple equivalent sample. The size of the simple equivalent sample is the size of a simple random sample that has the same standard error as the complex sample, and is calculated by dividing the size of the complex sample by the design effect. Calculations of standard errors can then be based on the size of the simple equivalent sample.

In general, the higher sampling error of cluster samples is due to members within a cluster tending to be similar while differences between clusters can be large (Australian Bureau of Statistics, 1993b). The extent of the increased sampling error depends on how representative the clustered sample members are of the target population. For the same overall total sample size, a survey in which a larger number of clusters is selected gives more precise results than a survey of a smaller number of clusters (Bennett et al., 1991). Increasing the number of clusters sampled decreases the design effect of clustering for a given level of intraclass correlation.

Table D1 presents the intraclass correlations and design effects for each main area of service using the patient as the unit of analysis. Intraclass correlations were calculated from analysis of variance using the dentist as the independent variable. This provides a measure of homogeneity within clusters of patients treated by the same dentist. The design effect was calculated based on the intraclass correlation and mean cluster size. Higher intraclass correlations indicate greater within-cluster association and higher design effects. The highest intraclass correlations occurred for orthodontic and total services, indicating that these services tend to be associated within clusters (i.e., dentists have characteristic patterns for these services across their patients). A design effect of 1.0 is equivalent to a simple random sample, design effects greater than 1.0 indicate that clustering has an influence, while design effects less than 1.0 indicate that the design is better than a simple random sample. Design effects ranged from a high of 2.57 for orthodontic services to a low of 1.28 for prosthodontic services. Relative standard errors provide a measure of precision for each estimate, and tend to be higher (i.e., less precise) for low rate areas such as periodontic and orthodontic services, and lower (i.e., more precise) for high rate areas such as restorative, diagnostic, preventive and total services per visit.

For each service area the size of a simple equivalent sample was calculated by dividing the unadjusted sample size by the design effect. This results in reduced sample size equivalents for each area. The size of the simple equivalent sample was used to adjust the standard error and relative standard error. In general, the adjusted standard errors are larger than the unadjusted, as they are based on smaller equivalent sample sizes. This also results in larger relative standard errors. However, even the largest are below 20%, with the majority being below 10%, indicating that adequate levels of precision were present after adjusting for the design effect of clustering.

Table D1: Main areas of service: - intraclass correlations and design effects (n=4074)

				unadjusted			adjusted	
Area	ICC	Deff	Mean	SE	%RSE	n_{ses}	SE	%RSE
Restorative	0.040	1.41	0.566	0.016	2.83	2,889	0.018	3.18
Diagnostic	0.083	1.86	0.650	0.012	1.85	2,190	0.017	2.62
Preventive	0.084	1.87	0.379	0.011	2.90	2,179	0.015	3.96
Endodontic	0.037	1.39	0.112	0.007	6.25	2,931	0.008	7.14
Prosthodontic	0.027	1.28	0.098	0.008	8.16	3,183	0.009	9.18
Extraction	0.033	1.34	0.086	0.006	6.98	3,040	0.007	8.14
Crown/bridge	0.036	1.37	0.077	0.006	7.79	2,974	0.007	9.09
General/misc.	0.045	1.47	0.042	0.003	7.14	2,771	0.004	9.52
Periodontic	0.072	1.75	0.019	0.002	10.53	2,328	0.003	15.79
Orthodontic	0.151	2.57	0.021	0.002	9.52	1,585	0.004	19.05
Total per visit	0.143	2.49	2.051	0.020	0.98	1,636	0.031	1.51

ICC = intraclass correlation (rho)
Deff = design effect
SE = standard error
%RSE = relative standard error
n_{ses} = size of simple equivalent sample

Table D2 presents sample size estimates for main areas of service based on the 1993-94 wave of the Longitudinal Study of Dentists' Practice Activity. These consist of two-group comparisons for a range of hypothetical rate ratios with alpha = 0.05 and power = 0.80. These are compared to the obtained sample size, and the sample adjusted to the simple equivalent sample size. Obtained and adjusted numbers are presented divided by two, so these can be compared directly to the required number. They should be equal to or greater than the required number to be able to detect a difference of a given magnitude. In general, high rate areas have smaller required numbers than low rate areas for any given rate ratio, and for any given service area the required numbers decrease as the rate ratio or size of difference detected increases. Adjusting for clustering reduces the equivalent sample size with some loss of statistical power. However, the adjusted sample size shows that rate ratios of 2.0 can be detected in 9 out of 10 areas of service, rate ratios of 1.75 in 8 out of 10 areas, rate ratios of 1.50 in 7 out of 10 areas, and rate ratios of 1.25 in 3 out of 10 areas. Overall, the sample size after adjustment for clustering is capable of detecting weak to moderate effects in the majority of service areas.

Table D2: Sample sizes by main areas of service: required cell sizes for two-group comparisons for hypothetical rate ratios (based on 1993-94 LS of DPA) compared to obtained and adjusted simple equivalent sample size.

	Required n (2-group comparisons)				Obtained n		Adjusted n	
	Hypothetical rate ratios							
	1.25	1.50	1.75	2.0	n	n/2	n [illegible]	n [illegible]/2
Restorative	149	33	<14	<14	4,074	2,037	2,889	1,445
Diagnostic	173	40	15	<15	4,074	2,037	2,190	1,095
Preventive	561	150	70	41	4,074	2,037	2,179	1,090
Endodontic	2,322	650	319	195	4,074	2,037	2,931	1,466
Prosthodontic	2,586	725	356	219	4,074	2,037	3,183	1,592
Extraction	2,909	817	401	247	4,074	2,037	3,040	1,520
Crown/bridge	3,831	1,078	532	328	4,074	2,037	2,974	1,487
General/misc.	6,943	1,962	971	601	4,074	2,037	2,771	1,386
Periodontic	14,356	4,023	1,996	1,239	4,074	2,037	2,328	1,164
Orthodontic	14,356	4,023	1,996	1,239	4,074	2,037	1,585	793

7.5 Appendix E: (Logistic regression models: patient-level)

This section presents details of the logistic regression models of receipt of services by the set of independent variables. The dependent variables were main areas of service, coded as 1 if one or more services were received or 0 if no services were received in that service area. Independent variables were all coded as indicator variables using 1 to identify the variable and 0 to identify the reference category. The coding of the independent variables consists of: AGE1 (18-24 years), AGE2 (25-44 years), AGE3 (45-64 years), reference (65+ years); MALEPAT (sex of patient coded as male, reference is female); INS (insurance status coded as insured, reference uninsured); ROP (visit type coded as emergency, reference non-emergency); NEWPAT (patient status coded as new, reference previous); CAPBIN (location coded as capital city, reference non-capital); AADENTS (denture status coded as present, reference absent); DTBIN (decayed teeth coded as no decay, reference 1+ decay); KNOWBIN (Knowledge sub-scale coded as less than or equal to the median, indicating a higher knowledge rating, reference lower knowledge rating); PAYBIN (Payment sub-scale coded as less than or equal to the median, indicating a higher rating of willing and able to pay, reference lower payment rating); NT20BIN (number of teeth coded as 1 - 20 teeth, reference 21 - 32 teeth); and IRSDMED (SEIFA index coded as less than or equal to the median, indicating more disadvantaged postcode areas, reference less disadvantaged postcode areas). The output of the models using SAS Proc LOGISTIC is presented in the remainder of this section (SAS, 1990).

Model (1) Diagnostic services

The LOGISTIC Procedure

Data Set: WORK.SLOG
Response Variable: DIAGBIN
Response Levels: 2
Number of Observations: 2620
Weight Variable: DIAGWT
Sum of Weights: 1408.6021505
Link Function: Logit

Response Profile

Ordered Value	DIAGBIN	Count	Total Weight
1	1	1311	704.83871
2	0	1309	703.76344

WARNING: 569 observation(s) were deleted due to missing values for the response or explanatory variables.

Model Fitting Information and Testing Global Null Hypothesis BETA=0

Criterion	Intercept Only	Intercept and Covariates	Chi-Square for Covariates
AIC	1954.736	1903.605	.
SC	1960.607	1991.669	.
-2 LOG L	1952.736	1873.605	79.132 with 14 DF (p=0.0001)
Score	.	.	76.749 with 14 DF (p=0.0001)

The LOGISTIC Procedure

Analysis of Maximum Likelihood Estimates

Variable	DF	Parameter Estimate	Standard Error	Wald Chi-Square	Pr > Chi-Square	Standardized Estimate	Odds Ratio
INTERCPT	1	0.1962	0.2586	0.5757	0.4480	.	.
AGE1	1	0.4638	0.2603	3.1763	0.0747	0.054404	1.590
AGE2	1	-0.00507	0.1968	0.0007	0.9795	-0.001007	0.995
AGE3	1	-0.0130	0.1850	0.0049	0.9440	-0.002532	0.987
MALEPAT	1	0.0327	0.1117	0.0855	0.7699	0.006553	1.033
INS	1	0.1605	0.1140	1.9818	0.1592	0.032448	1.174
ROP	1	-0.0873	0.1315	0.4407	0.5068	-0.015180	0.916
NEWPAT	1	0.9377	0.1776	27.8790	0.0001	0.126767	2.554
CAPBIN	1	0.0820	0.1362	0.3619	0.5474	0.014770	1.085
AADENTS	1	-0.4153	0.1749	5.6350	0.0176	-0.069141	0.660
DTBIN	1	-0.5488	0.1145	22.9611	0.0001	-0.110909	0.578
KNOWBIN	1	-0.0504	0.1211	0.1730	0.6775	-0.010157	0.951
PAYBIN	1	-0.0358	0.1227	0.0852	0.7704	-0.007039	0.965
NT20BIN	1	-0.2205	0.1923	1.3158	0.2513	-0.034270	0.802
IRSDMED	1	-0.0503	0.1224	0.1688	0.6812	-0.010168	0.951

Model (2) Preventive services

The LOGISTIC Procedure

Data Set: WORK.SLOG
Response Variable: PREVBIN
Response Levels: 2
Number of Observations: 2620
Weight Variable: PREVWT
Sum of Weights: 1401.0695187
Link Function: Logit

Response Profile

Ordered Value	PREVBIN	Count	Total Weight
1	1	734	392.5134
2	0	1886	1008.5561

WARNING: 569 observation(s) were deleted due to missing values for the response or explanatory variables.

Model Fitting Information and Testing Global Null Hypothesis BETA=0

Criterion	Intercept Only	Intercept and Covariates	Chi-Square for Covariates
AIC	1663.942	1487.764	.
SC	1669.812	1575.828	.
-2 LOG L	1661.942	1457.764	204.177 with 14 DF (p=0.0001)
Score	.	.	175.783 with 14 DF (p=0.0001)

The LOGISTIC Procedure

Analysis of Maximum Likelihood Estimates

Variable	DF	Parameter Estimate	Standard Error	Wald Chi-Square	Pr > Chi-Square	Standardized Estimate	Odds Ratio
INTERCPT	1	-0.5526	0.3015	3.3583	0.0669	.	.
AGE1	1	0.0937	0.2897	0.1045	0.7465	0.010955	1.098
AGE2	1	-0.00699	0.2290	0.0009	0.9757	-0.001385	0.993
AGE3	1	-0.2147	0.2182	0.9689	0.3249	-0.041733	0.807
MALEPAT	1	0.0749	0.1303	0.3298	0.5658	0.014980	1.078
INS	1	0.2055	0.1328	2.3917	0.1220	0.041412	1.228
ROP	1	-1.7921	0.2220	65.1560	0.0001	-0.310821	0.167
NEWPAT	1	0.1601	0.2094	0.5848	0.4444	0.021592	1.174
CAPBIN	1	0.3189	0.1648	3.7419	0.0531	0.057303	1.376
AADENTS	1	-0.4630	0.2177	4.5216	0.0335	-0.076877	0.629
DTBIN	1	-0.8596	0.1335	41.4417	0.0001	-0.173245	0.423
KNOWBIN	1	0.00421	0.1396	0.0009	0.9760	0.000846	1.004
PAYBIN	1	0.2975	0.1465	4.1260	0.0422	0.058325	1.346
NT20BIN	1	-0.3567	0.2444	2.1294	0.1445	-0.055273	0.700
IRSDMED	1	-0.1696	0.1418	1.4318	0.2315	-0.034201	0.844

Model (3) Periodontic services

The LOGISTIC Procedure

Data Set: WORK.SLOG
Response Variable: PERIBIN
Response Levels: 2
Number of Observations: 2620
Weight Variable: PERIWT
Sum of Weights: 1497.1428571
Link Function: Logit

Response Profile

Ordered Value	PERIBIN	Count	Total Weight
1	1	57	32.5714
2	0	2563	1464.5714

WARNING: 569 observation(s) were deleted due to missing values for the response or explanatory variables.

Model Fitting Information and Testing Global Null Hypothesis BETA=0

Criterion	Intercept Only	Intercept and Covariates	Chi-Square for Covariates
AIC	315.788	328.523	.
SC	321.659	416.587	.
-2 LOG L	313.788	298.523	15.265 with 14 DF (p=0.3603)
Score	.	.	14.513 with 14 DF (p=0.4122)

The LOGISTIC Procedure

Analysis of Maximum Likelihood Estimates

Variable	DF	Parameter Estimate	Standard Error	Wald Chi-Square	Pr > Chi-Square	Standardized Estimate	Odds Ratio
INTERCPT	1	-4.9100	0.9888	24.6566	0.0001	.	.
AGE1	1	-0.7382	1.1492	0.4126	0.5207	-0.089257	0.478
AGE2	1	0.0243	0.7214	0.0011	0.9731	0.004988	1.025
AGE3	1	0.5684	0.6681	0.7238	0.3949	0.114186	1.765
MALEPAT	1	0.0481	0.3625	0.0176	0.8944	0.009951	1.049
INS	1	0.3658	0.3851	0.9024	0.3422	0.076216	1.442
ROP	1	0.4246	0.3996	1.1291	0.2880	0.076135	1.529
NEWPAT	1	-0.4508	0.7109	0.4021	0.5260	-0.062825	0.637
CAPBIN	1	0.7824	0.5755	1.8480	0.1740	0.145338	2.187
AADENTS	1	-0.4736	0.6033	0.6162	0.4324	-0.081300	0.623
DTBIN	1	-0.2468	0.3709	0.4427	0.5058	-0.051415	0.781
KNOWBIN	1	-0.0506	0.3859	0.0172	0.8956	-0.010529	0.951
PAYBIN	1	0.4331	0.4302	1.0136	0.3140	0.087774	1.542
NT20BIN	1	-0.0393	0.6438	0.0037	0.9513	-0.006301	0.961
IRSDMED	1	-0.2589	0.4033	0.4122	0.5209	-0.053969	0.772

Model (4) Extraction services

The LOGISTIC Procedure

Data Set: WORK.SLOG
Response Variable: ORALBIN
Response Levels: 2
Number of Observations: 2620
Weight Variable: ORALWT
Sum of Weights: 1955.2238806
Link Function: Logit

Response Profile

Ordered Value	ORALBIN	Count	Total Weight
1	1	177	132.0896
2	0	2443	1823.1343

WARNING: 569 observation(s) were deleted due to missing values for the response or explanatory variables.

Model Fitting Information and Testing Global Null Hypothesis BETA=0

Criterion	Intercept Only	Intercept and Covariates	Chi-Square for Covariates
AIC	968.952	767.644	.
SC	974.823	855.708	.
-2 LOG L	966.952	737.644	229.308 with 14 DF (p=0.0001)
Score	.	.	263.082 with 14 DF (p=0.0001)

The LOGISTIC Procedure

Analysis of Maximum Likelihood Estimates

Variable	DF	Parameter Estimate	Standard Error	Wald Chi-Square	Pr > Chi-Square	Standardized Estimate	Odds Ratio
INTERCPT	1	-3.8408	0.4937	60.5294	0.0001	.	.
AGE1	1	-0.1114	0.4935	0.0510	0.8214	-0.015395	0.895
AGE2	1	0.2711	0.3721	0.5308	0.4663	0.063479	1.311
AGE3	1	-0.0532	0.3551	0.0224	0.8810	-0.012206	0.948
MALEPAT	1	0.1634	0.1995	0.6708	0.4128	0.038632	1.178
INS	1	-0.7601	0.2183	12.1197	0.0005	-0.180985	0.468
ROP	1	2.4056	0.2238	115.5502	0.0001	0.492883	11.085
NEWPAT	1	0.4678	0.2344	3.9826	0.0460	0.074510	1.596
CAPBIN	1	-0.0479	0.2285	0.0440	0.8339	-0.010176	0.953
AADENTS	1	-0.00127	0.3111	0.0000	0.9967	-0.000250	0.999
DTBIN	1	-0.00597	0.2160	0.0008	0.9779	-0.001422	0.994
KNOWBIN	1	-0.4117	0.2359	3.0452	0.0810	-0.097844	0.663
PAYBIN	1	-0.2387	0.2111	1.2786	0.2582	-0.055284	0.788
NT20BIN	1	0.5018	0.3193	2.4697	0.1161	0.091858	1.652
IRSDMED	1	0.5178	0.2256	5.2697	0.0217	0.123339	1.678

Model (5) Endodontic services

The LOGISTIC Procedure

Data Set: WORK.SLOG
Response Variable: ENDOBIN
Response Levels: 2
Number of Observations: 2620
Weight Variable: ENDOWT
Sum of Weights: 1884.8920863
Link Function: Logit

Response Profile

Ordered Value	ENDOBIN	Count	Total Weight
1	1	220	158.2734
2	0	2400	1726.6187

WARNING: 569 observation(s) were deleted due to missing values for the response or explanatory variables.

Model Fitting Information and Testing Global Null Hypothesis BETA=0

Criterion	Intercept Only	Intercept and Covariates	Chi-Square for Covariates
AIC	1089.050	1058.034	.
SC	1094.921	1146.098	.
-2 LOG L	1087.050	1028.034	59.016 with 14 DF (p=0.0001)
Score	.	.	64.195 with 14 DF (p=0.0001)

The LOGISTIC Procedure

Analysis of Maximum Likelihood Estimates

Variable	DF	Parameter Estimate	Standard Error	Wald Chi-Square	Pr > Chi-Square	Standardized Estimate	Odds Ratio
INTERCPT	1	-3.4589	0.4371	62.6156	0.0001	.	.
AGE1	1	0.4818	0.4130	1.3610	0.2434	0.065368	1.619
AGE2	1	0.3643	0.3304	1.2160	0.2701	0.083763	1.440
AGE3	1	0.1922	0.3162	0.3694	0.5433	0.043317	1.212
MALEPAT	1	0.2154	0.1711	1.5860	0.2079	0.050003	1.240
INS	1	0.1997	0.1770	1.2733	0.2591	0.046691	1.221
ROP	1	1.1596	0.1761	43.3629	0.0001	0.233282	3.189
NEWPAT	1	-0.6788	0.2921	5.4009	0.0201	-0.106149	0.507
CAPBIN	1	0.0395	0.2119	0.0347	0.8523	0.008223	1.040
AADENTS	1	-0.2002	0.2788	0.5154	0.4728	-0.038551	0.819
DTBIN	1	0.4112	0.1807	5.1802	0.0228	0.096117	1.509
KNOWBIN	1	0.1499	0.1877	0.6375	0.4246	0.034977	1.162
PAYBIN	1	-0.0312	0.1881	0.0275	0.8684	-0.007087	0.969
NT20BIN	1	0.2521	0.2947	0.7322	0.3922	0.045322	1.287
IRSDMED	1	-0.0804	0.1891	0.1808	0.6707	-0.018804	0.923

Model (6) Restorative services

The LOGISTIC Procedure

Data Set: WORK.SLOG
Response Variable: RESTBIN
Response Levels: 2
Number of Observations: 2620
Weight Variable: RESTWT
Sum of Weights: 1858.1560284
Link Function: Logit

Response Profile

Ordered Value	RESTBIN	Count	Total Weight
1	1	990	702.1277
2	0	1630	1156.0284

WARNING: 569 observation(s) were deleted due to missing values for the response or explanatory variables.

Model Fitting Information and Testing Global Null Hypothesis BETA=0

Criterion	Intercept Only	Intercept and Covariates	Chi-Square for Covariates
AIC	2465.945	2188.750	.
SC	2471.816	2276.814	.
-2 LOG L	2463.945	2158.750	305.194 with 14 DF (p=0.0001)
Score	.	.	289.782 with 14 DF (p=0.0001)

The LOGISTIC Procedure

Analysis of Maximum Likelihood Estimates

Variable	DF	Parameter Estimate	Standard Error	Wald Chi-Square	Pr > Chi-Square	Standardized Estimate	Odds Ratio
INTERCPT	1	-0.6307	0.2462	6.5658	0.0104	.	.
AGE1	1	-0.9582	0.2522	14.4344	0.0001	-0.129081	0.384
AGE2	1	-0.4714	0.1874	6.3282	0.0119	-0.107606	0.624
AGE3	1	-0.2691	0.1767	2.3189	0.1278	-0.060227	0.764
MALEPAT	1	0.1336	0.1059	1.5927	0.2069	0.030790	1.143
INS	1	0.0629	0.1087	0.3345	0.5630	0.014591	1.065
ROP	1	-0.2262	0.1241	3.3239	0.0683	-0.045182	0.798
NEWPAT	1	-0.6256	0.1631	14.7076	0.0001	-0.097144	0.535
CAPBIN	1	-0.2586	0.1287	4.0347	0.0446	-0.053509	0.772
AADENTS	1	-0.1997	0.1665	1.4394	0.2302	-0.038193	0.819
DTBIN	1	1.7141	0.1127	231.3158	0.0001	0.397836	5.552
KNOWBIN	1	0.0191	0.1156	0.0274	0.8686	0.004430	1.019
PAYBIN	1	-0.0707	0.1163	0.3702	0.5429	-0.015971	0.932
NT20BIN	1	-0.4848	0.1842	6.9240	0.0085	-0.086521	0.616
IRSDMED	1	-0.1424	0.1165	1.4924	0.2219	-0.033058	0.867

Model (7) Crown and bridge services

The LOGISTIC Procedure

Data Set: WORK.SLOG
Response Variable: CRBRBIN
Response Levels: 2
Number of Observations: 2620
Weight Variable: CRBRWT
Sum of Weights: 1912.4087591
Link Function: Logit

Response Profile

Ordered Value	CRBRBIN	Count	Total Weight
1	1	166	121.1679
2	0	2454	1791.2409

WARNING: 569 observation(s) were deleted due to missing values for the response or explanatory variables.

Model Fitting Information and Testing Global Null Hypothesis BETA=0

Criterion	Intercept Only	Intercept and Covariates	Chi-Square for Covariates
AIC	905.082	818.905	.
SC	910.952	906.969	.
-2 LOG L	903.082	788.905	114.177 with 14 DF (p=0.0001)
Score	.	.	95.255 with 14 DF (p=0.0001)

The LOGISTIC Procedure

Analysis of Maximum Likelihood Estimates

Variable	DF	Parameter Estimate	Standard Error	Wald Chi-Square	Pr > Chi-Square	Standardized Estimate	Odds Ratio
INTERCPT	1	-3.6276	0.5314	46.6061	0.0001	.	.
AGE1	1	-2.0533	1.2340	2.7689	0.0961	-0.280616	0.128
AGE2	1	0.4913	0.4126	1.4178	0.2338	0.113778	1.634
AGE3	1	1.2212	0.3801	10.3209	0.0013	0.277270	3.391
MALEPAT	1	-0.1784	0.2014	0.7845	0.3758	-0.041713	0.837
INS	1	0.3423	0.2113	2.6240	0.1053	0.080603	1.408
ROP	1	-1.3210	0.3607	13.4112	0.0003	-0.267682	0.267
NEWPAT	1	-1.2563	0.6064	4.2923	0.0383	-0.197900	0.285
CAPBIN	1	0.1591	0.2606	0.3726	0.5416	0.033399	1.172
AADENTS	1	0.3226	0.2838	1.2922	0.2556	0.062589	1.381
DTBIN	1	-0.5307	0.2066	6.5958	0.0102	-0.124951	0.588
KNOWBIN	1	0.1196	0.2123	0.3173	0.5732	0.028110	1.127
PAYBIN	1	0.6896	0.2512	7.5359	0.0060	0.157947	1.993
NT20BIN	1	-0.5007	0.3435	2.1245	0.1450	-0.090662	0.606
IRSDMED	1	-0.1688	0.2180	0.5995	0.4388	-0.039759	0.845

Model (8) Prosthodontic services

The LOGISTIC Procedure

Data Set: WORK.SLOG
Response Variable: PROSBIN
Response Levels: 2
Number of Observations: 2620
Weight Variable: PROSWT
Sum of Weights: 2046.875
Link Function: Logit

Response Profile

Ordered Value	PROSBIN	Count	Total Weight
1	1	160	125.0000
2	0	2460	1921.8750

WARNING: 569 observation(s) were deleted due to missing values for the response or explanatory variables.

Model Fitting Information and Testing Global Null Hypothesis BETA=0

Criterion	Intercept Only	Intercept and Covariates	Chi-Square for Covariates
AIC	943.145	597.980	.
SC	949.016	686.044	.
-2 LOG L	941.145	567.980	373.165 with 14 DF (p=0.0001)
Score	.	.	459.866 with 14 DF (p=0.0001)

The LOGISTIC Procedure

Analysis of Maximum Likelihood Estimates

Variable	DF	Parameter Estimate	Standard Error	Wald Chi-Square	Pr > Chi-Square	Standardized Estimate	Odds Ratio
INTERCPT	1	-4.2241	0.5297	63.5933	0.0001	.	.
AGE1	1	0.0729	0.7701	0.0090	0.9246	0.010307	1.076
AGE2	1	0.1428	0.3710	0.1482	0.7002	0.034220	1.154
AGE3	1	0.1077	0.2522	0.1823	0.6694	0.025293	1.114
MALEPAT	1	0.0774	0.2232	0.1203	0.7287	0.018723	1.080
INS	1	-0.5278	0.2277	5.3732	0.0204	-0.128599	0.590
ROP	1	-0.4941	0.2905	2.8925	0.0890	-0.103585	0.610
NEWPAT	1	0.2461	0.3790	0.4216	0.5161	0.040104	1.279
CAPBIN	1	-0.3215	0.2649	1.4723	0.2250	-0.069827	0.725
AADENTS	1	3.2503	0.3800	73.1574	0.0001	0.652380	25.799
DTBIN	1	-1.3065	0.2436	28.7689	0.0001	-0.318266	0.271
KNOWBIN	1	-0.1226	0.2432	0.2541	0.6142	-0.029808	0.885
PAYBIN	1	0.00603	0.2422	0.0006	0.9801	0.001429	1.006
NT20BIN	1	1.1931	0.2807	18.0628	0.0001	0.223478	3.297
IRSDMED	1	0.1304	0.2559	0.2598	0.6103	0.031787	1.139

Model (9) General/miscellaneous services

The LOGISTIC Procedure

Data Set: WORK.SLOG
Response Variable: GENMBIN
Response Levels: 2
Number of Observations: 2620
Weight Variable: GENMWT
Sum of Weights: 1782.3129252
Link Function: Logit

Response Profile

Ordered Value	GENMBIN	Count	Total Weight
1	1	118	80.2721
2	0	2502	1702.0408

WARNING: 569 observation(s) were deleted due to missing values for the response or explanatory variables.

Model Fitting Information and Testing Global Null Hypothesis BETA=0

Criterion	Intercept Only	Intercept and Covariates	Chi-Square for Covariates
AIC	656.600	640.452	.
SC	662.471	728.516	.
-2 LOG L	654.600	610.452	44.148 with 14 DF (p=0.0001)
Score	.	.	48.821 with 14 DF (p=0.0001)

The LOGISTIC Procedure

Analysis of Maximum Likelihood Estimates

Variable	DF	Parameter Estimate	Standard Error	Wald Chi-Square	Pr > Chi-Square	Standardized Estimate	Odds Ratio
INTERCPT	1	-2.4451	0.5416	20.3834	0.0001	.	.
AGE1	1	-0.5020	0.5461	0.8449	0.3580	-0.066227	0.605
AGE2	1	-0.3300	0.4053	0.6630	0.4155	-0.073784	0.719
AGE3	1	-0.4060	0.3936	1.0636	0.3024	-0.088984	0.666
MALEPAT	1	-0.4350	0.2461	3.1244	0.0771	-0.098192	0.647
INS	1	-0.2352	0.2417	0.9472	0.3304	-0.053475	0.790
ROP	1	1.4248	0.2410	34.9612	0.0001	0.278723	4.157
NEWPAT	1	-0.5063	0.3925	1.6641	0.1971	-0.076989	0.603
CAPBIN	1	-0.2376	0.2889	0.6768	0.4107	-0.048163	0.788
AADENTS	1	-0.2390	0.3916	0.3725	0.5416	-0.044759	0.787
DTBIN	1	-0.3167	0.2432	1.6949	0.1930	-0.071983	0.729
KNOWBIN	1	-0.1597	0.2572	0.3856	0.5346	-0.036231	0.852
PAYBIN	1	0.2723	0.2624	1.0761	0.2996	0.060199	1.313
NT20BIN	1	-0.3248	0.4325	0.5641	0.4526	-0.056776	0.723
IRSDMED	1	-0.2954	0.2672	1.2222	0.2689	-0.067182	0.744

7.6 Appendix F:

(Ordinary least squares models: patient-level)

This section presents details of the linear regression models of receipt of services by the set of independent variables. The independent variables were coded as indicator variables with 1 being used to identify the variable and 0 to identify the reference category. The coding of the independent variables consists of: AGE1 (18-24 years), AGE2 (25-44 years), AGE3 (45-64 years), reference (65+ years); MALEPAT (sex of patient coded as male, reference is female); INS (insurance status coded as insured, reference uninsured); ROP (visit type coded as emergency, reference non-emergency); NEWPAT (patient status coded as new, reference previous); CAPBIN (location coded as capital city, reference non-capital); AADENTS (denture status coded as present, reference absent); DTBIN (decayed teeth coded as no decay, reference 1+ decay); KNOWBIN (Knowledge sub-scale coded as less than or equal to the median, indicating a higher knowledge rating, reference lower knowledge rating); PAYBIN (Payment sub-scale coded as less than or equal to the median, indicating a higher rating of willing and able to pay, reference lower payment rating); NT20BIN (number of teeth coded as 1 - 20 teeth, reference 21 - 32 teeth); and IRSDMED (SEIFA index coded as less than or equal to the median, indicating more disadvantaged postcode areas, reference less disadvantaged postcode areas).

The dependent variables consisted of numbers of services per visit, with each main area of service forming the dependent variable for a separate regression model. The number of services was log transformed prior to the analysis to improve the distribution for linear regression. In each service area in Table F1, except orthodontic services, the skewness and kurtosis was reduced for the transformed compared to the raw data.

Table F1: Distributions of raw and log transformed service areas (patient level)

	Raw data		Transformed data	
	Skew	Kurtosis	Skew	Kurtosis
Diagnostic	2.16	14.47	0.37	-1.32
Preventive	1.95	4.53	1.23	-0.12
Periodontic	9.06	103.08	7.22	52.95
Extraction	12.12	288.76	3.93	15.95
Endodontic	4.90	30.04	3.42	10.92
Restorative	2.75	12.55	0.86	-0.56
Crown and bridge	5.87	45.25	3.86	14.52
Prosthodontic	10.26	133.15	4.78	25.35
Orthodontic	15.00	223.14	15.00	223.14
General/miscellaneous	5.75	40.42	4.66	20.90
Total services	2.28	10.78	0.54	-0.25

The output of the models based on SAS Proc REG are presented in the remainder of this section (SAS, 1988).

Model (1) Diagnostic services

Model: MODEL1
Dependent Variable: LDIAG

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	6.72941	0.48067	11.517	0.0001
Error	2605	108.71899	0.04173		
C Total	2619	115.44840			

Root MSE	0.20429	R-square	0.0583
Dep Mean	-0.02748	Adj R-sq	0.0532
C.V.	-743.55059		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.021441	0.02569645	-0.834	0.4041
AGE1	1	0.056989	0.02541596	2.242	0.0250
AGE2	1	0.007400	0.01955642	0.378	0.7052
AGE3	1	0.003967	0.01833448	0.216	0.8287
MALEPAT	1	0.007780	0.01108680	0.702	0.4829
INS	1	0.022909	0.01132049	2.024	0.0431
ROP	1	-0.005805	0.01301969	-0.446	0.6557
NEWPAT	1	0.143873	0.01685503	8.536	0.0001
CAPBIN	1	0.016253	0.01351819	1.202	0.2293
AADENTS	1	-0.062652	0.01735480	-3.610	0.0003
DTBIN	1	-0.061166	0.01132428	-5.401	0.0001
KNOWBIN	1	-0.015092	0.01203928	-1.254	0.2101
PAYBIN	1	-0.001096	0.01217457	-0.090	0.9283
NT20BIN	1	-0.030230	0.01903317	-1.588	0.1123
IRSDMED	1	-0.003190	0.01217840	-0.262	0.7934

Model (2) Preventive services

Model: MODEL1
Dependent Variable: LPREV

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	20.86988	1.49071	27.138	0.0001
Error	2605	143.09204	0.05493		
C Total	2619	163.96193			

Root MSE	0.23437	R-square	0.1273
Dep Mean	-0.14906	Adj R-sq	0.1226
C.V.	-157.22748		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.104917	0.02161582	-4.854	0.0001
AGE1	1	0.018123	0.02137987	0.848	0.3967
AGE2	1	0.001073	0.01645083	0.065	0.9480
AGE3	1	-0.024224	0.01542294	-1.571	0.1164
MALEPAT	1	0.008692	0.00932620	0.932	0.3515
INS	1	0.027583	0.00952278	2.897	0.0038
ROP	1	-0.129682	0.01095214	-11.841	0.0001
NEWPAT	1	0.017433	0.01417843	1.230	0.2190
CAPBIN	1	0.035671	0.01137149	3.137	0.0017
AADENTS	1	-0.037793	0.01459884	-2.589	0.0097
DTBIN	1	-0.087739	0.00952597	-9.211	0.0001
KNOWBIN	1	-0.000118	0.01012743	-0.012	0.9907
PAYBIN	1	0.024955	0.01024123	2.437	0.0149
NT20BIN	1	-0.033442	0.01601068	-2.089	0.0368
IRSDMED	1	-0.015460	0.01024446	-1.509	0.1314

Model (3) Periodontic services

Model: MODEL1
Dependent Variable: LPERI

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	0.08460	0.00604	1.896	0.0225
Error	2605	8.30139	0.00319		
C Total	2619	8.38600			

Root MSE	0.05645	R-square	0.0101
Dep Mean	-0.29003	Adj R-sq	0.0048
C.V.	-19.46383		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.297134	0.00688745	-43.141	0.0001
AGE1	1	-0.005332	0.00681227	-0.783	0.4339
AGE2	1	-0.000657	0.00524173	-0.125	0.9003
AGE3	1	0.007179	0.00491421	1.461	0.1442
MALEPAT	1	0.000663	0.00297161	0.223	0.8236
INS	1	0.003548	0.00303424	1.169	0.2423
ROP	1	0.003858	0.00348968	1.106	0.2690
NEWPAT	1	-0.003903	0.00451767	-0.864	0.3877
CAPBIN	1	0.005397	0.00362330	1.490	0.1364
AADENTS	1	-0.005026	0.00465163	-1.081	0.2800
DTBIN	1	-0.001409	0.00303526	-0.464	0.6425
KNOWBIN	1	-0.000831	0.00322690	-0.257	0.7969
PAYBIN	1	0.004961	0.00326316	1.520	0.1285
NT20BIN	1	-0.000704	0.00510148	-0.138	0.8902
IRSDMED	1	-0.003970	0.00326419	-1.216	0.2241

Model (4) Extraction services

Model: MODEL1
Dependent Variable: LORAL

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	4.28876	0.30634	26.875	0.0001
Error	2605	29.69382	0.01140		
C Total	2619	33.98258			

Root MSE	0.10677	R-square	0.1262
Dep Mean	-0.26624	Adj R-sq	0.1215
C.V.	-40.10061		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.287863	0.01139855	-25.254	0.0001
AGE1	1	-0.000175	0.01127412	-0.016	0.9876
AGE2	1	0.007208	0.00867492	0.831	0.4061
AGE3	1	-0.002038	0.00813289	-0.251	0.8021
MALEPAT	1	0.002065	0.00491793	0.420	0.6746
INS	1	-0.020389	0.00502159	-4.060	0.0001
ROP	1	0.090065	0.00577533	15.595	0.0001
NEWPAT	1	0.022674	0.00747663	3.033	0.0024
CAPBIN	1	-0.000265	0.00599646	-0.044	0.9648
AADENTS	1	-0.005409	0.00769832	-0.703	0.4823
DTBIN	1	0.000822	0.00502328	0.164	0.8700
KNOWBIN	1	-0.009163	0.00534044	-1.716	0.0863
PAYBIN	1	-0.004452	0.00540045	-0.824	0.4098
NT20BIN	1	0.024339	0.00844282	2.883	0.0040
IRSDMED	1	0.015215	0.00540215	2.816	0.0049

Model (5) Endodontic services

Model: MODEL1
Dependent Variable: LENDO

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	1.64857	0.11775	6.131	0.0001
Error	2605	50.03232	0.01921		
C Total	2619	51.68089			

Root MSE	0.13859	R-square	0.0319
Dep Mean	-0.25274	Adj R-sq	0.0267
C.V.	-54.83392		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.289888	0.01506943	-19.237	0.0001
AGE1	1	0.019570	0.01490493	1.313	0.1893
AGE2	1	0.014360	0.01146867	1.252	0.2107
AGE3	1	0.006285	0.01075207	0.585	0.5589
MALEPAT	1	0.007712	0.00650174	1.186	0.2357
INS	1	0.007198	0.00663879	1.084	0.2784
ROP	1	0.059890	0.00763527	7.844	0.0001
NEWPAT	1	-0.031150	0.00988446	-3.151	0.0016
CAPBIN	1	0.003795	0.00792761	0.479	0.6321
AADENTS	1	-0.014518	0.01017755	-1.426	0.1539
DTBIN	1	0.015486	0.00664101	2.332	0.0198
KNOWBIN	1	0.005050	0.00706032	0.715	0.4745
PAYBIN	1	-0.003445	0.00713965	-0.482	0.6295
NT20BIN	1	0.011862	0.01116181	1.063	0.2880
IRSDMED	1	-0.001081	0.00714190	-0.151	0.8797

Model (6) Restorative services

Model: MODEL1
Dependent Variable: LREST

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	24.95800	1.78271	32.408	0.0001
Error	2605	143.29691	0.05501		
C Total	2619	168.25491			

Root MSE	0.23454	R-square	0.1483
Dep Mean	-0.08020	Adj R-sq	0.1438
C.V.	-292.43035		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.087871	0.02568573	-3.421	0.0006
AGE1	1	-0.123294	0.02540536	-4.853	0.0001
AGE2	1	-0.058911	0.01954826	-3.014	0.0026
AGE3	1	-0.033807	0.01832683	-1.845	0.0652
MALEPAT	1	0.018440	0.01108217	1.664	0.0963
INS	1	0.015690	0.01131577	1.387	0.1657
ROP	1	-0.041268	0.01301426	-3.171	0.0015
NEWPAT	1	-0.072965	0.01684799	-4.331	0.0001
CAPBIN	1	-0.031077	0.01351255	-2.300	0.0215
AADENTS	1	-0.038265	0.01734756	-2.206	0.0275
DTBIN	1	0.219320	0.01131956	19.375	0.0001
KNOWBIN	1	-0.006577	0.01203426	-0.547	0.5847
PAYBIN	1	-0.006138	0.01216949	-0.504	0.6140
NT20BIN	1	-0.044299	0.01902523	-2.328	0.0200
IRSDMED	1	-0.016558	0.01217332	-1.360	0.1739

Model (7) Crown and bridge services

Model: MODEL1
Dependent Variable: LCRBR

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	1.63179	0.11656	8.778	0.0001
Error	2605	34.59052	0.01328		
C Total	2619	36.22231			

Root MSE	0.11523	R-square	0.0450
Dep Mean	-0.26630	Adj R-sq	0.0399
C.V.	-43.27170		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.284119	0.01243950	-22.840	0.0001
AGE1	1	-0.013601	0.01230371	-1.105	0.2691
AGE2	1	0.012782	0.00946714	1.350	0.1771
AGE3	1	0.036061	0.00887561	4.063	0.0001
MALEPAT	1	-0.004513	0.00536705	-0.841	0.4005
INS	1	0.009961	0.00548018	1.818	0.0692
ROP	1	-0.025723	0.00630275	-4.081	0.0001
NEWPAT	1	-0.014607	0.00815942	-1.790	0.0735
CAPBIN	1	0.004621	0.00654408	0.706	0.4802
AADENTS	1	0.012413	0.00840135	1.478	0.1397
DTBIN	1	-0.016170	0.00548202	-2.950	0.0032
KNOWBIN	1	0.004938	0.00582814	0.847	0.3969
PAYBIN	1	0.016568	0.00589363	2.811	0.0050
NT20BIN	1	-0.015542	0.00921384	-1.687	0.0918
IRSDMED	1	-0.003529	0.00589549	-0.599	0.5495

Model (8) Prosthodontic services

Model: MODEL1
Dependent Variable: LPROS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	8.81177	0.62941	46.568	0.0001
Error	2605	35.20884	0.01352		
C Total	2619	44.02061			

Root MSE	0.11626	R-square	0.2002
Dep Mean	-0.26580	Adj R-sq	0.1959
C.V.	-43.73892		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.282780	0.01213095	-23.311	0.0001
AGE1	1	0.010634	0.01199853	0.886	0.3755
AGE2	1	0.014166	0.00923232	1.534	0.1251
AGE3	1	0.011451	0.00865546	1.323	0.1859
MALEPAT	1	-0.000951	0.00523393	-0.182	0.8559
INS	1	-0.011001	0.00534425	-2.059	0.0396
ROP	1	-0.008491	0.00614642	-1.382	0.1672
NEWPAT	1	0.001353	0.00795703	0.170	0.8649
CAPBIN	1	-0.010947	0.00638176	-1.715	0.0864
AADENTS	1	0.106327	0.00819297	12.978	0.0001
DTBIN	1	-0.031278	0.00534604	-5.851	0.0001
KNOWBIN	1	-0.003331	0.00568358	-0.586	0.5579
PAYBIN	1	0.004323	0.00574745	0.752	0.4521
NT20BIN	1	0.068939	0.00898530	7.672	0.0001
IRSDMED	1	0.002954	0.00574926	0.514	0.6074

Model (9) Orthodontic services

Model: MODEL1
Dependent Variable: LORTH

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	0.02796	0.00200	4.315	0.0001
Error	2605	1.20551	0.00046		
C Total	2619	1.23346			

Root MSE	0.02151	R-square	0.0227
Dep Mean	-0.29848	Adj R-sq	0.0174
C.V.	-7.20717		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.306333	0.00318065	-96.312	0.0001
AGE1	1	0.014337	0.00314593	4.557	0.0001
AGE2	1	0.003656	0.00242065	1.510	0.1311
AGE3	1	-0.000036919	0.00226940	-0.016	0.9870
MALEPAT	1	0.002199	0.00137230	1.602	0.1092
INS	1	0.000789	0.00140122	0.563	0.5733
ROP	1	-0.002125	0.00161155	-1.319	0.1874
NEWPAT	1	-0.001121	0.00208628	-0.537	0.5912
CAPBIN	1	0.002225	0.00167325	1.330	0.1838
AADENTS	1	0.000526	0.00214814	0.245	0.8064
DTBIN	1	-0.003230	0.00140169	-2.304	0.0213
KNOWBIN	1	0.002214	0.00149019	1.486	0.1375
PAYBIN	1	0.002405	0.00150694	1.596	0.1105
NT20BIN	1	-0.000652	0.00235588	-0.277	0.7821
IRSDMED	1	0.003762	0.00150741	2.495	0.0126

Model (10) General/miscellaneous services

Model: MODEL1
Dependent Variable: LGENM

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	0.50524	0.03609	4.793	0.0001
Error	2605	19.61316	0.00753		
C Total	2619	20.11839			

Root MSE	0.08677	R-square	0.0251
Dep Mean	-0.27827	Adj R-sq	0.0199
C.V.	-31.18160		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.266952	0.00970279	-27.513	0.0001
AGE1	1	-0.008718	0.00959687	-0.908	0.3637
AGE2	1	-0.003792	0.00738436	-0.514	0.6076
AGE3	1	-0.006956	0.00692296	-1.005	0.3151
MALEPAT	1	-0.009003	0.00418629	-2.151	0.0316
INS	1	-0.004254	0.00427453	-0.995	0.3197
ROP	1	0.035389	0.00491614	7.199	0.0001
NEWPAT	1	-0.012019	0.00636433	-1.889	0.0591
CAPBIN	1	-0.002519	0.00510437	-0.494	0.6217
AADENTS	1	-0.004547	0.00655304	-0.694	0.4878
DTBIN	1	-0.006536	0.00427596	-1.528	0.1265
KNOWBIN	1	-0.004077	0.00454594	-0.897	0.3698
PAYBIN	1	0.007059	0.00459702	1.536	0.1247
NT20BIN	1	-0.006260	0.00718678	-0.871	0.3838
IRSDMED	1	-0.005150	0.00459847	-1.120	0.2628

Model (11) Total services per visit

Model: MODEL1
Dependent Variable: LTOTP

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	0.90830	0.06488	4.769	0.0001
Error	2605	35.44200	0.01361		
C Total	2619	36.35030			

Root MSE	0.11664	R-square	0.0250
Dep Mean	0.37550	Adj R-sq	0.0197
C.V.	31.06326		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.343291	0.01697551	20.223	0.0001
AGE1	1	-0.017894	0.01679021	-1.066	0.2866
AGE2	1	0.004531	0.01291930	0.351	0.7258
AGE3	1	0.000898	0.01211206	0.074	0.9409
MALEPAT	1	0.015642	0.00732413	2.136	0.0328
INS	1	0.027166	0.00747851	3.632	0.0003
ROP	1	-0.019760	0.00860102	-2.297	0.0217
NEWPAT	1	0.019751	0.01113471	1.774	0.0762
CAPBIN	1	0.012838	0.00893035	1.438	0.1507
AADENTS	1	-0.028382	0.01146487	-2.476	0.0134
DTBIN	1	0.020899	0.00748101	2.794	0.0053
KNOWBIN	1	-0.016266	0.00795335	-2.045	0.0409
PAYBIN	1	0.019402	0.00804272	2.412	0.0159
NT20BIN	1	-0.005283	0.01257363	-0.420	0.6744
IRSDMED	1	-0.008329	0.00804526	-1.035	0.3007

7.7 Appendix G

(Ordinary least squares models: dentist-level)

This section presents details of the linear regression models of receipt of services by the set of independent variables. The independent variables were coded as indicator variables with 1 being used to identify the variable and 0 to identify the reference category. The coding of the independent variables consists of: (a) Dentist factors: Treatment choice clusters - CLUST1 (Patient cluster), CLUST2 (Cost cluster), reference (Oral health cluster); Practice belief scales - INFGMED (Information giving), PORIMED (Preventive orientation), PINFMED (Patient influence), Dentist preference sub-scales - BHAVMED (Dental behaviour), PERSMED (Personality), COMPMED (General behaviour) and FINAMED (Finance) all coded as less than or equal to the median or higher agreement, reference is lower agreement); Dentist characteristics - MALEDENT (sex of dentist coded as male, reference is female); DAGE1B (dentist age 20-29 years), DAGE2B (dentist age 30-39 years), DAGE3B (dentist age 40-49 years) reference category was 50 years or older; (b) Practice factors referring to the main private practice: SOLO (practice type coded as solo, reference non-solo); CAPBIN (location coded as capital city, reference non-capital); NDENTMED (number of other dentists in practice), WAITMED (waiting time for an appointment), FTEMED (number of non-dentist staff), and PPYMED (number of patient visits per year), these were all coded as less than or equal to the median, reference greater than the median; (c) Patient factors: PROPMED (proportion of emergency visits), PINSMED (proportion of insured patients),PAGE2MED (proportion of patients aged 25-44 years), PDTMED (proportion of patients with decayed teeth) PNEWMED (proportion of patients which were new), PDENTMED (proportion of patients with dentures), all coded as the proportion greater than the median, with the reference coded as those less than or equal to the median; and IRSDMED (proportion of SEIFA index of disadvantage coded as less than or equal to the median, with the reference coded as those greater than the median).

The dependent variables consisted of numbers of services per visit, with each main area of service forming the dependent variable for a separate regression model. The number of services was log transformed prior to the analysis to improve the distribution for linear regression. In each service area in Table G1 the skewness and kurtosis was reduced for the transformed compared to the raw data, although not appreciably for orthodontic and general services,.

Table G1: Distributions of raw and log transformed service areas (dentist level)

	Raw data		Transformed data	
	Skew	Kurtosis	Skew	Kurtosis
Diagnostic	1.21	3.06	0.01	0.22
Preventive	1.13	1.49	0.32	-0.36
Periodontic	4.34	23.86	3.54	14.48
Extraction	4.07	27.49	2.17	6.38
Endodontic	1.98	4.82	1.24	1.08
Restorative	1.86	6.94	0.26	0.57
Crown and bridge	2.94	12.10	1.84	4.00
Prosthodontic	11.26	161.58	3.64	20.15
Orthodontic	6.77	49.41	6.52	44.57
General/miscellaneous	2.68	8.75	2.12	4.54
Total services	1.27	3.33	0.34	0.41

The output of the models based on SAS Proc REG are presented in the remainder of this section (SAS, 1988).

Model (1) Diagnostic services

Model: MODEL1
Dependent Variable: LDIAG

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	26	0.77568	0.02983	1.656	0.0259
Error	288	5.18847	0.01802		
C Total	314	5.96415			

Root MSE	0.13422	R-square	0.1301
Dep Mean	0.05176	Adj R-sq	0.0515
C.V.	259.31840		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.005385	0.04694168	0.115	0.9087
CLUST1	1	-0.011515	0.01951744	-0.590	0.5557
CLUST2	1	0.012357	0.01958608	0.631	0.5286
INFGMED	1	0.013595	0.01612628	0.843	0.3999
PORIMED	1	0.010395	0.01694979	0.613	0.5402
PINFMED	1	0.001886	0.01584809	0.119	0.9054
BHAVMED	1	0.040560	0.02015223	2.013	0.0451
PERSMED	1	0.002351	0.01968147	0.119	0.9050
COMPMED	1	-0.010561	0.01994769	-0.529	0.5969
FINAMED	1	-0.032198	0.01754580	-1.835	0.0675
MALEDENT	1	0.008869	0.02159012	0.411	0.6815
DAGE1B	1	0.031955	0.02773593	1.152	0.2502
DAGE2B	1	-0.010134	0.02230302	-0.454	0.6499
DAGE3B	1	0.030879	0.02116210	1.459	0.1456
SOLO	1	-0.035074	0.01839701	-1.907	0.0576
CAPBIN	1	0.034566	0.02087606	1.656	0.0989
NDENTMED	1	-0.017534	0.02057149	-0.852	0.3947
WAITMED	1	0.008973	0.01658086	0.541	0.5888
FTEMED	1	-0.014472	0.01672570	-0.865	0.3876
PPYMED	1	0.038957	0.01674201	2.327	0.0207
PROPMED	1	0.010331	0.01591690	0.649	0.5168
PINSMED	1	-0.005109	0.01611091	-0.317	0.7514
PAGE2MED	1	-0.003478	0.01664136	-0.209	0.8346
PDTMED	1	-0.019187	0.01629909	-1.177	0.2401
PNEWMED	1	0.036289	0.01674268	2.167	0.0310
PDENTMED	1	-0.015773	0.01652006	-0.955	0.3405
IRSDMED	1	-0.005846	0.01731718	-0.338	0.7359

Model (2) Preventive services

Model: MODEL1
Dependent Variable: LPREV

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	26	1.21809	0.04685	2.835	0.0001
Error	288	4.75916	0.01652		
C Total	314	5.97725			

Root MSE	0.12855	R-square	0.2038
Dep Mean	-0.08592	Adj R-sq	0.1319
C.V.	-149.61549		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.046510	0.04495773	-1.035	0.3018
CLUST1	1	-0.004062	0.01869255	-0.217	0.8281
CLUST2	1	-0.009696	0.01875830	-0.517	0.6056
INFGMED	1	-0.010694	0.01544472	-0.692	0.4892
PORIMED	1	-0.010832	0.01623342	-0.667	0.5052
PINFMED	1	0.008079	0.01517828	0.532	0.5950
BHAVMED	1	0.042887	0.01930051	2.222	0.0271
PERSMED	1	-0.011457	0.01884965	-0.608	0.5438
COMPMED	1	0.014764	0.01910462	0.773	0.4403
FINAMED	1	-0.026068	0.01680424	-1.551	0.1219
MALEDENT	1	-0.047528	0.02067763	-2.299	0.0222
DAGE1B	1	0.043353	0.02656370	1.632	0.1038
DAGE2B	1	0.016826	0.02136040	0.788	0.4315
DAGE3B	1	0.006136	0.02026771	0.303	0.7623
SOLO	1	0.028681	0.01761948	1.628	0.1047
CAPBIN	1	0.038346	0.01999375	1.918	0.0561
NDENTMED	1	0.019670	0.01970206	0.998	0.3189
WAITMED	1	0.011333	0.01588009	0.714	0.4760
FTEMED	1	-0.004560	0.01601880	-0.285	0.7761
PPYMED	1	-0.006034	0.01603442	-0.376	0.7070
PROPMED	1	-0.043805	0.01524419	-2.874	0.0044
PINSMED	1	0.029356	0.01543000	1.903	0.0581
PAGE2MED	1	-0.013418	0.01593802	-0.842	0.4005
PDTMED	1	-0.036547	0.01561023	-2.341	0.0199
PNEWMED	1	-0.021655	0.01603507	-1.350	0.1779
PDENTMED	1	-0.021781	0.01582185	-1.377	0.1697
IRSDMED	1	-0.038277	0.01658528	-2.308	0.0217

Model (3) Periodontic services

Model: MODEL1
Dependent Variable: LPERI

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	26	0.07380	0.00284	1.261	0.1829
Error	288	0.64839	0.00225		
C Total	314	0.72218			

Root MSE	0.04745	R-square	0.1022
Dep Mean	-0.28437	Adj R-sq	0.0211
C.V.	-16.68541		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.281910	0.01659419	-16.988	0.0001
CLUST1	1	-0.004647	0.00689954	-0.674	0.5011
CLUST2	1	0.003416	0.00692381	0.493	0.6221
INFGMED	1	-0.002625	0.00570075	-0.461	0.6455
PORIMED	1	-0.006736	0.00599186	-1.124	0.2619
PINFMED	1	-0.001827	0.00560240	-0.326	0.7446
BHAVMED	1	-0.014236	0.00712395	-1.998	0.0466
PERSMED	1	0.001789	0.00695753	0.257	0.7972
COMPMED	1	0.019914	0.00705164	2.824	0.0051
FINAMED	1	-0.001545	0.00620256	-0.249	0.8034
MALEDENT	1	0.009692	0.00763225	1.270	0.2052
DAGE1B	1	0.006233	0.00980483	0.636	0.5255
DAGE2B	1	0.008032	0.00788426	1.019	0.3092
DAGE3B	1	0.006643	0.00748094	0.888	0.3753
SOLO	1	0.003024	0.00650346	0.465	0.6423
CAPBIN	1	0.003783	0.00737982	0.513	0.6087
NDENTMED	1	-0.003477	0.00727216	-0.478	0.6329
WAITMED	1	-0.009085	0.00586144	-1.550	0.1223
FTEMED	1	-0.010559	0.00591264	-1.786	0.0752
PPYMED	1	0.010119	0.00591841	1.710	0.0884
PROPMED	1	-0.000422	0.00562673	-0.075	0.9403
PINSMED	1	-0.000278	0.00569531	-0.049	0.9611
PAGE2MED	1	-0.006220	0.00588283	-1.057	0.2912
PDTMED	1	0.003282	0.00576184	0.570	0.5694
PNEWMED	1	-0.000483	0.00591865	-0.082	0.9350
PDENTMED	1	0.002895	0.00583995	0.496	0.6205
IRSDMED	1	-0.014785	0.00612174	-2.415	0.0164

Model (4) Extraction services

Model: MODEL1
Dependent Variable: LORAL

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	26	0.56703	0.02181	3.208	0.0001
Error	288	1.95771	0.00680		
C Total	314	2.52474			

Root MSE	0.08245	R-square	0.2246
Dep Mean	-0.24366	Adj R-sq	0.1546
C.V.	-33.83715		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.291298	0.02883452	-10.102	0.0001
CLUST1	1	-0.008267	0.01198884	-0.690	0.4910
CLUST2	1	0.009570	0.01203100	0.795	0.4270
INFGMED	1	-0.011010	0.00990577	-1.111	0.2673
PORIMED	1	-0.019866	0.01041162	-1.908	0.0574
PINFMED	1	0.015531	0.00973489	1.595	0.1117
BHAVMED	1	-0.011950	0.01237876	-0.965	0.3352
PERSMED	1	0.032359	0.01208959	2.677	0.0079
COMPMED	1	-0.003589	0.01225313	-0.293	0.7698
FINAMED	1	0.003051	0.01077773	0.283	0.7773
MALEDENT	1	0.014498	0.01326201	1.093	0.2752
DAGE1B	1	-0.012377	0.01703715	-0.726	0.4682
DAGE2B	1	-0.011886	0.01369991	-0.868	0.3863
DAGE3B	1	-0.017618	0.01299909	-1.355	0.1764
SOLO	1	-0.001045	0.01130060	-0.093	0.9264
CAPBIN	1	-0.009186	0.01282338	-0.716	0.4743
NDENTMED	1	-0.023591	0.01263630	-1.867	0.0629
WAITMED	1	0.013714	0.01018501	1.347	0.1792
FTEMED	1	0.002214	0.01027397	0.216	0.8295
PPYMED	1	0.022575	0.01028399	2.195	0.0289
PROPMED	1	0.025584	0.00977716	2.617	0.0093
PINSMED	1	-0.025486	0.00989633	-2.575	0.0105
PAGE2MED	1	0.015378	0.01022216	1.504	0.1336
PDTMED	1	0.015573	0.01001193	1.555	0.1209
PNEWMED	1	0.019258	0.01028441	1.873	0.0621
PDENTMED	1	0.014971	0.01014766	1.475	0.1412
IRSDMED	1	0.036003	0.01063730	3.385	0.0008

Model (5) Endodontic services

Model: MODEL1
Dependent Variable: LENDO

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	26	0.44625	0.01716	1.485	0.0643
Error	288	3.32830	0.01156		
C Total	314	3.77455			

Root MSE	0.10750	R-square	0.1182
Dep Mean	-0.21163	Adj R-sq	0.0386
C.V.	-50.79706		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.314010	0.03759673	-8.352	0.0001
CLUST1	1	0.007702	0.01563199	0.493	0.6226
CLUST2	1	-0.011632	0.01568697	-0.742	0.4590
INFGMED	1	0.004485	0.01291593	0.347	0.7287
PORIMED	1	0.014111	0.01357550	1.039	0.2995
PINFMED	1	0.013810	0.01269312	1.088	0.2775
BHAVMED	1	0.014089	0.01614041	0.873	0.3834
PERSMED	1	0.013652	0.01576337	0.866	0.3872
COMPMED	1	-0.038534	0.01597659	-2.412	0.0165
FINAMED	1	-0.001434	0.01405286	-0.102	0.9188
MALEDENT	1	0.010650	0.01729205	0.616	0.5385
DAGE1B	1	0.058564	0.02221438	2.636	0.0088
DAGE2B	1	0.038454	0.01786303	2.153	0.0322
DAGE3B	1	0.020119	0.01694924	1.187	0.2362
SOLO	1	-0.014291	0.01473461	-0.970	0.3329
CAPBIN	1	0.026116	0.01672014	1.562	0.1194
NDENTMED	1	-0.002877	0.01647621	-0.175	0.8615
WAITMED	1	0.007915	0.01328002	0.596	0.5517
FTEMED	1	0.007355	0.01339602	0.549	0.5834
PPYMED	1	-0.002760	0.01340908	-0.206	0.8371
PROPMED	1	0.016192	0.01274823	1.270	0.2051
PINSMED	1	0.017770	0.01290362	1.377	0.1695
PAGE2MED	1	-0.027194	0.01332847	-2.040	0.0422
PDTMED	1	0.015699	0.01305434	1.203	0.2301
PNEWMED	1	0.026396	0.01340962	1.968	0.0500
PDENTMED	1	0.002497	0.01323132	0.189	0.8504
IRSDMED	1	0.029426	0.01386975	2.122	0.0347

Model (6) Restorative services

Model: MODEL1
Dependent Variable: LREST

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	26	1.12713	0.04335	2.262	0.0006
Error	288	5.52024	0.01917		
C Total	314	6.64737			

Root MSE	0.13845	R-square	0.1696
Dep Mean	0.03286	Adj R-sq	0.0946
C.V.	421.29942		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.003192	0.04841926	-0.066	0.9475
CLUST1	1	0.049137	0.02013179	2.441	0.0153
CLUST2	1	0.000804	0.02020260	0.040	0.9683
INFGMED	1	-0.016311	0.01663389	-0.981	0.3276
PORIMED	1	0.028360	0.01748332	1.622	0.1059
PINFMED	1	0.021529	0.01634694	1.317	0.1889
BHAVMED	1	-0.014650	0.02078656	-0.705	0.4815
PERSMED	1	-0.003282	0.02030098	-0.162	0.8717
COMPMED	1	-0.023366	0.02057559	-1.136	0.2571
FINAMED	1	0.042453	0.01809809	2.346	0.0197
MALEDENT	1	-0.014156	0.02226971	-0.636	0.5255
DAGE1B	1	0.009285	0.02860898	0.325	0.7458
DAGE2B	1	0.044228	0.02300505	1.923	0.0555
DAGE3B	1	0.009225	0.02182822	0.423	0.6729
SOLO	1	-0.023257	0.01897609	-1.226	0.2214
CAPBIN	1	-0.009176	0.02153317	-0.426	0.6703
NDENTMED	1	0.018672	0.02121902	0.880	0.3796
WAITMED	1	-0.010965	0.01710278	-0.641	0.5220
FTEMED	1	-0.014238	0.01725217	-0.825	0.4099
PPYMED	1	-0.032350	0.01726900	-1.873	0.0620
PROPMED	1	-0.017550	0.01641792	-1.069	0.2860
PINSMED	1	0.018551	0.01661804	1.116	0.2652
PAGE2MED	1	0.025584	0.01716518	1.490	0.1372
PDTMED	1	0.068344	0.01681214	4.065	0.0001
PNEWMED	1	0.002554	0.01726969	0.148	0.8825
PDENTMED	1	-0.008662	0.01704006	-0.508	0.6116
IRSDMED	1	-0.023903	0.01786227	-1.338	0.1819

Model (7) Crown and bridge services

Model: MODEL1
Dependent Variable: LCRBR

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	26	0.26608	0.01023	1.231	0.2066
Error	288	2.39353	0.00831		
C Total	314	2.65960			

Root MSE	0.09116	R-square	0.1000
Dep Mean	-0.23772	Adj R-sq	0.0188
C.V.	-38.34866		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.263684	0.03188293	-8.270	0.0001
CLUST1	1	0.006667	0.01325631	0.503	0.6154
CLUST2	1	0.010566	0.01330293	0.794	0.4277
INFGMED	1	0.021084	0.01095302	1.925	0.0552
PORIMED	1	0.013297	0.01151235	1.155	0.2490
PINFMED	1	-0.018819	0.01076407	-1.748	0.0815
BHAVMED	1	-0.000304	0.01368745	-0.022	0.9823
PERSMED	1	-0.003566	0.01336771	-0.267	0.7898
COMPMED	1	-0.003849	0.01354854	-0.284	0.7765
FINAMED	1	0.005736	0.01191716	0.481	0.6307
MALEDENT	1	0.015712	0.01466408	1.071	0.2849
DAGE1B	1	-0.026829	0.01883833	-1.424	0.1555
DAGE2B	1	0.003871	0.01514828	0.256	0.7985
DAGE3B	1	0.014488	0.01437337	1.008	0.3143
SOLO	1	0.015242	0.01249531	1.220	0.2235
CAPBIN	1	0.011429	0.01417908	0.806	0.4209
NDENTMED	1	-0.003286	0.01397222	-0.235	0.8142
WAITMED	1	-0.003586	0.01126177	-0.318	0.7504
FTEMED	1	0.009123	0.01136015	0.803	0.4226
PPYMED	1	-0.007756	0.01137122	-0.682	0.4958
PROPMED	1	-0.004175	0.01081081	-0.386	0.6996
PINSMED	1	0.007966	0.01094258	0.728	0.4672
PAGE2MED	1	-0.003962	0.01130286	-0.351	0.7262
PDTMED	1	-0.014034	0.01107039	-1.268	0.2059
PNEWMED	1	0.004034	0.01137168	0.355	0.7231
PDENTMED	1	-0.003283	0.01122048	-0.293	0.7701
IRSDMED	1	-0.015220	0.01176188	-1.294	0.1967

Model (8) Prosthodontic services

Model: MODEL1
Dependent Variable: LPROS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	26	0.78075	0.03003	2.322	0.0004
Error	288	3.72432	0.01293		
C Total	314	4.50507			

Root MSE	0.11372	R-square	0.1733
Dep Mean	-0.24154	Adj R-sq	0.0987
C.V.	-47.08047		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.298810	0.03977061	-7.513	0.0001
CLUST1	1	0.011418	0.01653585	0.690	0.4905
CLUST2	1	0.022502	0.01659401	1.356	0.1762
INFGMED	1	-0.018122	0.01366274	-1.326	0.1858
PORIMED	1	0.019077	0.01436044	1.328	0.1851
PINFMED	1	0.014006	0.01342705	1.043	0.2978
BHAVMED	1	-0.005089	0.01707366	-0.298	0.7659
PERSMED	1	0.027971	0.01667482	1.677	0.0945
COMPMED	1	0.003652	0.01690038	0.216	0.8291
FINAMED	1	-0.013822	0.01486541	-0.930	0.3532
MALEDENT	1	0.014329	0.01829190	0.783	0.4341
DAGE1B	1	0.008043	0.02349884	0.342	0.7324
DAGE2B	1	0.016838	0.01889589	0.891	0.3736
DAGE3B	1	0.031096	0.01792927	1.734	0.0839
SOLO	1	0.010153	0.01558658	0.651	0.5153
CAPBIN	1	-0.039832	0.01768692	-2.252	0.0251
NDENTMED	1	-0.005094	0.01742888	-0.292	0.7703
WAITMED	1	0.012186	0.01404788	0.867	0.3864
FTEMED	1	0.002688	0.01417059	0.190	0.8497
PPYMED	1	-0.002254	0.01418441	-0.159	0.8739
PROPMED	1	-0.010841	0.01348535	-0.804	0.4221
PINSMED	1	0.022080	0.01364972	1.618	0.1068
PAGE2MED	1	-0.006030	0.01409913	-0.428	0.6692
PDTMED	1	-0.019052	0.01380915	-1.380	0.1688
PNEWMED	1	0.002612	0.01418498	0.184	0.8540
PDENTMED	1	0.067380	0.01399636	4.814	0.0001
IRSDMED	1	0.003986	0.01467171	0.272	0.7860

Model (9) Orthodontic services

Model: MODEL1
Dependent Variable: LORTH

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	26	0.00672	0.00026	0.915	0.5870
Error	288	0.08137	0.00028		
C Total	314	0.08809			

Root MSE	0.01681	R-square	0.0763
Dep Mean	-0.29827	Adj R-sq	-0.0071
C.V.	-5.63524		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.304282	0.00587841	-51.763	0.0001
CLUST1	1	0.001331	0.00244413	0.545	0.5865
CLUST2	1	-0.000552	0.00245273	-0.225	0.8221
INFGMED	1	0.000376	0.00201946	0.186	0.8526
PORIMED	1	0.001054	0.00212259	0.497	0.6198
PINFMED	1	-0.000665	0.00198462	-0.335	0.7379
BHAVMED	1	-0.000723	0.00252362	-0.287	0.7746
PERSMED	1	-0.005498	0.00246467	-2.231	0.0265
COMPMED	1	0.003503	0.00249801	1.402	0.1619
FINAMED	1	0.004128	0.00219723	1.879	0.0613
MALEDENT	1	0.003763	0.00270369	1.392	0.1651
DAGE1B	1	-0.000210	0.00347332	-0.060	0.9519
DAGE2B	1	0.005544	0.00279296	1.985	0.0481
DAGE3B	1	0.002398	0.00265009	0.905	0.3664
SOLO	1	-0.001238	0.00230382	-0.537	0.5915
CAPBIN	1	0.001701	0.00261427	0.651	0.5157
NDENTMED	1	0.001398	0.00257613	0.543	0.5879
WAITMED	1	0.001130	0.00207639	0.544	0.5866
FTEMED	1	-0.001329	0.00209453	-0.634	0.5264
PPYMED	1	-0.001369	0.00209657	-0.653	0.5142
PROPMED	1	-0.003371	0.00199324	-1.691	0.0919
PINSMED	1	-0.001748	0.00201754	-0.866	0.3870
PAGE2MED	1	0.000187	0.00208396	0.090	0.9287
PDTMED	1	-0.003325	0.00204110	-1.629	0.1044
PNEWMED	1	-0.000386	0.00209665	-0.184	0.8541
PDENTMED	1	0.001295	0.00206877	0.626	0.5318
IRSDMED	1	0.003633	0.00216860	1.675	0.0950

Model (10) General/miscellaneous services

Model: MODEL1
Dependent Variable: LGENM

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	26	0.14352	0.00552	1.387	0.1038
Error	288	1.14601	0.00398		
C Total	314	1.28953			

Root MSE	0.06308	R-square	0.1113
Dep Mean	-0.26704	Adj R-sq	0.0311
C.V.	-23.62209		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.217188	0.02206144	-9.845	0.0001
CLUST1	1	-0.005115	0.00917272	-0.558	0.5775
CLUST2	1	-0.000573	0.00920498	-0.062	0.9504
INFGMED	1	-0.009563	0.00757896	-1.262	0.2080
PORIMED	1	-0.004047	0.00796599	-0.508	0.6118
PINFMED	1	-0.004623	0.00744822	-0.621	0.5353
BHAVMED	1	0.016030	0.00947106	1.693	0.0916
PERSMED	1	-0.009334	0.00924981	-1.009	0.3138
COMPMED	1	-0.006314	0.00937493	-0.673	0.5012
FINAMED	1	-0.010127	0.00824610	-1.228	0.2204
MALEDENT	1	0.007020	0.01014683	0.692	0.4896
DAGE1B	1	-0.018359	0.01303521	-1.408	0.1601
DAGE2B	1	-0.019322	0.01048187	-1.843	0.0663
DAGE3B	1	-0.011958	0.00994567	-1.202	0.2302
SOLO	1	-0.012778	0.00864615	-1.478	0.1405
CAPBIN	1	-0.008190	0.00981124	-0.835	0.4045
NDENTMED	1	0.009745	0.00966810	1.008	0.3143
WAITMED	1	-0.013077	0.00779260	-1.678	0.0944
FTEMED	1	-0.023899	0.00786067	-3.040	0.0026
PPYMED	1	0.010141	0.00786834	1.289	0.1985
PROPMED	1	0.001204	0.00748056	0.161	0.8722
PINSMED	1	-0.007320	0.00757174	-0.967	0.3345
PAGE2MED	1	-0.000085087	0.00782103	-0.011	0.9913
PDTMED	1	0.003638	0.00766018	0.475	0.6352
PNEWMED	1	0.000738	0.00786865	0.094	0.9254
PDENTMED	1	0.005693	0.00776402	0.733	0.4640
IRSDMED	1	-0.015850	0.00813865	-1.948	0.0524

Model (11) Total services per visit

Model: MODEL1
Dependent Variable: LTOTP

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	26	0.47373	0.01822	1.829	0.0096
Error	288	2.86906	0.00996		
C Total	314	3.34279			

Root MSE	0.09981	R-square	0.1417
Dep Mean	0.41710	Adj R-sq	0.0642
C.V.	23.92925		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.349771	0.03490672	10.020	0.0001
CLUST1	1	0.013221	0.01451354	0.911	0.3631
CLUST2	1	0.012361	0.01456458	0.849	0.3968
INFGMED	1	-0.012811	0.01199181	-1.068	0.2863
PORIMED	1	0.023232	0.01260418	1.843	0.0663
PINFMED	1	0.019685	0.01178494	1.670	0.0959
BHAVMED	1	0.021408	0.01498558	1.429	0.1542
PERSMED	1	0.012670	0.01463551	0.866	0.3874
COMPMED	1	-0.011894	0.01483348	-0.802	0.4233
FINAMED	1	-0.005609	0.01304739	-0.430	0.6676
MALEDENT	1	-0.006521	0.01605482	-0.406	0.6849
DAGE1B	1	0.040912	0.02062496	1.984	0.0482
DAGE2B	1	0.035943	0.01658495	2.167	0.0310
DAGE3B	1	0.036880	0.01573654	2.344	0.0198
SOLO	1	-0.007440	0.01368037	-0.544	0.5870
CAPBIN	1	0.012838	0.01552383	0.827	0.4089
NDENTMED	1	-0.003007	0.01529735	-0.197	0.8443
WAITMED	1	0.013212	0.01232984	1.072	0.2848
FTEMED	1	-0.023675	0.01243755	-1.904	0.0580
PPYMED	1	0.015467	0.01244967	1.242	0.2151
PROPMED	1	-0.018395	0.01183611	-1.554	0.1213
PINSMED	1	0.024695	0.01198038	2.061	0.0402
PAGE2MED	1	-0.000994	0.01237483	-0.080	0.9361
PDTMED	1	0.002164	0.01212031	0.179	0.8584
PNEWMED	1	0.015439	0.01245017	1.240	0.2160
PDENTMED	1	0.010289	0.01228463	0.838	0.4030
IRSDMED	1	-0.022476	0.01287738	-1.745	0.0820

8. Bibliography

Albrecht GL (1977) The negotiated diagnosis and treatment of occlusal problems. *Soc Sci Med* 11:277-83.

Armstrong RL (1987) The midpoint on a five-point Likert scale. *Percept Mot Skills* 64:359-62.

Ashford JR (1978) Regional variations in dental care in England and Wales. *Br Dent J* 145:275-83.

Ashford J, Cole P (1981) Aspects of general dental practice in the National Health Service. *J Dent* 9:1-15.

Atchison KA, Schoen MH (1990) A comparison of quality in a dual-choice dental plan: capitation versus fee-for-service. *J Public Health Dent* 50:186-93.

Australian Bureau of Statistics (1980) *Dental health (persons aged 15 years or more) February - May 1979*. Canberra: ABS; Catalogue No. 4339.0.

Australian Bureau of Statistics (1993a) *Information paper. 1991 Census. Socio-economic indexes for small areas*. Canberra: ABS; Catalogue No. 2912.0.

Australian Bureau of Statistics (1993b) *An introduction to sample surveys. A user's guide.* Canberra: Commonwealth Government Printer; Catalogue No. 1202.2.

Australian Dental Association (1992) *Schedule of Dental Services.* Supplement to ADA News Bulletin, November, 1992.

Australian Dental Association (1996) *An Australian Schedule of Dental Services and Glossary. Fifth edition 1996.* St Leonards, NSW: Australian Dental Association.

Australian Institute of Health and Welfare (1994) *Australia's health 1994: the fourth biennial health report of the Australian Institute of Health and Welfare*. Canberra: AGPS.

Australian Institute of Health and Welfare (1996) *Australia's health 1996: the fifth biennial report of the Australian Institute of Health and Welfare*. Canberra: AGPS.

Australian Institute of Health and Welfare (1999) *Health expenditure bulletin no. 15: Australia's health services expenditure to 1997-98*. Canberra: AIHW.

Australian Institute of Health and Welfare - Dental Statistics and Research Unit (1996) *Newsletter August 1996, Volume VII, Number 1*. Adelaide: AIHW DSRU.

Australian Institute of Health and Welfare - Dental Statistics and Research Unit (1998) *Newsletter September 1998, Volume IX, Number 1*. Adelaide: AIHW DSRU.

Bader JD (1992a) The emergence of appropriateness-of-care issues. *J Dent Res* 71:502-4.

Bader JD (1992b) Health services research in dental public health. *J Pub Health Dent* 52:23-6.

Bader JD, Kaplan AL (1983) Treatment distributions in dental practice. *J Dent Educ* 47:142-8.

Bader JD, Shugars DA (1992) Understanding dentists' restorative treatment decisions. *J Pub Health Dent* 52:102-10.

Bader JD, Shugars DA (1993) Agreement among dentists' recommendations for restorative treatment. *J Dent Res* 72:891-6.

Bader JD, Shugars DA (1995a) Variation in dentists' clinical decisions. *J Pub Health Dent* 55:181-8.

Bader JD, Shugars DA (1995b) Variation, treatment outcomes, and practice guidelines in dental practice. *J Dent Educ* 59:61-95.

Bader JD, Shugars DA (1997) What do we know about how dentists make caries-related treatment decisions? *Community Dent Oral Epidemiol* 25:97-103.

Bader JD, Shugars DA, Roberson TM (1996) Using crowns to prevent tooth fracture. *Community Dent Oral Epidemiol* 24:47-51.

Bader JD, Shugars DA, Rozier RG (1993) Relationship between epidemiologic coronal caries assessments and practitioners' treatment recommendations in adults. *Community Dent Oral Epidemiol* 21:96-101.

Bailit HL, Chiriboga D, Grasso J, Willemain TR, Damuth L (1979) A new intermediate dental outcome measure: amalgam replacement rate. *Med Care* 17:780-6.

Bailit H, Newhouse J, Brook R, Duan N, Goldberg G, Hanley J, Kamberg C, Spolsky V, Black A, Lohr K (1985) Does more generous dental insurance coverage improve oral health? *J Am Dent Assoc* 110:701-7.

Bailit H, Clive J (1981) The development of dental practice profiles. *Med Care* 19:30-46.

Barnard PD (1993) *National Oral health Survey of Australia 1987-88*. Canberra: AGPS.

Bennett S, Woods T, Liyanage WM, Smith DL (1991) A simplified general method for cluster-sample surveys of health in developing countries. *World Health Stat Q* 44:98-106.

Bensing JM, Van den Brink-Muinen A, De Bakker DH (1993) Gender differences in practice style: a Dutch study of general practitioners. *Med Care* 31:219-29.

Berge TI (1993) General practitioners' and dental students' decisions on third-molar diagnoses, treatment, and referrals. *Acta Odont Scand* 51:171-81.

Boyle C (1986) The career pattern of Scottish female dental graduates from 1974 to 1983. *Br Dent J* 160:138-9.

Brennan DS (1996) Geographic location and the provision of dental services in Australia. *Aust Health Rev* 19:138-40.

Brennan DS (1997) *Dental service provision in private general practice: patterns and trends.* Adelaide: Master of Public Health thesis, Department of Public Health, The University of Adelaide.

Brennan DS, Carter KD, Stewart JF, Spencer AJ (1999) *Commonwealth Dental Health Program Evaluation Report 1994-1996.* Adelaide: The University of Adelaide.

Brennan DS, Spencer AJ (1999) Evaluation of service provision patterns during a public-funded dental program. *Aust NZ J Public Health* 23:140-6.

Brennan DS, Spencer AJ, Slade GD (1996) Provision of public dental services in urban, rural and remote locations. *Community Dent Health* 13:157-62.

Brennan DS, Spencer AJ, Slade GD (1997) Service provision among adult public dental service patients: baseline data from the Commonwealth Dental Health Program. *Aust NZ J Public Health* 21:40-4.

Brennan DS, Spencer AJ, Szuster FSP (1992) Differences in time devoted to practice by male and female dentists. *Br Dent J* 172:348-9.

Brennan DS, Spencer AJ, Szuster FSP (1994) Trends in work effort among private general practitioners. *Int Dent J* 44:223-9.

Brennan DS, Spencer AJ, Szuster FSP (1996a) Dentist service rates and distribution of practice styles over time. *Community Dent Oral Epidemiol* 24:145-51.

Brennan DS, Spencer AJ, Szuster FSP (1996b) Productivity among Australian private general dental practitioners across a ten year period. *Int Dent J* 46:139-45.

Brennan DS, Spencer AJ, Szuster FSP (1997) Insurance status and provision of dental services in Australian private general practice. *Community Dent Oral Epidemiol* 25:423-8.

Brennan DS, Spencer AJ, Szuster FSP (1998a) Rates of dental service provision between capital city and non-capital locations in Australian private general practice. *Aust J Rural Health* 6:12-7.

Brennan DS, Spencer AJ, Szuster FSP (1998b) Service provision trends between 1983-84 and 1993-94 in Australian private general practice. *Aust Dent J* 43:331-6.

Brennan DS, Spencer AJ, Szuster FSP (1999) Diagnosis and provision of services in private general practice. [abstract] *J Dent Res* 78:947.

Brennan DS, Stewart JF (1993) *Use of dental care.* Chapter 6, pp 37-42. In: Dental care for adults in Australia. Proceedings of a workshop. Adelaide: AIHW Dental Statistics and Research Unit.

Breslow NE, Day NE (1987) *Statistical methods in cancer research. Volume II. The design and analysis of cohort studies*. Lyon: IARC.

Brickley M, Kay E, Shepherd J (1995) Public health aspects of third molar surgery. The effect of surgeons' treatment thresholds on efficiency and effectiveness. *Community Dent Health* 12:70-6.

Britt H, Miles DA, Bridges-Webb C, Neary S, Charles J, Traynor V (1993) A comparison of country and metropolitan general practice. *Med J Aust* 159:s9-s64.

Brown LJ, Caldwell SB, Eklund SA (1995) How fee and insurance changes could affect dentistry: results from a microsimulation model. *J Am Dent Assoc* 126:449-59.

Brownlea AA, Taylor CM (1984) Australia's environment and its influences on health. *Soc Sci Med* 18:901-7.

Cabot LB (1990) Variability in complete denture assessment. *J Dent* 18:98-101.

Carter KD, Stewart JF, Davies MJ, Szuster FSP, Allister JH, Slade GD, Spencer AJ (1994) *National Dental Telephone Interview Survey 1994*. Adelaide: The University of Adelaide.

Chang L (1997) Dependability of anchoring labels of Likert-type scales. *Educ Psychol Meas* 57:800-8.

Charlesworth M (1982) *Science, non-science and pseudo-science*. Victoria: DUP.

Chassin MR, Brook RH, Park RE, Keesey J, Fink A, Kosecoff J, Kahn K, Merrick N, Soloman DH (1986) Variations in the use of medical and surgical services by the medicare population. *N Engl J Med* 314:285-90.

Child D (1978) *The essentials of factor analysis*. London: Holt, Rinehart and Winston.

Christensen GC (1986) Future of dental practice. *J Dent Educ* 50:114-8.

Clappison RA, Pressey WA, Freeman RC (1965) Relative value method of fee determination. *J Can Dent Assoc* 31:763-78.

Colton T. (1974) *Statistics in medicine*. Boston: Little, Brown and Company.

Conover WJ, Iman RL (1976) On some alternative procedures using ranks for the analysis of experimental designs. *Comm Statist - Theor Meth* A5:1349-68.

Conover WJ, Iman RL (1981) Rank transformations as a bridge between parametric and nonparametric statistics. *Amer Stat* 35:124-9.

Conrad DA, Milgrom P, Kiyak A (1984) Insurance plan effects on dental provider treatment patterns for elderly patients. An experimental economics approach. *Med Care* 22:430-46.

Council on Dental Health, Bureau of Economic Research and Statistics (1968) Study of relative values of dental services. *J Am Dent Assoc* 76:117-22.

Crowley S, Antioch K, Carter R, Waters AM, Conway L, Mathers C (1992) *The cost of diet-related disease in Australia*. Canberra: AIHW and NHMRC.

Davey Smith G, Bartley M, Blane D (1990) The Black Report on socioeconomic inequalities in health 10 years on. *Br Med J* 301:373-7.

Davies JA (1984) The relationship between change of dentist and treatment received in the General Dental Service. *Br Dent J* 157:322-4.

Davies AR, Ware JE, Jr. (1981) Measuring patient satisfaction with dental care *Soc Sci Med* 15A:751-60.

Davies MJ, Spencer AJ (1995) *The child dental health survey 1993*. AIHW Dental Statistics and Research series no. 7. Adelaide: The University of Adelaide.

Diehr P, Grembowski D (1990) A small area simulation approach to determining excess variation in dental procedure rates. *Am J Public Health* 80:1343-8.

Dillman DA (1978) *Mail and telephone surveys. The total design method.* New York: Wiley and sons.

Douglass CW (1988) Implications of demographic and dental disease changes for the financing of geriatric dental services. *Health Matrix* 6:113-8.

Douglass CW, Gammon MD (1985) The future need for dental treatment in Canada. *J Canad Dent Assoc* 51:583-90.

Drake CW, Maryniuk GA, Bentley C (1990) Reasons for restoration replacement: differences in practice patterns. *Quintessence Int* 21:125-30.

DuBois B, Burns JA (1975) An analysis of the meaning of the question mark response category in attitude scales. *Educ Psychol Meas* 35:869-84.

Eddie S, Davies JA (1984) The relationship between periodontal disease and its treatment in the General Dental Service in Scotland. *Br Dent J* 157:235-9.

Eisenberg JM (1985) Physician utilization. The state of research about physicians' practice patterns. *Med Care* 23:461-83.

Eklund SA, Pittman JL, Smith RC (1997) Trends in dental care among insured Americans: 1980 to 1995. *J Am Dent Assoc* 128:171-8.

Elderton RJ (1988) Changing scene in restorative dentistry. *Br Dent J* 165:263-4.

Elderton RJ, Dowell TB (1989) Decisions in forward-looking oral health care: summary statement. *Br Dent J* 166:467-9.

Elderton RJ, Eddie S (1983a) The changing pattern of treatment in the general dental service 1965-1981. Part 1 - general trends and non-restorative treatment. *Br Dent J* 155:387-9.

Elderton RJ, Eddie S (1983b) The changing pattern of treatment in the general dental service 1965-1981. Part 2 - restorative treatment and implications for the future. *Br Dent J* 155:421-3.

Elderton RJ, Nuttall NM (1983) Variation among dentists in planning treatment. *Br Dent J* 154:201-6.

Espelid I (1986) Radiographic diagnoses and treatment decisions on approximal caries. *Community Dent Oral Epidemiol* 14:265-70.

Espelid I, Tveit AB (1986) Diagnostic quality and observer variation in radiographic diagnoses of approximal caries. *Acta Odontol Scand* 44:39-46.

Espelid I, Tveit A, Haugejorden O, Riordan PJ (1985) Variation in radiographic interpretation and restorative treatment decisions on approximal caries among dentists in Norway. *Community Dent Oral Epidemiol* 13:26-9.

Feinstein JS (1993) The relationship between socioeconomic status and health: a review of the literature. *Millbank Q* 71:279-322.

Frazier PJ, Jenny J, Bagramian RA, Robinson E, Proshek JM (1977) Provider expectations and consumer perceptions of the importance and value of dental care. *Am J Pub Health* 67:37-43.

Glynn RJ, Buring JE (1996) Ways of measuring rates of recurrent events. *Br Med J* 312:364-6.

Gotowka TD, Clive J (1988) Small area variation in dental services utilization. *J Dent Educ* 52:658-9.

Greenwald NJ, O'Connell SM (1970) Comparison of dichotomous and Likert formats. *Psychol Rep* 27:481-2.

Grembowski D (1997) The role of health services research in the renaissance of the dental profession. *J Dent Educ* 61:10-5.

Grembowski D, Conrad D, Milgrom P (1985) Utilization of dental services in the United States and an insured population. *Am J Public Health* 75:87-9.

Grembowski D, Conrad D, Weaver M, Milgrom P (1988) The structure and function of dental-care markets. A review and agenda for research. *Med Care* 26:132-47.

Grembowski D, Fiset L, Milgrom P, Forrester K, Spadafora A (1997a) Factors influencing the appropriateness of restorative dental treatment: an epidemiologic perspective. *J Public Health Dent* 57:19-30.

Grembowski D, Fiset L, Milgrom P, Conrad D, Spadafora A (1997b) Does fluoridation reduce the use of dental services among adults? *Med Care* 35:454-71.

Grembowski D, Milgrom P, Fiset L (1988) Factors influencing dental decision making. *J Pub Health Dent* 48:159-67.

Grembowski D, Milgrom P, Fiset L (1989) Clinical decision making among dental students and general practitioners. *J Dent Educ* 53:189-92.

Grembowski D, Milgrom P, Fiset L (1990a) Variation in dentist service rates in a homogeneous patient population. *J Pub Health Dent* 50:235-43.

Grembowski D, Milgrom P, Fiset L (1990b) Factors influencing variation in dentist service rates. *J Pub Health Dent* 50:244-50.

Grembowski D, Milgrom P, Fiset L (1991) Dental decision making and variation in dentist service rates. *Soc Sci Med* 32:287-94.

Guy RF, Norvell M (1977) The neutral point on a Likert scale. *J Psychol* 95:199-204.

Hanes CM, Myers DR, Dushku JC (1992) The influence of practice type, region, and age on treatment recommendations for primary teeth. *Pediatr Dent* 14:240-5.

Hazelkorn HM (1985) A comparison of dental treatment plans under different reimbursement systems. *J Public Health Pol* June: 223-35.

Humphreys JS (1988) Social provision and service delivery: problems of equity, health and health care in rural Australia. *Geoforum* 19:323-38.

Iman RL, Conover WJ (1979) The use of the rank transform in regression. *Technometrics* 21:499-509.

Johnson RA, Wichern DW (1988) *Applied multivariate statistical analysis*. Second edition. Englewood Cliffs, NJ: Prentice-Hall.

Kay E, Nuttall N (1995a) Clinical decision making - an art or a science? Part I: An introduction. *Br Dent J* 178:76-8.

Kay E, Nuttall N (1995b) Clinical decision making - an art or a science? Part II: Making sense of treatment decisions. *Br Dent J* 178:113-6.

Kay E, Nuttall N (1995c) Clinical decision making - an art or a science? Part III: To treat or not to treat? *Br Dent J* 178:153-5.

Kay E, Nuttall N (1995d) Clinical decision making - an art or a science? Part V: Patient preferences and their influence on decision making. *Br Dent J* 178:229-33.

Kay EJ, Nuttall NM, Knill-Jones R (1992) Restorative treatment thresholds and agreement in treatment decision-making. *Community Dent Oral Epidemiol* 20:265-8.

Kent DL, Carter KD, Spencer AJ (1998) Service-mix provision by male and female dentists in Australia. [abstract] *J Dent Res* 77:1136.

Kerlinger FN (1986) *Foundations of behavioural research.* Third edition. Florida: Holt, Rinehart and Winston.

Konrad TR, DeFriese GH (1981) *The dental office practice productivity study: findings.* In: Bawden JW, DeFriese GH, eds. Planning for dental care on a statewide basis. Chapel Hill, NC: The Dental Foundation of North Carolina, 91-113.

Kovar MG, Jack S, Bloom B (1988) Dental care and dental health: NHIS. *Am J Public Health* 78:1496-7.

Kim J, Mueller CW (1978) *Factor analysis. Statistical methods and practical issues.* Sage university paper series on quantitative applications in the social sciences, 07-014. Beverly Hills and London: Sage publications.

Kleinbaum DG, Kupper LL, Muller KE, Nizam A (1998) *Applied regression analysis and other multivariable methods.* Third edition. CA: Brooks/Cole.

Knutsson K, Brehmer B, Lysell L, Rohlin M (1992a) General dental practitioners' evaluation of the need for extraction of asymptomatic mandibular third molars. *Community Dent Oral Epidemiol* 21:347-50.

Knutsson K, Brehmer B, Lysell L, Rohlin M (1992b) Asymptomatic mandibular third molars: oral surgeons' judgment of the need for extraction. *J Oral Maxillofac Surg* 50:329-33.

Korten AE, Jacomb PA, Jiao Z, Christensen H, Jorm AF, Henderson AS, Rodgers B (1998) Predictors of GP service use: a community survey of an elderly Australian sample. *Aust NZ J Public Health* 22:609-15.

Kress GC (1980) Toward a definition of the appropriateness of dental treatment. *Public Health Rep* 95:564-71.

Kroeze HJ, Plasschaert AJ, van 'tHof MA, Truin GJ (1990) Prevalence and need for replacement of amalgam and composite restorations in Dutch adults. *J Dent Res* 69:1270-4.

Kvist T, Reit C, Esposito M, Mileman P, Bianchi S, Pettersson K, Andersson C (1994) Prescribing endodontic retreatment: towards a theory of dentist behaviour. *Int Endod J* 27:285-90.

Lahti S, Tuutti H, Hausen H, Kaariainen R (1992) Dentist and patient opinions about the ideal dentist and patient. Developing a compact questionnaire. *Community Dent Oral Epidemiol* 20:229-34.

Lahti S, Tuutti H, Hausen H, Kaariainen R (1995) Comparison of ideal and actual behaviour of patients and dentists during dental treatment. *Community Dent Oral Epidemiol* 23:374-8.

Langlais RP, Skoczylas LJ, Prihoda TJ, Langland OE, Schiff T (1987) Interpretation of bitewing radiographs: application of the kappa statistic to determine rater agreements. *Oral Surg Oral Med Oral Pathol* 64:751-6.

Leeder S (1998) National health forum aims for best practice. *In touch - Newsletter of the Public Health Association of Australia.* 15:3.

Legge D (1999) The evaluation of health development: the next methodological frontier? *Aust NZ J Public Health* 23:117-8.

Locker D (1993) Measuring social inequality in dental health services research: individual, household and area-based measures. *Community Dent Health* 10:139-50.

Locker D, Ford J (1994) Evaluation of an area-based measure as an indicator of inequalities in oral health. *Community Dent Oral Epidemiol* 22:80-5.

Locker D, Leake JL (1993) Inequities in health: dental insurance coverage and use of dental services among older Ontario adults. *Can J Public Health* 84:139-40.

Mackie IC, Lennon MA (1984) The relative values of preventive items in a resource related index. *Community Dent Health* 1:213-9.

Magee B (1973) *Popper*. London: Fontana.

Manning WG, Bailit HL, Benjamin B, Newhouse JP (1985) The demand for dental care: evidence from a randomized trial in health insurance. *J Am Dent Assoc* 110:895-902.

Marcus M, Koch AL, Schoen MH, Tuominen R (1990) A proposed new system for valuing dental procedures. *Med Care* 28:943-51.

Marmot MG, Kogevinas M, Elston MA (1987) Social/economic status and disease. *Annu Rev Public Health* 8:11-35.

Martens LV, Born DO, Meskin LH, Gambucci JR (1987) Practice profiles of younger and older dentists. *Gerodontics* 3:70-3.

Martin JA, Bader JD (1997) Five-year treatment outcomes for teeth with large amalgams and crowns. *Oper Dent* 22:72-8.

Martin P, Bateson P (1986) *Measuring behaviour. An introductory guide.* Cambridge: Cambridge University Press.

Maryniuk GA (1990) Practice variation: learned and socio-economic factors. *Adv Dent Res* 4:19-24.

Maryniuk GA, Kaplan SH (1986) Longevity of restorations: survey results of dentists' estimates and attitudes. *J Am Dent Assoc* 112:39-45.

Matell MS, Jacoby J (1971) Is there a an optimal number of alternatives for Likert-scale items? I. Reliability and validity. *Educ Psychol Meas* 31:657-74.

McEwen EM, Seward MH (1988a) The contribution of women to dentistry in the 1980s. *Br Dent J* 165:339-41.

McEwen EM, Seward MH (1988b) Women dentists at work. *Br Dent J* 165:380-2.

Mechanic D (1979) Correlates of physician utilization: why do some major multivariate studies of physician utilization find trivial psychosocial and organizational effects? *J Health Soc Behav* 20:387-96.

Medawar PB (1979) *Advice to a young scientist*. London: Harper and Row.

Medawar PB (1982) *Pluto's republic*. Oxford: OUP.

Mileman PA, Espelid I (1988) Decisions on restorative treatment and recall intervals based on bitewing radiographs. A comparison between national surveys of Dutch and Norwegian practitioners. *Community Dent Health* 5:273-84.

Mileman P, Purdell-Lewis D, Van der Weele L (1982) Variation in radiographic caries diagnosis and treatment decisions among university teachers. *Community Dent Oral Epidemiol* 10:329-34.

Mileman P, Van der Weele L, Van de Poel F, Purdell-Lewis D (1988) Dutch dentists' decisions to take bitewing radiographs. *Community Dent Oral Epidemiol* 16:368-73.

Milgrom P, Kiyak HA, Conrad D, Weinstein P, Ratener P (1981) A study of treatment planning: periodontal services for the elderly. *J Dent Educ* 45:522-8.

Milgrom P, Ratener P, Weinstein P (1983) Evidence of the validity of a model of determinants of quality of restorative dental care. *Community Dent Oral Epidemiol* 11:33-9.

Miller ME, Holahan J, Welch WP (1995) Geographic variations in physician service utilization. *Med Care Res Rev* 52:252-78.

Mueller CD, Monheit AC (1988) Insurance coverage and the demand for dental care. Results for non-aged whites. *J Health Economics* 7:59-72.

Nash KD, Bentley JE (1991) Is restorative dentistry on its way out? *J Am Dent Assoc* 122:79-80.

National Health and Medical Research Council Expert Advisory Panel (1993) *The impact of change in oral health status on dental education, workforce, practices and services in Australia.* Canberra: NHMRC.

National Health Strategy (1992) *Improving dental health in Australia. Background paper no. 9.* Canberra: Department of Health, Housing and Community Services.

Noar SJ, Smith BG (1990) Diagnosis of caries and treatment decisions in approximal surfaces of posterior teeth in vitro. *J Oral Rehabil* 17:209-18.

Nuttall NM (1984) General Dental Service treatment received by frequent and infrequent attenders in Scotland. *Br Dent J* 156:363-6.

Nuttall NM, Pitts NB (1990) Restorative treatment thresholds reported to be used by dentists in Scotland. *Br Dent J* 169:119-26.

O'Shea RM, Corah NL, Ayer WA (1983) Dentists' perceptions of the 'good' adult patient: an exploratory study. *J Am Dent Assoc* 106:813-6.

Pack AR, Lala JA, Sue MP, Taylor KM, Wadsworth LM (1987) Professional and family commitments of women dentists in New Zealand. *NZ Dent J* 83:94-7.

Pilot T (1988) Issues for the dental profession: manpower and education. *NZ Dent J* 84:46-51.

Pippin DJ, Feil P (1992) Interrater agreement on subgingival calculus detection following scaling. *J Dent Educ* 56:322-6.

Pitts NB (1997) Diagnostic tools and measurements - impact on appropriate care. *Community Dent Oral Epidemiol* 25:24-35.

Price SS (1990) A profile of women dentists. *J Am Dent Assoc* 120:403-7.

Redford M, Gift HC (1997) Dentist-patient interactions in treatment decision-making: a qualitative study. *J Dent Educ* 61:16-21.

Reinhardt JW, Douglass CW (1989) The need for operative dentistry services: projecting the effects of changing disease patterns. *Oper Dent* 14:114-20.

Roberts-Thomson K, Brennan DS, Spencer AJ (1995) Social inequality in the use and comprehensiveness of dental services. *Aust NZ J Public Health* 19:80-5.

Rocky BN (1988) Practice profiling. *J Can Dent Assoc* 54:817-9.

Romesburg HC (1984) *Cluster analysis for researchers*. California: Lifetime Learning.

Roos NP, Roos LL (1981) High and low surgical rates: risk factors for area residents. *Am J Public Health* 71:591-600.

Roos NP, Roos LL (1982) Surgical rate variations: do they reflect the health or socioeconomic characteristics of the population? *Med Care* 20:945-58.

Rosier M (1998) An introduction to cluster sampling. *Australasian Epidemiologist* 5:8-11.

Rothman KJ (1986) *Modern epidemiology*. Boston: Little, Brown and Company.

Rouse RA, Hamilton MA (1991) Dentists evaluate their patients: an empirical investigation of preferences. *J Behav Med* 14:637-48.

Rytomaa I, Jarvinen V, Jarvinen J (1979) Variation in caries recording and restorative treatment plan among university teachers. *Community Dent Oral Epidemiol* 7:335-9.

Sahai H, Khurshid A (1996) *Statistics in epidemiology. Methods, techniques, and applications*. Boca Raton: CRC Press.

Salant P, Dillman DA (1994) *How to conduct your own survey*. New York: Wiley and sons.

SAS Institute (1988) *SAS/STAT user's guide. Version 6.03*. Cary, NC: SAS Institute.

SAS Institute (1990) *CALIS and LOGISTIC procedures. Version 6.04*. Cary, NC: SAS Institute.

Schwarz E (1989) Dental treatment provided to young adult Danes enroled in alternative dental treatment programs during a 3-year period. *Acta Odontol Scand* 47:159-65.

Selvin S (1996) *Statistical analysis of epidemiologic data*. Second edition. Oxford: Oxford University Press.

Seward MH, McEwen EM (1987) The provision of dental care by women dentists in England and Wales in 1985: a ten year review. *Br Dent J* 162:50-1.

Siegel S, Castellan NJ (1988) *Nonparametric statistics for the behavioural sciences.* Second edition. New York: Mc Graw -Hill.

Short R, Horn J (1984) Some notes on factor analysis of behavioural data. *Behaviour* 90:203-14.

Shugars DA, Bader JD (1995) Practice parameters in dentistry: where do we stand? *J Am Dent Assoc* 126:1134-38,40-3.

Shugars DA, Bader JD (1996) Cost implications of differences in dentists' restorative treatment decisions. *J Public Health Dent* 56:219-22.

Shugars DA, Hayden WJ Jr, Crall JJ, Scurria MS (1997) Variation in the use of crowns and their alternatives. *J Dent Educ* 61:22-8.

Sivaneswaran S, Allister JH, Barnard PD (1994) Dental insurance and utilisation of dental services by Australians 35-44 years, 1987-88. [abstract] *J Dent Res* 73:741.

Sivaneswaran S, Allister JH, Barnard PD (1995) Utilisation pattern and oral health of insured and non-insured elderly. [abstract] *J Dent Res* 74:520.

Smeeton NC (1986) Distribution of episodes of mental illness in general practice: results from the Second National Morbidity Survey. *J Epidemiol Community Health* 40:130-3.

Smits HL (1986) Medical practice variations revisited. *Health affairs* Fall:91-6.

Sondell K, Soderfeldt B (1997) Dentist-patient communication: a review of relevant models. *Acta Odontol Scand* 55:116-26.

Spencer AJ (1993) *Introduction.* Chapter 1, pp 1-3. In: Dental care for adults in Australia. Proceedings of a workshop. Adelaide: AIHW Dental Statistics and Research Unit.

Spencer AJ, Brennan DS, Szuster FSP (1994a) Changing provision of restorative services in Australia. *J Dent* 22:136-40.

Spencer AJ, Brennan DS, Szuster FSP (1994b) Trends in work effort among private general dental practitioners. *Int Dent J* 44:223-9.

Spencer AJ, Lewis JM (1988a) The delivery of dental services: information, issues and directions. *Comm Health Stud* XII: 16-30.

Spencer AJ, Lewis JM (1988b) The practice of dentistry by male and female dentists. *Community Dent Oral Epidemiol* 16:202-7.

Spencer AJ, Lewis JM (1989a) Service-mix in general dental practice in Australia. *Aust Dent J* 34:69-74.

Spencer AJ, Lewis JM (1989b) The provision of periodontal services in general dental practice in Australia. *Community Dent Health* 6:337-47.

Spencer AJ, Slade GD, Davies MJ, Brennan DS (1994) Caries prevalence in Australasia. *Int Dent J* 44:415-23.

Spencer AJ, Szuster FSP, Brennan DS (1994) Service-mix provided to patients in Australian private practice. *Aust Dent J* 39:316-20.

SPSS Inc. (1988) *SPSS^x user's guide*. Chicago: SPSS Inc.

Stewart JF, Carter KD, Brennan DS (1998) *Adult access to dental care - rural and remote dwellers*. AIHW Dental statistics and research series no. 17. Adelaide: The University of Adelaide.

Streiner DL, Norman GR (1995) *Health measurement scales. A practical guide to their development and use*. Second edition. Oxford: Oxford University Press.

Szuster FSP (1993) *Availability of dental services*. In: Dental care for adults in Australia: proceedings of a workshop. Adelaide: AIHW Dental statistics and research unit, 31-6.

Szuster FSP, Spencer AJ (1997) *Dental practitioner statistics, Australia, 1994*. AIHW dental statistics and research series no. 11. Adelaide: The University of Adelaide.

Tveit AB, Espelid I (1992) Class II amalgams: interobserver variations in replacement decisions and diagnosis of caries and crevices. *Int Dent J* 42:12-8.

Vehkalahati M, Helminen S (1994) Outcome of public oral health services in relation to treatment mix. *Acta Odontol Scand* 52:1-6.

Von Korff MR, Howard JA, Truelove EL, Sommers E, Wagner EH, Dworkin S (1988) Temporomandibular disorders. Variation in clinical practice. *Med Care* 26:307-14.

Weinstein P, Milgrom P, Ratener P, Read W, Morrison K (1978) Dentists' perceptions of their patients: relation to quality of care. *J Public Health Dent* 38:10-21.

Weinstein P, Milgrom P, Ratener P, Morrison K (1979) Patient dental values and their relationship to oral health status, dentist perceptions and quality of care. *Community Dent Oral Epidemiol* 7:121-7.

Weintraub JA, Burt BA (1985) Oral health status in the United States: tooth loss and edentulism. *J Dent Educ* 49:368-76.

Wennberg J (1986) Which rate is right? *N Engl J Med* 314:310-1.

Williams SJ, Calnan M (1991) Convergence and divergence: assessing criteria of consumer satisfaction across general practice, dental and hospital care. *Soc Sci Med* 33:707-16.

Wills TA (1978) Perceptions of clients by professional helpers. *Psych Bull* 85:968-1000.

Wilson EO (1994) *Naturalist*. London: Penguin.

World Health Organisation (1990) *Educational imperatives for oral health personnel: change or decay?* Geneva: WHO Technical report series no. 794:18-25.