Influence of Patient, Visit, and Oral Health Factors on Dental Service Provision

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Abstract

Objectives: *Service provision should reflect the oral health of the patient. However, patient and visit factors may influence service patterns and the appropriateness of care delivered. The aim of this study was to examine factors associated with variation in dental services and to assess whether variation by patient and visit characteristics persisted after controlling for oral health status.* ***Methods:*** *A random sample of Australian dentists was surveyed during 1997–98 (response rate=60.3%). Private general practitioners (n=345) provided data on service provision, as well as patient, visit and oral health variables from a log of a typical clinical day (n=4,115 patients). Multivariate Poisson regression models were run for eight service areas (e.g., diagnostic, preventive, and restorative).* ***Results:*** *Significant effects (P<.05) were observed for oral health factors in all eight models, visit factors in all eight models, patient demographics in four models, dental knowledge/behavior in one model, and area-based socioeconomic status in one model.* ***Conclusions:*** *After controlling for oral health, visit characteristics persisted as significant predictors of services, with nonemergency visits, insurance, and capital city location associated with more favorable service mix patterns. Higher socioeconomic status areas and payment scale ratings also were associated with a better service pattern in particular service areas. These findings show that a wide range of factors, in addition to oral health, contribute to variation in service provision. [J Public Health Dent 2002;62(3):148-57]*

Key Words: patients, oral health, dental health services, dental general practice.

The issue of variation in service provision has been noted for both medical and dental procedures (1-3), raising concerns about appropriateness of care (4). A range of investigations have attempted to explain this variation, with service patterns being related to a range of patient and visit factors. Some patient factors that have been related to service patterns include patient demographics such as age and sex (2,5,6). Visit factors related to service patterns include insurance status, reason for visit, and geographic location. Insurance coverage has been positively associated with use and mix of services and oral health (7-9). Service patterns also have been associated with reason for visit (i.e., emergency visits, defined as relief of pain, vs nonemergency visits), with a less favorable service mix for emergency visits after controlling for insurance status (10). Geographic location also has been associated with service patterns, with more favorable service patterns within urban compared to rural locations (11,12).

Variation in service rates may be acceptable under some circumstances, such as underlying differences in the health status of populations (13). In dentistry, there have been attempts to control for health status by employing homogeneous patient populations (14,15) or using diagnosis of main condition (16). These attempts to control for oral health status represent an indirect form of control, which rests on assumptions that homogeneity of some patient characteristics is reflected in health status and that a similar diagnosis provides adequate control for health status. Other analyses have included health status in simulations of treatment planning such as role playing using actors as patients (17) and interpretation of radiographs (18), or have studied oral health status as an outcome of the service provision process (7,19). A study of factors influencing the appropriateness of restorative dental treatment that did include oral health factors found that clinical and perceived oral health status were important explanatory variables (20). Probability of overtreatment was higher for adults who had more fillings at baseline, while adults' probability of undertreatment was higher if they had fewer decayed or more missing tooth surfaces at baseline. Another study looking at the quality of restorative care found that patients with better oral health received better care (21). However, in general, there has been a paucity of studies assessing 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 providing dental services, the lack of control for oral health status represents a major weakness in studies of variation in dental service rates. The need to control for oral health status has been recognized (15), with calls for further studies that include measures of oral health status to address the issue of the extent to which unexplained variation in rates of service provision reflects differences in oral health. To enhance the comprehensiveness of service provision models, other factors in addition to patient, visit, and oral health factors—such as measures of dental knowledge/behavior and socioeconomic status (SES)—are also de-

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sirable. This paper addresses the issue of explaining variation in service rates by constructing service models incorporating a range of patient, visit, oral health, dental knowledge/behavior, and SES factors as independent variables. The specific aim of this study was to examine factors associated with variation in dental service rates, with particular reference to the research problem of whether variation by patient and visit characteristics persists after controlling for the presenting oral health status.

Methods

Sample and Response. A random sample of 13.5 percent of dentists was drawn from the registers of each Australian state and territory, resulting in a total sample of 1,202 dentists. Data on service provision, patient and visit characteristics, and oral health status were collected by self-complete mailed questionnaire during the 1997–98 period (22). A total of 676 dentists responded to the survey, a response rate of 60.3 percent. Of these 676 dentists, a total of 552 were included in the analysis, with the remainder being excluded for reasons such as ill health or retirement. Of these 552 dentists, 451 were in general practice, with 418 in the private sector and 407 currently treating patients. Of the 407 private general practitioners currently treating patients, a total of 345 private general practitioners provided service log data from a typical clinical day. The characteristics of these dentists were compared with the 62 dentists who did not provide service logs to assess potential bias. The age distribution of the sample was not known because the age of each dentist was not listed on the published dental registers. However, the age and sex distribution of respondents were compared to national data reported on the population of registered dentists to assess potential bias.

Data Items. Services provided during a typical day were collected using a one-day log of services. Service items were recorded using the three-digit coding scheme from the Australian Dental Association's "Schedule of Dental Services" (23). Characteristics of patients treated during the one-day log (e.g., age, sex) and visit details (e.g., insurance status, visit type) were recorded at the time of service provision by the responding dentists. The number of patients sampled by each dentist varied according to their typical level of activity. The data reported here are restricted to private general practitioners. Dentists were free to choose which day to include in their service log. Only sampled dentists in a group practice provided data. Dentists were instructed to record services for each patient treated regardless of whether or how they were charged to the patient. Patients were not identified, but were expected to make a single visit over the one-day period of the log. Hence, the dental visit comprised the unit of analysis, with the number of services provided in each area of service being expressed as a rate per visit, and entered in statistical models as the number of services divided by the number of visits. The sample of visits included in the one-day log would include first, intermediate, and final visits. These were not differentiated in the analysis because they were sampled at random and hence would provide a representative cross-section of these visit types. Oral health variables were recorded to indicate the status of each patient at the beginning of the current visit. A rating of these patients in terms of dental knowledge and payment factors also was recorded using a five-point Likert scale of items related to patient dental values (24,25). Residential postal code was also recorded for each patient treated and used to link with an area-based indicator of SES derived from census data (26).

Data Analysis. Analysis involved examination of the distributions of dependent (i.e., service rates) and independent (i.e., patient, visit, and oral health) variables, testing of associations between dependent and independent variables, and construction of multivariate models. No adjustment was made for multiple comparisons in the bivariate analysis. This was not necessary, as all tests, both nonsignificant and significant, were presented (27). Indicator variables (coded as 1, reference as 0) were used for all independent variables, which were entered in multivariate Poisson regression models of service provision, with number of services in each main area of service divided by the number of patient visits as the dependent variable. Continuous independent variables were converted into dichotomous variables prior to coding as indicator variables. The median was used as a cutoff point for the area-based indicator of SES, while scores on the "strongly agree" side of the midpoint were used for the factor analysis-based scales of the dentist ratings of patients.

Models included main effects, but interaction terms were not included. Interactions are difficult to detect unless their effects are large and there are sufficient subjects to cover the wide range of categories of the joint distributions of the variables involved; hence, caution is advised in accepting and interpreting interactions (28). The analytic strategy of the paper was to build a comprehensive set of independent variables that could be compared across a range of service areas. The inclusion of interaction terms would have been unwieldy, especially in the absence of specific hypotheses regarding interaction. Nonsignificant terms were retained for comparability across the models, and their potential value in controlling for confounding (27). The design effect for clustering of patients within the primary sampling unit of dentists was calculated for each service area and used to weight the models to the size of the equivalent simple random sample (29).

Results

Sample Characteristics. There was a higher percentage of male (80.0%) than female dentists (20.0%), and the majority of responding 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%). The responding practitioners had a similar age distribution compared to the dentist population (30), with both distributions dominated by the 30–39 and 40–49 years age groups and male dentists having an older age distribution than female dentists. There were no significant differences between these dentists who supplied service data and responding dentists in the sample who did not provide service data by sex of dentist, age of dentist, practice type, geographic location, years since graduation, percent of time worked and number of other dentists in their main practice, practice activity measures (i.e., patients per hour, hours per

year worked, patients per year, and appointment time), and number of full-time equivalent support staff (i.e., chairside assistants, hygienists, managers, secretaries, other staff). The responding private general practitioners collected data from a total of 4,115 patients (number of patients seen per practitioner was: mean=11.9; SD=4.1).

Distributions of Independent Variables: Patient, Visit, and Oral Health Factors. Table 1 presents patient, visit, and oral health variables as column percentages. The highest percentage of patients was in the 25–44-year and 45–64-year age groups. The age distribution approximated the estimated resident population of Australia, with similar percentages of those aged 65 years and older (12.0% vs 12.2%), but higher percentages of 45–64-year-olds (30.6% vs 21.8%) and 25–44-year-olds (34.4% vs 30.9%) and lower percentages for those younger than 24 years of age (23.1% vs 35.2%), with the largest difference occurring among those younger than 5 years of age (0.9% vs 6.9%) (31). There were more female (54.8%) than male patients. The majority of visits were nonemergencies (78.2%), just over half the visits were by insured patients (52.2%), and there were high percentages of visits by previously treated patients (86.2%) and patients at capital city locations (70.5%). Among dentate adult patients, the majority had no dentures (78.3%) and had 21–32 teeth (81.7%); about half had one or more decayed teeth (52.3%). Fewer than half the patients had high knowledge scale ratings (40.0%), but the majority of patients had high payment scale ratings (59.6%). Approximately half the patients were in the lower SES area category (50.1%). Further analysis was restricted to dentate adult patients aged 18 years and older to avoid problems of overlap in care provided to children through private practice and school dental services.

Associations of Services with Patient, Visit, and Oral Health Factors. Table 2 shows the bivariate associations of services with patient, visit, and oral health factors. The total row shows that diagnostic and restorative services dominated the profile of service provided, with preventive services also being provided at a high rate. A large number of statistically significant associations were observed, with nine of the 12 independent variables being associated with four or more of the eight main areas of service. All independent variables were significantly associated with some service areas, ranging from three out of eight service areas for sex of patient, insurance status, and the payment scale, and up to seven out of eight service areas for visit type and number of decayed teeth.

Multivariate Models of Services by Patient, Visit, and Oral Health Factors. Table 3 shows the rate ratios from Poisson regression models of service rates by the set of patient, visit, and oral health factors. The number of statistically significant associations between the independent variables and the eight service areas was lower in the multivariate models compared to the bivariate analyses. In particular, the knowledge scale was not significant in any model, while the payment scale and SES index were each significant in only one model. However, the number of decayed teeth was significant in seven service area models and visit type was statistically significant in six service area models. Pseudo R^2-values ranged from 0.025 for the diagnostic services model to 0.203 for the extraction services model and 0.340 for the prosthodontic services model.

Discussion

Choice of treatment is described as an art with many factors involved (e.g., economic, psychological, physiological) and few objective rules guiding what is seen as professional judgment (32). The widespread variation in dental decision making arises from variation in identification of diagnosis and severity of the condition, decisions to treat, and selection of treatment, which is influenced by differences in dentists' beliefs or knowledge (3). Common factors that 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 (33).

Representativeness of Findings. The findings presented here are restricted to adults receiving treatment in the private sector. In Australia, the majority of dentists are in private practice and most adult patients receive their dental care in the private sector (30). Most private patients must pay for their dental care, either directly or through individually purchased private dental insurance (10). Coverage of private dental insurance in Austra-

TABLE 1
Distributions of Patient, Visit, and Oral Health Variables

Patient, Visit, Oral Health Variables	%
Age of patient (years)	
<18	15.7
18–24	7.4
25–44	34.4
45–64	30.6
≥65	12.0
Sex of patient	
Male	45.2
Female	54.8
Visit type	
Emergency	21.8
Nonemergency	78.2
Insurance status	
Insured	52.2
Uninsured	47.8
Patient status	
New	13.8
Previous	86.2
Location	
Capital city	70.5
Noncapital	29.5
Denture status*	
Present	21.7
Absent	78.3
Number of teeth*	
1–20	18.3
21–32	81.7
Decayed teeth*	
No decay	47.7
1+ decayed	52.3
Knowledge scale†	
Lower rating	60.1
Higher rating	40.0
Payment scale‡	
Lower rating	40.4
Higher rating	59.6
SEIFA Index ¶	
Higher SES	49.9
Lower SES	50.1

*Dentate, 18 years or older.
†Rating of dental knowledge and following instructions.
‡Rating of being willing and able to pay for care.
¶Area-based index of relative socioeconomic disadvantage linked to postal code.

lia was 40.4 percent during 1994, and was positively associated with income (34). It is likely that the results can be generalized to represent the Australian context, as they were from a national survey based on a random sample from a comprehensive sampling frame (i.e., all the state and territory dental registers) that achieved an acceptable response rate (35), was restricted to private general practitioners who comprise the majority of dentists in Australia, and was based on a sample of patients with an age distribution that approximated the estimated resident population of Australia. The use of service data from a self-selected typical day could potentially introduce bias if dentists selected a day to show their practice in the best light. This bias should be minimized in this study through the privacy and confidentiality provisions of the survey process. Furthermore, a report found there was no significant difference in service rates in all 10 main areas of service between data collected over a 10-day sampling period compared with estimates based on one typical day nominated from the 10-day sampling period by the responding dentists (36).

Associations with Service Provision. *Patient Demographics.* Patient age showed 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 toward 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 (37). Reductions in levels of tooth loss have been linked with increased treatment needs, especially in the elderly (38,39). Crown and bridge services similarly reflect a trend toward 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 years and 65 years or older over the period 1983 to 1994 (6), which point to a shift in treatment emphasis toward middle-aged and older adults.

TABLE 2
Bivariate Associations of Services per Visit by Patient, Visit, and Oral Health Variables: Dentate, Aged 18 Years and Older (Poisson Regression)
[cont. page 152]

	Diagnostic Mean (SE)	Preventive Mean (SE)	Restorative Mean (SE)	Crown & Bridge Mean (SE)
Patient age	*P*<.01	*P*<.01	*P*<.01	*P*<.01
18–24 years	0.85 (0.05)	0.47 (0.04)	0.39 (0.05)	0.01 (0.01)
25–44 years	0.69 (0.02)	0.38 (0.02)	0.66 (0.03)	0.08 (0.01)
45–64 years	0.61 (0.02)	0.31 (0.02)	0.64 (0.03)	0.14 (0.01)
65+ years	0.51 (0.03)	0.34 (0.03)	0.70 (0.06)	0.05 (0.01)
Patient sex			*P*<.01	
Male	0.67 (0.02)	0.35 (0.02)	0.69 (0.03)	0.09 (0.01)
Female	0.64 (0.02)	0.36 (0.02)	0.59 (0.02)	0.09 (0.01)
Visit type		*P*<.01	*P*<.01	*P*<.01
Emergency	0.70 (0.03)	0.09 (0.01)	0.53 (0.03)	0.03 (0.01)
Nonemergency	0.67 (0.02)	0.46 (0.02)	0.62 (0.02)	0.11 (0.01)
Insurance status		*P*<.01		*P*<.01
Insured	0.66 (0.02)	0.42 (0.02)	0.66 (0.03)	0.13 (0.01)
Uninsured	0.65 (0.02)	0.29 (0.02)	0.60 (0.02)	0.06 (0.01)
Patient status	*P*<.01		*P*<.01	*P*<.01
New	1.05 (0.05)	0.31 (0.03)	0.52 (0.05)	0.01 (0.01)
Previous	0.59 (0.01)	0.36 (0.01)	0.65 (0.02)	0.10 (0.01)
Location	*P*<.05	*P*<.01		*P*<.05
Capital city	0.67 (0.02)	0.39 (0.01)	0.63 (0.02)	0.10 (0.01)
Noncapital	0.60 (0.03)	0.27 (0.02)	0.66 (0.03)	0.07 (0.01)
Denture status	*P*<.01	*P*<.01	*P*<.01	
Present	0.47 (0.03)	0.24 (0.02)	0.53 (0.04)	0.10 (0.02)
Absent	0.70 (0.02)	0.39 (0.01)	0.66 (0.02)	0.09 (0.01)
Number of teeth	*P*<.01	*P*<.01	*P*<.05	
1–20	0.49 (0.03)	0.22 (0.02)	0.56 (0.05)	0.07 (0.02)
21–32	0.69 (0.02)	0.39 (0.01)	0.65 (0.02)	0.10 (0.01)
Decayed teeth	*P*<.05	*P*<.01	*P*<.01	*P*<.01
No decay	0.68 (0.02)	0.48 (0.02)	0.32 (0.02)	0.13 (0.01)
1+ decayed	0.61 (0.02)	0.23 (0.01)	0.92 (0.03)	0.06 (0.01)
Knowledge scale	*P*<.05	*P*<.01	*P*<.01	*P*<.01
Lower rating	0.68 (0.02)	0.31 (0.01)	0.67 (0.03)	0.06 (0.01)
Higher rating*	0.62 (0.02)	0.43 (0.02)	0.58 (0.03)	0.13 (0.01)
Payment scale		*P*<.01		*P*<.01
Lower rating	0.65 (0.02)	0.29 (0.02)	0.65 (0.03)	0.05 (0.01)
Higher rating†	0.66 (0.02)	0.41 (0.01)	0.61 (0.02)	0.12 (0.01)
SEIFA Index		*P*<.01		*P*<.01
Higher SES	0.67 (0.02)	0.41 (0.02)	0.64 (0.03)	0.11 (0.01)
Lower SES‡	0.64 (0.02)	0.30 (0.02)	0.63 (0.03)	0.08 (0.01)
Total	0.65 (0.01)	0.35 (0.01)	0.64 (0.02)	0.09 (0.01)

*Higher dental knowledge rating.
†Higher rating of willing and able to pay for care.
‡More disadvantaged postal code area.

Predicted international trends include an increased preventive orientation, decreased requirements for dentures, and shifts in restorative procedures such as more complex restorations of teeth in older persons (39-41). The higher provision of prosthodontic services observed among middle-

TABLE 2
Bivariate Associations of Services per Visit by Patient, Visit, and Oral Health Variables: Dentate, Aged 18 Years and Older (Poisson Regression)
[cont. from page 151]

	Endodontic Mean (SE)	Extraction Mean (SE)	General/ Misc. Mean (SE)	Prostho-dontic Mean (SE)
Patient age	*P*<.01			P<.01
18–24 years	0.14 (0.03)	0.09 (0.02)	0.04 (0.01)	0.03 (0.02)
25–44 years	0.15 (0.02)	0.09 (0.01)	0.06 (0.01)	0.04 (0.01)
45–64 years	0.12 (0.01)	0.08 (0.01)	0.05 (0.01)	0.14 (0.02)
65+ years	0.09 (0.02)	0.08 (0.02)	0.04 (0.01)	0.21 (0.03)
Patient sex	*P*<.05	*P*<.05		
Male	0.15 (0.01)	0.10 (0.01)	0.04 (0.01)	0.10 (0.01)
Female	0.12 (0.01)	0.07 (0.01)	0.06 (0.01)	0.10 (0.01)
Visit type	*P*<.01	*P*<.01	*P*<.01	*P*<.05
Emergency	0.25 (0.02)	0.25 (0.02)	0.10 (0.01)	0.08 (0.02)
Nonemergency	0.09 (0.01)	0.02 (0.004)	0.03 (0.004)	0.11 (0.01)
Insurance status		*P*<.01		
Insured	0.13 (0.01)	0.04 (0.01)	0.05 (0.01)	0.09 (0.02)
Uninsured	0.13 (0.01)	0.13 (0.01)	0.05 (0.01)	0.11 (0.01)
Patient status	*P*<.05	*P*<.01		P<.01
New	0.09 (0.02)	0.15 (0.02)	0.04 (0.01)	0.06 (0.01)
Previous	0.14 (0.01)	0.07 (0.01)	0.05 (0.005)	0.11 (0.01)
Location		P<.01		P<.01
Capital city	0.14 (0.01)	0.07 (0.01)	0.05 (0.01)	0.08 (0.01)
Noncapital	0.12 (0.02)	0.11 (0.02)	0.05 (0.01)	0.15 (0.03)
Denture status	*P*<.01			P<.01
Present	0.09 (0.01)	0.10 (0.01)	0.04 (0.01)	0.43 (0.04)
Absent	0.14 (0.01)	0.08 (0.01)	0.05 (0.01)	0.01 (0.005)
Number of teeth		P<.01		P<.01
1–20	0.11 (0.02)	0.15 (0.03)	0.03 (0.01)	0.40 (0.04)
21–32	0.14 (0.01)	0.07 (0.01)	0.05 (0.005)	0.03 (0.01)
Decayed teeth	*P*<.01	*P*<.01		P<.01
No decay	0.11 (0.01)	0.07 (0.01)	0.05 (0.01)	0.16 (0.02)
1+ decayed	0.15 (0.01)	0.10 (0.01)	0.05 (0.01)	0.05 (0.01)
Knowledge scale		P<.01		
Lower rating	0.14 (0.01)	0.11 (0.01)	0.05 (0.01)	0.10 (0.01)
Higher rating*	0.13 (0.01)	0.04 (0.01)	0.05 (0.01)	0.09 (0.02)
Payment scale		*P*<.01		
Lower rating	0.14 (0.02)	0.11 (0.01)	0.05 (0.01)	0.09 (0.01)
Higher rating†	0.12 (0.01)	0.06 (0.01)	0.05 (0.01)	0.10 (0.01)
SEIFA Index		*P*<.01		*P*<.01
Higher SES	0.14 (0.01)	0.05 (0.01)	0.05 (0.01)	0.07 (0.01)
Lower SES‡	0.13 (0.01)	0.12 (0.01)	0.05 (0.01)	0.13 (0.02)
Total	0.13 (0.01)	0.08 (0.01)	0.05 (0.03)	0.10 (0.01)

*Higher dental knowledge rating.
†Higher rating of willing and able to pay for care.
‡More disadvantaged postal code area.

aged adults seems counterintuitive, as denture services generally increase across older age groups parallel with edentulism (6). However, the service patterns reported reflect dentate patients and are controlled for the presence of an existing denture, as well as number of teeth, which could account for the pattern observed. Sex of the patient had weak associations with restorative and general/miscellaneous services. Other analyses of dental service patterns in Australia have detected differences by sex of patient; however, statistically significant differences have been few in number and less pronounced in size compared to those observed for age of patient (6).

Dental Knowledge and Behavior Ratings. Higher payment scale ratings were associated with higher provision of crown and bridge services. This is consistent with provision of a higher cost treatment alternative. Cost variation in treatment selection could reflect diagnostic criteria, risk assessment, interpretation of nonclinical patient factors and interactions between dentists and patients (42). The knowledge and payment ratings had a range of significant associations with service rates in bivariate analyses, but most of these effects were removed after controlling for factors such as visit type and oral health.

Visit Characteristics. Emergency visits had strong negative associations with preventive and crown and bridge services, and positive associations with extraction, endodontic, and general services. 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 (34). 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 fewer fillings than those not eligible for a health card. Insurance was associated with higher preventive and lower extraction rates. These patterns are consistent with more favorable service patterns for nonemergency visits and insured patients observed in Australian private general practice (10) and for nonemergency visits in the public sector (43).

While there is evidence of improvements in oral health as reflected in changes in service patterns over time within a population of insured patients (44), 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 (45). 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 United Kingdom 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 (46).

Other studies have also found that attendance patterns have an influence on treatment provided. A comparison of frequent and infrequent attenders found that frequent attenders received more restorations while infrequent attenders had more extractions (47). 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 (48). 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 (49). 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 (50), and oral health status (34), and this is reflected in more favorable patterns of dental service provision in terms of prevention and maintenance of a natural dentition (51). The more favorable urban dental service patterns have been observed for both private general practice (11) and the public sector (12), and have been correlated with disparities in the level of supply of practitioners (30). Similar trends have been noted in the United Kingdom with more emphasis on extraction in regions with lower rates of dentists to population (52).

Socioeconomic Status. Relationships between socioeconomic status and health have often involved consideration of mortality by factors such as occupation, income, ethnic group, and social class (53,54). Large differentials in mortality and morbidity have been observed and reported to be widening (55). Such socioeconomic differentials have been reported for dental care in Australia (56). For example, income, age of leaving school, and occupation have been associated with use of dental services, and occupation with receipt of extractions (57). In this study, there was 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 (34).

Summary of Service Provision Models. Oral health factors were significant in all eight models: presence of decayed teeth was associated with lower provision of diagnostic, preventive, crown and bridge, general/miscellaneous, and prosthodontic services and higher provision of restorative and endodontic services; lower numbers of teeth were associated with higher extraction and prosthodontic rates; presence of dentures was associated with lower provision of diagnostic, endodontic, and restorative services, but higher provision of prosthodontic services. The percentage of patients with decayed teeth, while being high among the patients sampled, was consistent with population-level oral health survey data for Australia, which showed that restoration of permanent teeth was indicated for 39 percent of persons aged 5 years and older, and extraction was indicated for 8 percent (58). Visit factors were significant in all eight models: emergency visits were associated with lower rates of preventive, restorative, and crown and bridge services, and higher rates of endodontic, extraction, and general/miscellaneous services; insurance was associated with higher rates of preventive services, and lower extraction rates; new patients had higher rates of diagnostic, but lower rates of restorative, crown and bridge, and endodontic services; capital city location was associated with a higher preventive rate and a lower prosthodontic rate. Patient demographic factors were significant in four models: the reference age of 65 years or older was associated with a higher restorative rate, and lower rates of crown and bridge, and prosthodontic services compared to younger age groups, while male patients had a higher rate of restorative services, but a lower rate of general/miscellaneous services. Dental knowledge/behavior factors were significant in one model: higher payment scale ratings were associated with a higher crown and bridge rate. Area-based SES factors were significant in one model: residence in lower SES areas was associated with a higher extraction rate.

Rate ratios in the range 0.0–0.3 or ≥2.6 indicate strong effects, 0.4–0.5 or 1.7–2.5 moderate effects, and 0.6–0.8 or 1.2–1.6 weak effects, while those in the region of 0.9–1.1 are considered as indicating no effect (59). Of the eight service provision models, weak effects were observed in seven models, moderate effects in six models, and strong effects in seven models. There was a distribution of weak, moderate, and strong effects across the models, with four of the eight models comprising a mixture of all three effect sizes. Among individual variables, visit type stood out as having predominantly strong effects. Payment and SES had moderate effects only. Geographic location had only weak effects. Pseudo R^2 values may range between 0 and 1, and are based on likelihood statistics from a model containing the independent variables versus a model containing a constant term only, rather than a comparison of fitted to observed values as obtained from linear regression models (60). Pseudo R^2 values were highest for the extraction and prosthodontic service models.

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, location, ability to pay, and SES status). Oral health and visit type may interact in the formulation of an ideal treatment plan. The age of the patient represents another major influence on the pattern of treatment plan proposed. 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

TABLE 3
Multivariate Poisson Regression Models of Services per Visit: Dentate, 18 Years and Older *[cont. page 155]*

	Diagnostic Rate Ratio (95% CI)	Preventive Rate Ratio (95% CI)	Restorative Rate Ratio (95% CI)	Crown & Bridge Rate Ratio (95% CI)
Patient age				
18–24 years	1.20 (0.88–1.63)	1.05 (0.71–1.56)	0.43 (0.30–0.60)¶	0.18 (0.02–2.08)
25–44 years	1.06 (0.82–1.36)	0.95 (0.69–1.30)	0.75 (0.61–0.93)¶	2.79 (1.23–6.32)§
45–64 years	1.05 (0.82–1.34)	0.80 (0.59–1.09)	0.89 (0.73–1.09)	4.36 (2.02–9.42)¶
65+ years	Reference	Reference	Reference	Reference
Patient sex				
Male	1.05 (0.91–1.20)	1.07 (0.88–1.28)	1.14 (1.003–1.29)§	0.93 (0.67–1.32)
Female	Reference	Reference	Reference	Reference
Visit type				
Emergency	1.00 (0.86–1.18)	0.22 (0.15–0.32)¶	0.77 (0.66–0.90)¶	0.24 (0.12–0.49)¶
Nonemergency	Reference	Reference	Reference	Reference
Insurance status				
Insured	1.11 (0.96–1.27)	1.27 (1.05–1.52)§	1.11 (0.98–1.27)	1.25 (0.87–1.80)
Uninsured	Reference	Reference	Reference	Reference
Patient status				
New	1.70 (1.43–2.03)¶	1.18 (0.87–1.59)	0.70 (0.57–0.86)¶	0.30 (0.11–0.86)§
Previous	Reference	Reference	Reference	Reference
Location				
Capital city	1.10 (0.93–1.30)	1.38 (1.07–1.77)¶	0.88 (0.75–1.02)	1.18 (0.76–1.82)
Noncapital	Reference	Reference	Reference	Reference
Denture status				
Present	0.75 (0.60–0.95)¶	0.74 (0.53–1.02)	0.78 (0.64–0.95)§	1.50 (0.94–2.38)
Absent	Reference	Reference	Reference	Reference
Number of teeth				
1–20	0.87 (0.68–1.13)	0.75 (0.52–1.09)	0.81 (0.65–1.01)	0.66 (0.37–1.17)
21–32	Reference	Reference	Reference	Reference
Decayed teeth				
No decay	Reference	Reference	Reference	Reference
1+ decayed	0.81 (0.71–0.94)¶	0.55 (0.45–0.67)¶	3.14 (2.70–3.64)¶	0.58 (0.41–0.84)¶
Knowledge scale				
Lower rating	Reference	Reference	Reference	Reference
Higher rating*	0.88 (0.76–1.03)	1.08 (0.89–1.32)	0.93 (0.81–1.07)	1.16 (0.81–1.66)
Payment scale				
Lower rating	Reference	Reference	Reference	Reference
Higher rating†	1.05 (0.90–1.21)	1.22 (0.99–1.50)	0.95 (0.83–1.09)	1.72 (1.14–2.59)¶
SEIFA Index				
Higher SES	Reference	Reference	Reference	Reference
Lower SES‡	1.01 (0.87–1.17)	0.90 (0.73–1.11)	0.92 (0.80–1.05)	0.96 (0.67–1.39)
Peudo R^2	0.025	0.106	0.092	0.118

*Higher dental knowledge rating.
†Higher rating of willing and able to pay for care.
‡More disadvantaged postal code area.
¶$P<.05$ Poisson regression.
§$P<.01$.

hygiene (61). 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 ability to pay and socioeconomic status. Variability between treatment planned for similar conditions may be acceptable, providing there is a rational basis for the choices that have been made (62). 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 (63). Other potential sources of influence in this process in-

TABLE 3
Multivariate Poisson Regression Models of Services per Visit: Dentate, 18 Years and Older *[cont. from page 154]*

	Endodontic Rate Ratio (95% CI)	Extraction Rate Ratio (95% CI)	General/Misc. Rate Ratio (95% CI)	Prosthodontic Rate Ratio (95% CI)
Patient age				
18–24 years	1.49 (0.76–2.91)	1.22 (0.56–2.68)	0.52 (0.17–1.55)	1.15 (0.30–4.45)
25–44 years	1.51 (0.88–2.58)	1.29 (0.70–2.38)	0.87 (0.41–1.85)	2.22 (1.39–3.57)¶
45–64 years	1.26 (0.74–2.12)	0.94 (0.53–1.70)	0.59 (0.28–1.26)	1.34 (0.95–1.89)
65+ years	Reference	Reference	Reference	Reference
Patient sex				
Male	1.15 (0.88–1.50)	1.10 (0.79–1.54)	0.61 (0.38–0.98)§	0.90 (0.67–1.22)
Female	Reference	Reference	Reference	Reference
Visit type				
Emergency	2.81 (2.14–3.70)¶	7.42 (5.02–10.97)¶	3.41 (2.17–5.35)¶	0.83 (0.57–1.22)
Nonemergency	Reference	Reference	Reference	Reference
Insurance status				
Insured	1.10 (0.83–1.45)	0.50 (0.34–0.73)¶	0.96 (0.61–1.52)	0.91 (0.67–1.24)
Uninsured	Reference	Reference	Reference	Reference
Patient status				
New	0.47 (0.29–0.76)¶	1.20 (0.81–1.78)	0.65 (0.31–1.38)	0.87 (0.49–1.52)
Previous	Reference	Reference	Reference	Reference
Location				
Capital city	1.18 (0.84–1.66)	1.08 (0.74–1.57)	0.95 (0.54–1.66)	0.65 (0.46–0.91)
Noncapital	Reference	Reference	Reference	Reference
Denture status				
Present	0.57 (0.36–0.91)§	0.81 (0.48–1.36)	0.78 (0.37–1.65)	21.05 (11.97–37.02)¶
Absent	Reference	Reference	Reference	Reference
Number of teeth				
1–20	1.44 (0.90–2.30)	2.09 (1.25–3.52)¶	0.71 (0.30–1.68)	2.59 (1.75–3.81)¶
21–32	Reference	Reference	Reference	Reference
Decayed teeth				
No decay	Reference	Reference	Reference	Reference
1+ decayed	1.34 (1.003–1.78)§	1.11 (0.77–1.62)	0.62 (0.39–0.98)§	0.39 (0.28–0.55)¶
Knowledge scale				
Lower rating	Reference	Reference	Reference	Reference
Higher rating*	1.06 (0.79–1.43)	0.79 (0.52–1.20)	0.82 (0.51–1.33)	1.02 (0.88–1.68)
Payment scale				
Lower rating	Reference	Reference	Reference	Reference
Higher rating†	0.86 (0.65–1.15)	0.91 (0.64–1.30)	1.38 (0.85–2.25)	1.22 (0.88–1.68)
SEIFA Index				
Higher SES	Reference	Reference	Reference	Reference
Lower SES‡	0.92 (0.69–1.24)	1.82 (1.23–2.68)¶	0.77 (0.47–1.28)	1.24 (0.87–1.75)
Peudo R^2	0.057	0.203	0.065	0.340

*Higher dental knowledge rating.
†Higher rating of willing and able to pay for care.
‡More disadvantaged postal code area.
¶$P<.05$ Poisson regression.
§$P<.01$.

clude dentist and practice factors.

Sources of Variation in Service Rates. Variation in service rates has been related to practice characteristics, patient exposure to fluoridated water, and nonprice competition in the dental market (64). 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 nonprice and price competition in the marketplace (15). Fluoridation was associated with lower oral disease among insured adults; however, fluoridation

may or may not reduce use of restorative services, depending on clinical decisions of dentists (65). While clinical needs were the primary determinant of restorative demand, there was a market effect where overtreatment 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.

Caries-related treatment decisions have been described as a pattern-recognition process or nonanalytical processing using scripts based on summarized versions of the cumulative experience of a provider with similar clinical presentations (66). 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 (61). An episode of dental care is seen as a social process, a key element of which is the exchange relationship between patient and provider, which is structured by the environment and also the characteristics of patients and providers (67).

Conclusions

Factors such as visit characteristics were related to variation in service rates, controlling for oral health status. Nonemergency visits, insurance, and capital city location were associated with more favorable service patterns in terms of preventive orientation and retention of teeth. Higher SES areas and payment scale ratings also were associated with a better service pattern in terms of tooth retention in some service areas. However, dentist and practice characteristics may also influence variation in service rates. These findings contribute to a better understanding as they show that a wide range of factors, in addition to oral health, contribute to variation in service provision.

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