PERIODONTAL PRACTICE PATTERNS

A Thesis

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By

Janel Kimberlay Yu, D.D.S.

Graduate Program in Dentistry

The Ohio State University

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Dissertation Committee:

Dr. Angelo Mariotti, Advisor

Dr. Jed Jacobson

Dr. Eric Seiber
Abstract

Background: Differences in the rates of dental services between geographic regions are important since major discrepancies in practice patterns may suggest an absence of evidence-based clinical information leading to numerous treatment plans for similar dental problems and the misallocation of limited resources. Variations in dental care to patients may result from characteristics of the periodontist. Insurance claims data in this study were compared to the characteristics of periodontal providers to determine if variations in practice patterns exist.

Methods: Claims data, between 2000-2009 from Delta Dental of Ohio, Michigan, Indiana, New Mexico, and Tennessee, were examined to analyze the practice patterns of 351 periodontists. For each provider, the average number of select CDT periodontal codes (4000-4999), implants (6010), and extractions (7140) were calculated over two time periods in relation to provider variable, including state, urban versus rural area, gender, experience, location of training, and membership in organized dentistry. Descriptive statistics were performed to depict the data using measures of central tendency and measures of dispersion.
Results: Differences in periodontal procedures were present across states. Although the most common surgical procedure in the study period was osseous surgery, greater increases over time were observed in regenerative procedures (bone grafts, biologics, GTR) when compared to osseous surgery. There was also a 1.7 and 2.5 fold increase in implants and extractions, respectively. In the past five years, the greatest difference in total number of periodontal procedure codes (CDT codes 4000-4999) per provider between: a) states were 414%; b) urban and rural areas were 4%; c) educational backgrounds of providers were 189%; d) most and least experienced providers were 42%; e) men and women were 49%; and f) those who were and were not in organized dentistry were 62%. Furthermore, between many of the specific CDT codes, differences were observed when the characteristics of periodontal providers were considered.

Conclusions: There has been an evolution in treatment patterns that is dependent upon where periodontists work as well as their experience, educational background, gender, and participation in organized dentistry. If disease patterns are similar in patient populations, these data suggest that external influences may have a substantial impact on the treatment rendered to patients. Furthermore, if these practice patterns hold true in larger populations, it underscores the need for evidence-based practice guidelines and research to reduce variations in periodontal care and in so doing improve patient management.
Dedicated to my family, Joe, Josephine, and Janice
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Vita

2007 ...........................................D.D.S., University of Western Ontario

2007 to present ............................Graduate Teaching Associate,

Department of Periodontology, College

of Dentistry, The Ohio State University

Fields of Study

Major Field: Dentistry
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Chapter 1: Introduction

Periodontitis is a broad term that describes a number of pathological conditions of the supporting structures of the teeth.\(^1\) Diet, genetics, personal oral hygiene, social customs, group (public) preventive services, as well as personal dental preventive, diagnostic, and therapeutic services all influence the extent, severity and course of the disease.\(^2\) Most periodontal disease affects adults. According to the NHANES III study, it is estimated that about 35% of United States dentate adults aged 30 to 90 years have chronic periodontitis.\(^3\) When further classified, 21.8% representing 22.6 million persons, 9.5% representing 9.9 million persons, and 3.1% representing 3.2 million persons had slight, moderate, and severe forms of chronic periodontitis, respectively.\(^3\) Aggressive periodontitis tends to occur in a much younger age group, and prevalence ranges in the 11 to 25 year age group between 0.4% to 0.8% in North America.\(^4\)

Increasing age has been a risk indicator in the progression of periodontal disease. This is of significance as the “baby boom” generation, comprising approximately 77 million people or nearly a third of the US population, will be approaching retirement by age 2010. It is estimated by the year 2025 that there will be a projected 35% increase in the population aged 55 years and older with more of the population retaining more teeth and having more disease than in the past.

The impact of periodontal disease for a patient from a treatment standpoint is substantial. Periodontal disease can affect an individual's quality of life by means of
esthetics, sensitivity, pain, impaired function, and tooth loss. Although the majority (70%) of adults in the U.S. population have signs and symptoms of periodontal disease, only a small proportion currently receive treatment.¹

Access to health care services has been an ongoing issue. The greatest barriers to health care – including dental care – are experienced by minorities, the poor, the uninsured and those in relatively poor health.⁵ In 1994, Berk et al. reported that dentistry was the highest unmet health need, which represented over 21 million Americans or 8.5% of the population.⁶

Individuals lacking dental delivery systems may be compelled to seek care at physician offices, hospital emergency departments (EDs), or other ambulatory care settings. In 2001, it was estimated that more than one in five individuals (22.5%) who experienced a dental problem did not seek formal treatment for their condition.⁷ Approximately 3.1% of the US population experienced at least one dental problem outside the traditional office-based dental delivery system.⁷ Of those, approximately 2.7% received care in a hospital emergency room setting, while 7% received care in a medical setting. Dental emergency visits to physicians have been identified through the use of dental-related International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes. Gingival and periodontal diseases (523.0-523.9) accounted for 31.78% and 10.47% of all dental related emergency office-based claims by physicians and physician claims linked to ED claims, respectively (Table 1).⁸,⁹ Between 1997-2000, the national average of annual visits to emergency departments for complaints of tooth pain or tooth injury was 738,000.⁷ The number of missed days of
work as a result of acute dental conditions was estimated to be approximately 2,442,000 days according to the 1996 National Health Interview Survey.\textsuperscript{10}

Under-serviced areas are turning toward implementing alternative methods of care, including non-dentist providers. Alaska’s Dental Health Aide Therapist Initiative was designed to educate dental health aide therapists to provide dental care to Alaska natives in rural areas. The focus of the program is on prevention, pain and infection relief, and basic restorative services. In Minnesota, the Advanced Dental Hygiene Practitioner workforce model allows midlevel providers to perform surgical procedures including extractions and restorations without a supervising dentist.

Unmet needs have been attributed to financial reasons in at least half of reported cases.\textsuperscript{6} As health care expenses continue to escalate, people may be less willing or able to pay for services rendered; however, some people do pay for and receive dental care especially when they expect to derive a personal benefit from these payments. In cases where third parties are involved in financing the services, an even more complex relationship between consumer, provider, and insurer may influence utilization of dental services.\textsuperscript{11}

Dental care has three main sources of funding: public, private, and out-of-pocket expenditures. Public sources include Medicaid, Medicare, and other federal, state, and local government sources. Private insurance is generally considered to be a popular fringe benefit among many employees. Access to dental care remains largely through third party private coverage or out-of-pocket expenses by the patient. Almost two thirds of all Americans receive some assistance in paying for dental care through dental care coverage or dental insurance. In 1996, it was estimated that 51.4\% of all people had
private dental coverage, of which 56.6% reported at least one dental visit during that year. The mean total expenditure was substantially larger than for those without coverage ($417.20 vs. $298.70, p<0.05). In 1996, approximately 43% of all dental expenditures ($18 billion) were paid to dental providers from private insurance. By 2004, it was estimated that nearly 158 million individuals (54%) had some form of private dental coverage, while 12% of the community had public dental coverage. Another study estimated that $81.4 billion of dental services was attributed to private funding sources, while 6% or $5.2 billion came from a public fund (e.g. Medicaid, Medicare).

Dental insurance has been shown to be a determining factor in deciding to seek and use dental services. In 1989, 70% of people with dental insurance had at least one dental visit that year while only 50% of people without insurance had at least one visit during the same period. In 2004, 57% of the population with private coverage had a dental visit; 32% of the population with public dental coverage had a dental visit, and 27% of the population without any dental coverage had a visit; moreover, insurance coverage doubles the likelihood that one will obtain bridgework and increases by 38% the probability that a patient will receive a crown. Insurance coverage may increase the perceived price of care and consequently it is not surprising that patients with coverage might substitute higher-cost treatment options in place of lower-cost, and perhaps less-preferred alternatives. Other studies report that in an aging population, spending is higher among those without coverage and have an out-of-pocket expense than those who have dental insurance.
By way of public dental insurance, Medicaid provides a comprehensive child health program for individuals under 21 years. Furthermore, Medicaid has been used to study dental service utilization by children. Chi et al. examined preventative dental service utilization for Medicaid-enrolled children in New Hampshire and found that children were more likely to receive preventive services, such as fluoride treatment, at least two dental examinations, and sealants from a pediatric dentist than those seen by a general dentist. In Illinois, children enrolled in Medicaid or the Children’s Health Insurance Programs tended to have lower dental utilization rates in rural areas compared to urban regions, but after adjusting for dental supply and population factors, no significant relationship existed. Conversely, in Virginia, general, pediatric, and public health dentists in metropolitan and urban areas perform slightly more diagnostic services and fewer corrective services than practitioners in more rural areas.

Medicaid adult dental coverage has no minimal requirements and remains for the most part elective, state dependent, and discretionary. Historically, reimbursement for routine adult dental services was eliminated over 30 years ago. In 1993, Medicaid reimbursement to dentists for adult dental emergencies was eliminated, but physicians and hospital emergency departments continued to receive reimbursement for providing adult dental emergency care. Some states provide emergency dental services for adults, but less than half of the states provide comprehensive dental care. To date, there are no published studies looking at any trends in periodontics using Medicaid data.

Medicare is the nation’s largest health insurance program which provides health care coverage to over 40 million Americans who are aged 65 or older, some disabled people under age 65, and people of all ages with end-stage renal disease. Generally, any
dental treatment rendered for a Medicare enrollee is considered to be an out of pocket expense. Medicare covers neither routine dental care nor most dental procedures such as cleanings, restorations, extractions, or fabrication any prosthesis; however, certain dental services may be paid for when provided in hospital if an emergency or complex dental treatment is rendered even when dental care is not covered.

Utilization of dental services can be measured in terms of visits or amount of services received, usually within a specified time interval. In 1996, utilization rates for all forms of dental care in the United States were estimated to be approximately 44%. Sweet et al. compared Delta Dental of Iowa, a form of private insurance, and Medicaid claims data. These statewide insurance programs have overlapping but not consistent dental provider networks. In the fiscal year 1998, 69.3% of Delta Dental enrollees and 27.2% of Medicaid enrollees had a dental visit. The percentage of people in these populations who used dental services by major dental service categories is shown in Table 2. The percentage of Medicaid enrollees who received a periodontal service was about 10% higher than for Delta Dental enrollees (16.9 versus 6.2%). Nearly four times the proportion of Medicaid enrollees had a tooth extracted as compared with Delta Dental enrollees (27.4% versus 7.1%, respectively).

There is a increasing trend of expenditures toward dental care, with estimates of upwards of $101.2 billion being spent on personal dental services in 2008, compared to $13.3 billion in 1980. Expenditures can be measured in terms of the sum of charges, the sum of payments, or the sources of payments. Aggregate charges may be more accurate than a sum of payments to estimate the total resources used to provide all charges. The cost of dental services is increasing as a result of increasing production
costs and demand for services. In 1999, dental office revenues were estimated to exceed $56 billion and private dental benefit companies managed about 53% of these payments. Robertson et al. reported that approximately two-thirds of all dental costs were for examinations, radiographs, cleaning, fluoride/sealants, restorations, and single crowns. According to the American Dental Association (ADA) Survey of Dental Services Rendered in 1999, the total expenditure for periodontal and preventative procedures totaled $14.3 billion, with periodontal services alone accounting for $4.4 billion. Services varied from a preventative measure, such as prophylaxis and oral hygiene instruction, to periodontal procedures, including non-surgical therapy such as scaling and root planing, to surgical therapy, such as resective surgery, regenerative surgery, and soft tissue grafting.

In another report using claims data provided by the Washington Dental Service (WDS), a founding member of the national Delta Dental Plans Association, periodontal procedures (ADA procedure codes 4000-4999) totaled $32.7 million for the state of Washington and accounted for 6.4% of all dental expenditures for care supported through the WDS in 1999. Documented periodontal needs among the United States population are lacking; however, it has been estimated that overall, 3% of the adult US population require complex periodontal treatment, 90% needed scaling and prophylaxis, whereas nearly 5% do not need periodontal treatment or oral hygiene instruction.

Recent studies examining practice patterns in preventing and treating periodontitis are few, yet a thorough analysis would have considerable impact in assessing the delivery of oral health care.
**Geographic Location**

In the 2003 American Academy of Periodontology (AAP) practice profile survey\(^2^9\), periodontists were surveyed with regard to number of monthly procedures performed. The response rate was 30% (696 of 2,286). Many parameters including geographic location of the provider were examined (Table 3). Small variations were noted, but due to the small sample size, no statistical analysis was performed.

**Level of Training**

The two main providers of periodontal services are general practitioners and periodontists, but the distribution of services provided differs.\(^2\) In Washington State in 1999, general practitioners, periodontists, and other specialists performed 78.3%, 20.5%, and 1.2% of all periodontal procedures, respectively.\(^2^5\) By 2005, general practitioners performed 67.0% of the estimated 33.5 million periodontal procedures, while periodontists performed 32.4% of the procedures. Other specialists performed the remaining 0.6%.\(^2\) These findings differ slightly from the 1999 WDS data, which found that periodontists completed about 21% of all periodontal procedures which accounted for 36% of all expenditures (Table 4).\(^2^6\) Periodontal scaling and root planing and periodontal maintenance accounted for 89.8% of the procedures completed by general dentists compared to 71.9% for periodontists. Implant surgery was divided among generalists (27%, 13%), periodontists (35%, 48%), and other specialists (38%, 40%) in terms of proportion of procedures and expenditures, respectively.\(^2^6\)

**Age**

The increase in percentage of respondents greater than 50 years of age suggests a trend toward an aging membership among periodontists (Figure 1). There appears to be
some variation in the number of procedures performed by periodontists when they are sub-classified by age (Table 5).

**Gender**

In 2003, it was reported according to the AAP survey that 88.9% of dentists were male, which was down by 2% in both 2000 and 1998. There appeared to be a general trend that male periodontists tended to perform more procedures than female periodontists (Table 6).

**Small Area Variation in Medicine**

In studying dental care utilization, one can look to similar studies in the medical literature that examine small area variation or undertake physician profiling. Small area variation has been viewed by policy makers as a mechanism for containing expenditures.

**Profiling**

“Profiling” is the statistical analysis and monitoring of claims and encounter data to gain more information on the type of patient care rendered. Physician profiling may be examined using ambulatory-based profiling systems, resource utilization typically in a hospital environment, a patient’s complete medical problem, or an episode of care. Ambulatory-based profiling systems study treatment patterns in terms of procedures delivered and test ordered at the time of an office visit. The practice patterns of a single physician or a group is expressed as a rate: some measure of the resources during a defined period for the population is served. Profiling may allow for comparison with a norm either based on practice (other physician profiles) or based on standards (such as practice guidelines). Most profiling tends to be undertaken by insurers and is therefore proprietary.
Variations in clinical practice have been well documented in the medical literature.\textsuperscript{33, 34} Health care databases are particularly useful as a surveillance system because they are population-based, readily available, and relatively complete.\textsuperscript{35} In a series of articles spanning from 1987 to 1994, Wennberg et al.\textsuperscript{36, 37} investigated the rates of elective surgery and reported that the overall rate of surgery was nearly identical between residents of New Haven and Boston, yet the rates for individual procedures varied remarkably, even though the populations were well matched demographically.\textsuperscript{36} Small area variation has been demonstrated in the treatment of cardiac patients in the United States.\textsuperscript{38, 39} Characteristics of providers and hospitals explain in part the geographic variations in guideline-based care for elderly patients with heart failure.\textsuperscript{38} In contrast, a recent study conducted in the United Kingdom found no strong association between practice characteristics of the primary care physicians and operation rates for coronary artery bypass grafting, angioplasty, cataract surgery, and his replacement.\textsuperscript{40} Among insured adults in the United States, use of chiropractic care was higher in rural than in urban areas in Washington state.\textsuperscript{41} Geographic differences have also been reported by Welch et al.\textsuperscript{32} who noted higher resource utilization by attending physicians in hospitals in Florida compared to Oregon across all specialties and all types of service.

Variation in clinical practice between physicians is an important determinant of expenditure for primary physician services.\textsuperscript{42} Variation in expenditure for specific procedures has been attributed to physician-specific effects (49-61\%) and patient characteristics such as age and gender (about 1\%).\textsuperscript{42} A physician’s style of practice tended to be stable, which has been demonstrated by the fact that physicians who relocated their practice location and changed their patient population completely did not
change their practice style after moving. This suggested that practice style reflects an underlying behavior in how medicine was practiced. These findings are in agreement with another study that reported about 40% of variation in health care needs was explained by variation in clinical practice between physicians.

Preliminary studies in dentistry have been undertaken to examine the role of the dentist, practice, and patients factors in the provision of dental services. Variations may be related to the dentist (practice beliefs, clinical decision making, decision to intervene, dentist-patient interaction), practice characteristics (size and busyness of practices, practice age, geographic location), and the patient (age, gender, non-emergency visits, dental insurance, and socioeconomic status). Patient factors have been studied by Manski et al., who reported that when controlling for private dental insurance coverage, there were no rural- or urban-specific associations.

Unwarranted variation is defined as care that is not consistent with a patient’s preference or related to a patient’s underlying illness and may be further sub-categorized as effective, preference-sensitivity, and supply sensitive. Much of periodontal therapy may be considered to be “preference-sensitive care”, interventions in which there is a choice between at least two treatments that have different risks and benefits. For instance, a tooth can be maintained long term with surgery and routine maintenance therapy or can be extracted and replaced with a dental implant. The recommendations of the provider and cost involved ultimately may determine the course of treatment, and such recommendations may be linked with demographic variables of the practitioner.
Data Collection

Self reported surveys

The few studies available in the dental literature that examine utilization rates or patterns of care tend to be in the form of self-reported surveys. Provider self reports of preventative behaviors were always over-estimated compared with direct observations. Caution must be exercised in the interpretation of any data reported from surveys, as the data may be biased toward billable procedures, it may be incomplete, and they may not truly represent a provider population if there is a low response rate. Additionally, the data may not represent the practice behaviors of providers who did not respond or were not sampled in the survey. Surveys may also sample individuals receiving dental care. For example, the 1987 National Medical Expenditure Survey provided national estimates of health expenditures, utilization, sources of payment and insurance coverage for the civilian non-institutionalized population of the United States. Surveyed participants may be subject to missing or inconsistent expense values as a result of potential copayment amounts, potential flat fees or missing charges as a result of free delivery of services or a prepaid arrangement such as an HMO (health maintenance organizations).

Direct Observation / Chart Audits / Claims Data

Although costly and potentially intrusive, the gold standard to monitor the provision of services is direct observation. It has been used in medical practice to establish the validity and inter-method reliability of common data sources such as chart audit, dental claims, and self reported behaviors. Billing records provide a reasonable but generally lower estimate of services that are a single visit and reimbursable but substantially underestimate other non-procedural routine services. Procedures like
counseling services that may be delivered infrequently or not reliably charted may be inaccurate in estimating delivery of services. Demko et al.46 examined various methods to study provider behavior and found that chart audits were more sensitive that billing data for all observed procedures; chart and billing records were not sensitive for several prevention related tasks such as oral hygiene instruction.36 Claims data is a suitable alternative to surveys and direct observation since it is a well defined resource and one which eliminates any estimation of treatment rendered.

**Purpose**

The purpose of this study was to assess the practice patterns of periodontists enrolled in private insurance program by comparing periodontal care received by adults who receive care from periodontists.

**Hypothesis**

The hypothesis of this study was that adults being treated for periodontitis by one periodontist will receive similar periodontal services when compared to other periodontists. The hypothesis was based on the assumption that a periodontist: (1) undergoes at least two to three additional years of post-doctoral specialty training (2) is guided by standards of care described in the American Academy of Periodontology clinical guidelines; and (3) has a patient pool consisting primarily of adults.

Understanding periodontal practice patterns may allow for a better understanding of how oral health care is delivered across multiple states, an assessment of whether privately insured adults have adequate access to prevent and treat periodontal disease,
and an examination of the influence of third party coverage on the utilization of periodontal services. Periodontal trends may have implications in developing oral health care policies, consistent with the changing dental needs and demands of the population.26
Chapter 2: Methods

Sample and Data

A retrospective analysis of claims data from Delta Dental of Ohio, Michigan, Indiana, New Mexico, and Tennessee, were selected for review and data collection. There were 1,112,314 claims made by 351 periodontists between 2000-2009. The distribution of claims filed by state and year are displayed in Table 7. This project was approved by the Ohio State University Health Sciences Institutional Review Board.

Patients

The analysis was limited to patients aged 18 years and older who had at least one visit to a periodontist and were enrolled in Delta Dental plans of either Ohio, Michigan, Indiana, New Mexico, or Tennessee. Age at the time of treatment was noted from the claims data. No patient identifiers were obtained or recorded to ensure patient anonymity. The study sample included 214,730 adults with a mean age, 61.1 years (SD = 12.6 years). Mean patient age was also calculated by provider variable.

Independent Variable

The unit of analysis was the periodontist. A periodontist is a dentist licensed by his or her respective state to perform procedures within periodontal scope of practice,
which is limited to the prevention, diagnosis and treatment of periodontal disease and in
the placement of dental implants. A periodontist has undertaken additional training of
two to three years beyond dental school.

Periodontists’ practice characteristics (including gender, years since graduation,
geographic region of office, location of periodontal residency, and membership in
organized dentistry) were included in the analysis in two time intervals. Additionally
provider experience was evaluated in ten or eleven year increments from the year of
graduation. All institutions that trained periodontists who practiced in the states of study
were included in the study.

The provider’s practice location was used in this study, rather than where the
patient lived. Geographic variation was examined by state and at the regional level.
Regional analysis was performed by comparing urban and rural areas. Using ZIP codes,
counties were classified according to the 2006 Rural-Urban Commuting Area Codes
(RUCA; WWAMI Rural Health Research). The 10 RUCA codes (three metropolitan
and seven non metropolitan) were based on: a) 2000 Census work commuting
information, and b) Census Bureau defined urbanized areas (cities of 50,000 and greater
population) and urban clusters (cities/towns of from 2,500 through 49,999 populations).
These categories were aggregated into one metropolitan (urban, ZIP codes containing
cities of 50,000 or larger) and one rural category (population <50,000) to allow for an
exploration of regional variation.

Since Delta Dental had limited demographic information about the provider,
provider characteristics other than practice location were referenced from the American
Academy of Periodontology (AAP) membership directory of 2008 and 2009. Providers who were also classified as members and non-members of organized dentistry depending on if they were listed in the AAP members directory. The demographic information associated with each practitioner was assembled in the Ohio State University Division of Periodontology and sent to Delta Dental, where provider name was detached from the demographic data by assigning a unique, randomized study number, thereby ensuring the anonymity of the dentist.

**Dependent Variable**

The main outcome variable included the type of oral health service provided (e.g. preventive or treatment periodontal service) as indicated by the yearly rates of procedures. Initially, a list of common Current Dental Terminology (CDT) codes billed by a periodontist were examined (Table 8). The study was further limited to 18 preventive, periodontal, implant, and surgical codes (Table 9).

Yearly provider rates of service were examined for all but eight CDT codes between two time periods: early (2000-2004) and late (2005-2009). In 2003, the American Dental Association created additional codes to differentiate between quadrants (4 or more) and sextant (1-3 teeth) for periodontal scaling and root planing (SRP) and surgery based on the number of teeth treated. As a result, this study examined three year time periods for gingival flaps, osseous, and SRP (2003-5, 2006-8).
Data and Statistical Analysis

Analyses of dental care utilization involved examination of distribution of dependent (service rates) and independent (dentist variables), testing associations between the set of dentist variables and service rates. Analysis of service rates included preventive, periodontal, oral surgery, and implant services. Descriptive statistics were used to depict the data using measures of central tendency and measures of dispersion. Grouping of individuals prevented the identification of any single provider. Data were expressed as the mean ± standard deviation.
Chapter 3: Results

Demographic Characteristics of Periodontal Practices

The demographic characteristics of periodontists are found in Table 10. The majority of periodontists practiced in Ohio (37.3%) and in urban areas (92.9%). Most providers were males (84.4%). Although periodontists obtained training from institutions across the United States, most periodontists trained at institutions in the Midwest with the top three universities being named as follows: University A (51 grads, 15.7%), University B (56 grads, 16.0%), and University C (26 grads, 7.4%) representing the largest number of practicing periodontists. Only 17% did not maintain membership in organized dentistry through the American Association of Periodontology. The greatest percentage of periodontists were in practice for ≤ 11 years (29.3%).

Demographic Characteristics of Patients and Claims by State

During the study period (January 1, 2000 to December 31, 2009), there were a total of 1,129,314 claims made by periodontists for 214,730 patients (Table 11). On average, each patient had a mean of 4.8 visits. The mean age of the patient was 61.2 years (SD=12.6 years). Additionally, mean patient age as subcategorized by provider variable was calculated (Table 12).
**Overall Trends**

Non surgical periodontal therapy remained the most common procedure performed. Scaling and root planing and periodontal maintenance both increased over time, with a 6% and 19% increase in the difference between early and late study periods, respectively.

When examining all periodontal codes (4000-4999), the rates by geography were noted (Table 12). The range of rates of periodontal codes differed by provider characteristic. For example, when comparing between states the differences were 414% and between urban and rural areas only 4%.

Although the most common surgical procedure in the study period was osseous surgery (4260, 4261), statistically greater increases were observed in regenerative procedures (e.g., bone replacement grafts 4263, biologic procedures 4265, and guided tissue regeneration 4266, 4267) when compared to resective surgery. There was a 1.7 and 2.5 fold increase implants and extractions, respectively.

**By State**

*Adult Prophylaxis (1110)* (Figure 2). There were large differences in the numbers of adult prophylaxis performed between states in both the early and late 2000s. While there was an increase in prophylaxes in four states (IN, NM, OH, TN), there was a decrease in the number of prophylaxes in Michigan over time.

*Crown lengthening (4249)* (Figure 3). In general, most providers performed between 11-31 crown lengthening surgeries in Indiana, New Mexico, Ohio, and Tennessee over the
10 year period; Michigan performed more crown lengthening surgery than any other state, with the rates ranging between 56-65. With time, there were more surgeries being performed in every state except Indiana.

*Bone replacement grafts (4263)* (Figure 4). There were large differences in the use of bone replacement grafts (BRGs) between states with Michigan using the most BRGs and Indiana using the least BRGs over the 10 year period. There was an increase in the use of BRGs with time in all states, with the rates of increase ranging from 1.6 to 2.4-fold.

*Biologic materials (4265)* (Figure 5). There were differences in the use of biologics between states with Tennessee using the most biologics in the early 2000s and Ohio using the most biologics in the late 2000s. Indiana used the least amount of biologics over the 10 year period.

*Guided Tissue Regeneration – Resorbable barrier (4266)* (Figure 6). There were more resorbable barriers used in Michigan, followed by Tennessee. There were slight differences in the use of barriers between Indiana, New Mexico and Ohio. In general, the use of barrier membranes increased over time, except in Indiana where there was no change and in Tennessee where their use decreased.

*Guided tissue regeneration – Nonresorbable barrier (4267)* (Figure 7). There were differences in the use of nonresorbable barriers when comparing their use across states. In the early 2000s, more membranes were used in New Mexico, followed by Tennessee, Michigan, Ohio, then Indiana. In the late 2000s, the was a decreasing trend by state in the use of membranes was New Mexico, Ohio, Tennessee, Michigan, then Indiana.
Free Soft Tissue Graft (4271) (Figure 8). There were large differences in the rate of free soft tissue grafts or free gingival grafts (FGGs) performed by state. Over time, there was an increase in the rate of FGGs in every state, except in Michigan where there was a slight decrease over time. Between 2005-9, Ohio performed the most FGGs and Indiana the least.

Subepithelial CT Graft (4273) (Figure 9). In general, the number of subepithelial CT grafts (CTGs) performed between 2000-4 ranged between 20-67 for all states except in Michigan (137). In the following five years, the rates of CTGs increased between 1.6 – 3.1 fold, depending on the state.

Periodontal Maintenance (4910) (Figure 10). There were differences in the number of periodontal maintenance performed between states. Michigan performed the most, followed by Indiana. The rates of periodontal maintenance were similar of Ohio, Tennessee, and New Mexico. There was an increase across all states in the number of periodontal maintenance.

Gingival Flap Procedure (4+ teeth) (4240) (Figure 11). There were differences in the number of gingival flaps performed by state. Michigan performed more than any other state. The state performing the next most gingival flaps was Indiana, followed by Ohio, Tennessee, and New Mexico. Over time, there were decreasing rates of gingival flaps performed.

Gingival Flap Procedure (1-3 teeth) (4241) (Figure 12). There was a difference in the number of gingival flaps performed when examined by state. Over the six year time
period, Michigan performed the most. There was a general increase in the number of flaps performed in Indiana, Michigan, Ohio, and New Mexico, but a decrease in Tennessee.

*Osseous Surgery (4+ teeth) (4260)* (Figure 13). Wide variation was noted in the rates of osseous surgery performed between states over the six year time period. While the overall rates of osseous surgery remained relatively constant over time, there was a general decrease in Indiana, Michigan, New Mexico, and Tennessee. The rates of osseous surgery remained constant over time in Ohio at 102/year.

*Osseous Surgery (1-3 teeth) (4261)* (Figure 14). There were varying rates of osseous surgery performed when examining by state between 2003-5, with Ohio and Michigan performing the most sextants of osseous surgery. Over time, there was relatively little change within a given state.

*SRP (4+ teeth) (4341)* (Figure 15). Between 2003-5, the average number of SRP procedures were highest in Michigan (494) and lowest in Ohio (114). There were no differences in SRP between Ohio, New Mexico, and Tennessee. Overtime, the averages remained relatively constant with minor increases or decreases within a state.

*SRP (1-3 teeth) (4342)* (Figure 16). The average number of sextants of SRP ranged from 13 to 78 between 2003-5. In the later period, the rates increased across all states except in Tennessee, where there was no change.

*Endosteal Implant (6010)* (Figure 17). There were differences in the numbers of implant placement when comparing across states. The average number of implants among all
states ranged from 23-42, except in Michigan (97). There was an increase in the number of implants placed over all states except Indiana, where there was a slight decrease.

*Extraction of Erupted Tooth (7140)* (Figure 18). There were differences across all states in the mean number of extractions (range 37 to 77). Indiana performed more extractions between 2004-6 (77), while Michigan performed more extractions between 2007-9 (71). There was an increase in the rate of extractions in Michigan and New Mexico and a decrease in the rate of extractions in Indiana, Ohio, and Tennessee.

**Urban vs. Rural**

No large differences were noted in the rates of scaling and root planing and periodontal maintenance, except for a decrease in the rate of SRP (4+ teeth) in rural areas and an increase in the rate of SRP (1-3 teeth) in rural areas over time. In general there seemed to be more resective, hard and soft tissue regenerative procedures (4266, 4267, 4273), and implants performed in urban areas. Additionally, there were more gingival flaps (4240, 4241) done in urban areas following the change in procedural codes. More recently, there appeared to be more resective procedures (4261) performed in urban areas. There did not appear to be much difference in the numbers of certain surgical procedures, such as crown lengthening (4249) and free soft tissue grafts (4271).

*Adult Prophylaxis (1110)* (Figure 19). There were more prophylaxes performed in urban areas than rural areas over both time periods. Additionally, over time, there was an increase in number of prophylaxes in both urban and rural areas.
Crown lengthening (4249) (Figure 20). There was no difference in the rate of crown lengthening surgery performed in urban or rural localities. The rate of crown lengthening increased over the ten year period in both urban and rural areas.

Bone replacement graft (4263) (Figure 21). Between 2000-4, there was no difference in the use of BRGs performed in urban and rural areas; between 2005-9, there was an increase in number of BRGs, with a 1.7 fold and 2.8 fold increases in urban and rural areas, respectively.

Biologic materials (4265) (Figure 22). Between 2000-4, there were more biologics used in urban than rural areas (urban = 17.0, rural = 9.8). In the next five years, there was an increase in use of biologics in both urban (32.3) and rural (56.6) regions.

Guided tissue regeneration – resorbable barrier (4266) (Figure 23). Over 10 years, there were more resorbable barriers used in urban than rural areas. There was an increase in the use of membranes with time regardless of geography.

Guided tissue regeneration – nonresorbable barrier (4267) (Figure 24). There were almost twice as many nonresorbable barriers used in urban than rural locations over the 10 year period. There was an increase in use of non-resorbable barriers over time in both locations.

Free soft tissue graft (4271) (Figure 25). There were more FGGs performed in urban than rural areas over both time periods. There was an increase in the rates of FGGs performed with time over both periods, with the rate of FGGs performed in urban and rural regions between 2005-9 being 96.5 and 84.1, respectively.
Subepithelial CT graft (4273) (Figure 26). There were more CTGs performed in both urban and rural areas over the 10 year time period. There was an increase in number of CTGs between the early and late 2000s in both urban and rural locations.

Periodontal Maintenance (4910) (Figure 27). There were more periodontal maintenances performed in urban than rural areas between 2000-4, but there was no difference in the number of maintenance visits between 2005-9 when comparing between areas. Over time, there was an increase in maintenance procedures in both urban and rural areas.

Gingival Flap Procedure (4+ teeth) (4240) (Figure 28). There were more gingival flaps performed in urban than rural areas over the 6 year period. Over time, there was a decrease in the number of flaps performed in both urban and rural areas.

Gingival Flap Procedure (1-3 teeth) (4241) (Figure 29). There were more gingival flaps performed in urban than rural areas over the 6 year period. There was an increase in the rate of gingival flaps over time in both urban and rural areas.

Osseous Surgery (4+ teeth) (4260) (Figure 30). When examining the overall rates of osseous surgery over time, there was a decrease over time; however, when further subcategorized by urban and rural areas over all time periods the rate of osseous surgery decreased slightly in urban areas and to a larger extent in rural communities. No differences were noted in the rates of osseous surgery in the late time period.

Osseous Surgery (1-3 teeth) (4261) (Figure 31). There was no difference in the rates of osseous surgery over time when examining all providers regardless of urban and rural location. This trend was also consistent in urban areas; however, there was less sextants
of osseous surgery in rural areas in the early 2000s and an increase rural areas in the late 2000s. Regardless of time period, there was more osseous surgery performed in urban areas than rural areas.

SRP (4+ teeth) (4341) (Figure 32). The average number of SRP was higher in rural than urban areas over the first study period, but an inverse trend was noted in the second study period. Rates within urban localities remained relatively constant, while the rates of SRP decreased by 70% in rural areas.

SRP (1-3 teeth) (4342) (Figure 33). Rates of SRP were similar in urban and rural areas between 2003-5. There was a marked increase in the rate of SRP done in both urban and rural areas, with more SRP done in rural areas between 2006-8.

Endosteal Implant (6010) (Figure 34). There were more implants being placed in urban than rural areas. There were 4 times more implants being placed in urban areas between 2004-6; in 2007-9, there was an increase in the number of implants placed; with the rate increasing to 88.7 and 41.8 in urban and rural areas, respectively.

Extraction of Erupted Tooth (7140) (Figure 35). There were no differences in the number of extractions between urban and rural areas between 2004-6; with time there was no change in the rates in urban areas, while there was an increase in the rates in rural areas.
**Gender**

In general, male providers tended to perform more non-surgical and surgical therapy over both time periods at an increased rate of 1.4 to 20.1 times. The only exceptions were the use of biologics (4265) in the early period and the use of bone replacement grafts (4263) in both early and late periods where females used more BRGs than males.

*Adult Prophylaxis (1110)* (Figure 36). Males tended to perform at least 10-13 times more prophylaxes than females. Over time, there were increases in the rates of prophylaxes for both males and females.

*Crown Lengthening (4249)* (Figure 37). Males performed more crown lengthening surgeries than females (males 44-52; females 14-19); There were slight increases in the rates of crown lengthening within both genders over time.

*Bone Replacement Graft (4263)* (Figure 38). There were no differences in the numbers of BRGs used between 2000-4; however, over time, there was an increase in the use of BRGs by both males and females. Comparing between gender across 2005-9 time period, there was no differences.

*Biologic Materials (4265)* (Figure 39). Females used twice as much biologic materials compared to males between 2000-4. Over time, there was an increase in the use of biologics among males and females.
Guided Tissue Regeneration – Resorbable Barrier (4266) (Figure 40). Males use more resorbable barriers than females across all time periods. Over time, there was an increase in the use of barriers among both genders, with the rates of changes increasing by 29% among males and 185% among females.

Guided Tissue Regeneration – Nonresorbable Barriers (4267) (Figure 41). Similar trends were noted for nonresorbable barriers when comparing by gender as was noted for resorbable barriers. Over time, there was an increase in the use of nonresorbable barriers for males and no change the rates of use among females.

Free Soft Tissue Graft (4271) (Figure 42). Males performed more FGGs than females across all time periods. Over time, there was a doubling of the rates among males and slight increases among females.

Subepithelial CT graft (4273) (Figure 43). There were marked differences among gender in the use of CT grafting procedures with males performing more CTGs than females. Over time, there was a 2.3 and 2.7 fold increase in the rates of CTGs among males and females.

Periodontal Maintenance (4910) (Figure 44). Males performed more periodontal maintenance procedures than females in 2000-4; the rates increased among both males and females with time, with males performing 711 more 4910s on an annual basis than females in the later time period.

Gingival Flap Procedure (4+ teeth) (4240) (Figure 45). Between 2003-5, males performed more quadrants of gingival flaps than females (83.9 vs. 22.1); over time, there
was a decrease in the rates of flaps amongst males, but the rates of change stayed relatively constant among females.

*Gingival Flap Procedure (4241)* (Figure 46). Males tended to perform more sextants of gingival flaps more often than females. Over time, there were increases in the rates of gingival flaps performs among both males and females.

*Osseous Surgery (4+ teeth) (4260)* (Figure 47). Males performed more quadrants of osseous surgery than females. Over time, the rates of osseous surgery stayed relatively constant among males and females.

*Osseous Surgery (1-3 teeth) (4261)* (Figure 48). Males performed more osseous surgery than females across all time points. There was little change in the rates of osseous surgery among males; however there was an increase in the average number performed by females, from 31.4 to 52.5.

*SRP (4+ teeth) (4341)* (Figure 49). Males tended to perform more SRP than females across all time periods. There was little change between time periods when comparing by gender.

*SRP (1-3 teeth) (4342)* (Figure 50). Males tended to perform more SRP than females between 2003-5. In the later time period, there were increases in the rates of sextants of SRP among both genders (males = 55.0 to 107.3; females = 34.2 to 87.9)

*Endosteal Implant (6010)* (Figure 51). Males placed three times as many implants as females in practice in the early time period, 2003-2006. There was an increase in the
rates of implants among males and females. In the later time period, males placed at least 2.8 times as many implants as females.

*Extraction of Erupted Tooth (7140)* (Figure 52). Males extracted almost twice as many teeth than females; over time, there was no change among the rates among males and females.

**Experience**

*Non-Surgical.* With respect to adult prophylaxis, it appears that providers with 12-21 years of experience in the early period and providers with 22-31 years of experience in the late period tended to perform more procedures than the other providers. In regards to SRP, there did not appear to be much difference by experience except for providers with 42-51 years.

*Surgical.* There did not appear to be much difference between osseous surgery between providers except for the most experienced providers who performed more procedures than any other experience level. Providers with 12-31 years of experience tended to place more implants. There seemed to be an inverse correlation towards the number of extractions performed compared to the level of experience.

*Adult Prophylaxis (1110)* (Figure 53). Overall there was an increase in the number of prophylaxes over time. There was large variation noted in the number of procedures performed when subcategorized by experience. In 2000-4, those with 12-21 years experience performed > 900 prophylaxes, at least two or three times as many as any other group of providers, while in 2005-9, providers with 22-31 years of experience were
performing the most prophylaxes. There were increases in the rates over time for all groupings, except for 12-21 years experience where there was a decrease (900 to 100).

*Crown Lengthening (4249)* (Figure 54). Most providers tended to perform between 30 and 50 crown lengthening surgeries per year over all time periods. There were slight differences over time periods when subcategorized by experience, and larger changes between providers with 22-31 years experience and those with the most and least experience.

*Bone Replacement Graft (4263)* (Figure 55). Providers with 12-21 years of experience tended to outperform all other providers in the use of BRGs. There were increases across time for all providers when subcategorized by levels of experience group.

*Biologic Materials (4265)* (Figure 56). There were large variations in the number of procedures performed between experience levels. There were large increases in the rates of 4265 over time, with increases across all experience levels.

*Guided Tissue Regeneration – Resorbable Barrier (4266)* (Figure 57). Providers with 12-21 years of experience used the most resorbable barriers over both time periods. There were increases within each experience level except for those with 42-51 years of experience over time.

*Guided Tissue Regeneration – Nonresorbable Barrier (4267)* (Figure 58). There was large variation in the number of procedures performed across experience level for both time periods. Providers with 22-31 years of experience tended to use more nonresorbable barriers over both time periods.
Free Soft Tissue Graft (4271) (Figure 59). Between 2000-4, providers performed between 15-40 FGGs, with 12-21 years experience performing the most FGGs. There were increases in the number of FGGs performed only for the 0-11 and 22-31 years of experience.

Subepithelial CT graft (4273) (Figure 60). Providers with 12-21 years of experience tended to perform the most CTGs over all cross time periods, with a doubling of rates compared to any other provider. Over time, there were increases within experience level category, except for those providers with 42-51 years.

Periodontal Maintenance (4910) (Figure 61). There was some variation over time between years of experience and rates of periodontal maintenance. Providers with the least experience tended to perform that least maintenance visits in 2000-4, but by 2005-9, there was little difference in the rates of procedures performed across all levels of experience.

Gingival Flap Procedure (4+ teeth) (4240) (Figure 62). In the early time period, 2003-5, there were more gingival flaps performed with increasing levels of provider experience. Over time, there was a decrease in the rates of gingival flaps except in the 0-11 year of experience group, where there was a slight increase. Providers with 42-51 years of experience tended to perform more 4240s compared with all other providers.

Gingival Flap Procedure (1-3 teeth) (4241) (Figure 63). The rates of 4241s across providers appears to vary significantly across provider level of experience. There were increases across all experience levels over time.
Osseous Surgery (4+ teeth) (4260) (Figure 64). There were slight differences in the average number of osseous surgery procedures between experience levels between 0-41 years of experience between 2003-5. There most osseous surgery performed among those with 42-51 years of experience in the early time period. Comparing across provider experience level over time there was a decrease in the rates of osseous surgery performed.

Osseous Surgery (1-3 teeth) (4261) (Figure 65). Some variation was noted between provider experience levels for both time periods. There was little change in the rates of 4261 over time overall, but when subcategorized by provider experience level changes over time were noticeable. Four groups had increases, while one group had decreases in the rates of sextants of osseous surgery over time.

SRP (4+ teeth) (Figure 66). When examining all providers over time, there were slight increases over time. Over time, there was a decreasing trend toward SRP over 12-41 years of experience, but an increasing trend for 0-11 and 42-51 years of experience. Providers with 42-51 years of experience performed the most SRP (2.5 times more).

SRP (1-3 teeth) (Figure 67). There were differences in the rates of SRP performed across provider level. In general, there was an increase in the rates of SRP performed with increasing levels of experience. No trends could be concluded among the later time period (2006-8).

Endosteal Implant (6010) (Figure 68). Providers with 22-31 years of experience tended to do more implants across all time periods examined. There were differences comparing
between provider level of experience in the early period (2004-6). Over time, there were increases in the rates of 6010s performed across all provider levels.

*Extraction of Erupted Tooth (7140)* (Figure 69). There were some differences in the number of extractions performed comparing across all provider levels. Periodontists with 42-51 years of experience had the lowest rate of extractions for all time periods examined. There were decreases in the rates of extractions for those with 12-21 and 32-51 years of experience and increases for providers with 0-11 and 22-31 years of experience.

**Membership in Organized Dentistry**

Membership in organized dentistry appeared to be correlated with the increased rates and types of procedures performed.

Non Surgical Therapy: Members tended to do more adult prophylaxes between 2000-2004, while there was not much difference in the later period. Over both time periods, nonmembers tended to perform more scaling and root planing (1-3, 4+ teeth) and periodontal maintenances with the exception of members doing more sextants of SRP in the last three years.

Surgical Therapy: Members tended to do more 4263, 4265, 4266, 4271, 4273, while non-members tended to perform more 4267. Members performed more gingival flaps (4240, 4241). Members tended to place more implants and perform simple extractions.
Adult Prophylaxis (1110) (Figure 70). In general, there was an increase over time for all providers in adult prophylaxes. Although there were increases over time in both categories, members performed more procedures than nonmembers over the ten-year time period.

Crown Lengthening (4249) (Figure 71). Rates of crown lengthening increased over time. Members tended to perform more crown lengthening than nonmembers over all time periods, and within the nonmember group, there was a decrease over time in the rates of crown lengthening.

Bone Replacement Graft (4263) (Figure 72). The use of BRGs increased by ~50% over time. This trend was consistent among AAP members; however, nonmembers used less BRGs (~ 20 per year) and there was no change among nonmembers with time.

Biologic Materials (4265) (Figure 73). There was a doubling of the rate of biologics with time over all providers; this trend was similar for members, but there was a decrease in the use of biologic among the nonmember groups. The use of biologics among members was more common than among nonmembers for all time periods examined.

Guided Tissue Regeneration –Resorbable Barriers (4266) (Figure 74). There was an increase in the number of resorbable barriers used over time across all providers. Members tended to use more barriers than nonmembers. Over time, there was a slight increase in the use of barriers among members, but no change among nonmembers.
Guided Tissue Regeneration – Nonresorbable barriers (4267) (Figure 75). In general, there was an increase in the use of nonresorbable barriers over time among all providers. This trend was similar both members and non-members.

Free Soft Tissue Graft (4271). (Figure 76). In general, the number of FGGs performed by members was higher than nonmembers between 2000-2004. In both groups, the rates of FGGs increased, with the rates increasing more in the membership group than the non-member group.

Subepithelial CT graft (4273) (Figure 77). Members tended to perform more CTGs than nonmembers across all time points. There was an increase (2.5 fold) in the rate of CTGs among members, while there was no change in the rates of CTGs among nonmembers.

Periodontal Maintenance (4910) (Figure 78). In general, nonmembers tended to perform more periodontal maintenance across all time periods by twofold. There was a small increase in the rates of maintenance procedures done by both members and nonmembers over time.

Gingival Flap Procedure (4+ teeth) (4240) (Figure 79). Members tended to perform more gingival flaps than nonmembers across all time periods examined. There were decreases in the rates of gingival flaps for both members and nonmembers, with a decrease in the rates to <10 flaps/year for non-members.

Gingival Flap Procedure (1-3 teeth) (4241) (Figure 80). The rates of gingival flaps (1-3 teeth) were similar between member and non-member groups between 2003-2005. In the
later time period, there was an increase in the rates of gingival flaps among members, but a decrease in the rate among non-members.

*Osseous Surgery (4+ teeth) (4260)* (Figure 81). The rates of osseous surgery were higher among members than non-members in the early period (2003-5); over time, there was a slight decrease among members, but there was a doubling of the rates of osseous surgery among non-members.

*Osseous Surgery (1-3 teeth) (4261)* (Figure 82). Members tended to perform three times more sextants of osseous surgery than non-members across all time periods. The rates of osseous surgery remained relatively constant over time when looking at overall trends and among each subcategory.

*SRP (4+ teeth)* (Figure 83). The rates of scaling and root planing remained relatively constant over time among members but there was a decrease among nonmembers. Members performed less SRP in the early period and equal amounts of SRP in the later period compared to nonmembers.

*SRP (1-3 teeth)* (Figure 84). There were differences in the average numbers of SRP performed in the early time period (2003-5) with nonmembers performing more non-surgical therapy. In the late time period, there was an increase in SRP for both categories with there being more SRP being performed by members over non-members.

*Endosteal Implant (6010)* (Figure 85). Members tended to perform at least twice as many implant surgeries than non-members across all time periods. There were increases
within each group over time, with members and nonmembers placing 60 and 25 implants, respectively.

*Extraction of Erupted Tooth (7140)* (Figure 86). Members performed less extractions in the early time period but more extractions in the late time period. While there was an increase in the rate of extractions among members, there was a decrease in the rates of extractions among non-members.

**Location of Training**

There was a wide range of variability across all training institutions and no apparent trends in the rates of non-surgical and surgical procedures performed. As there were no patterns noted for Figure 87 to 103, no description by CDT code was provided except for comparisons between the graduates of three universities which represented the greatest number of practicing periodontists.

*Adult Prophylaxis (1110)* (Figure 87). Over both time periods, there were differences among training locations and the rates of prophylaxes. University B tended to perform more prophylaxes, eight times more in the early period and four times more in the later period.

*Crown lengthening* (4249) (Figure 88). There were differences in the rates of crown lengthening performed when comparing across institutions. Two of the major universities had increases in the rates of crown lengthening over time, while there was a decrease in the rate of crown lengthening.
Bone Replacement Graft (4263) (Figure 89). There were differences among training locations with respect to the use of BRGs. Over time, there were increases over time for all training institutions.

Biologic Materials (4265) (Figure 90). The use of biologic materials in the early time period (2000-4) was < 15 per year over all training institutions; however, between 2005-9, there were marked increases with providers training at one university increasing the use of biologics by three times.

Guided Tissue Regeneration – Resorbable Barrier (4266) (Figure 91). University B used a substantially larger number of barriers than the other two institutions. Over time, there were no changes in the use of barriers by graduates at one school, however, there were was a 2.5-fold increase in the use of barriers by alumni of the other two schools.

Guided Tissue Regeneration - Non-resorbable Barrier (4267) (Figure 92). There were differences in the use of non-resorbable barriers across training locations. Alumni from university A used the most barriers over time for all time periods; there was a slight increase in the use of barriers over time for alumni of university B, while there was a decrease among graduates of university A and C.

Free Soft Tissue Grafts (4271) (Figure 93). There were differences in the rates of FGGs performed among graduates of different training locations. Over time, the rates remained relatively constant by graduates of university C while there were increases in the rates of FGGS among university A and B.
Subepithelial CT Grafts (4273) (Figure 94). There were slight differences among graduates training across different institutions between 2000-4. Over time, there were greater increases across all training locations by 2 to 3 times.

Periodontal Maintenance (4910) (Figure 95). There were differences between training locations with respect to the rates of periodontal maintenance. Over time, the rates of maintenance procedures increases across all institutions.

Gingival Flap Procedure (4+ teeth) (4240) (Figure 96). The rates of gingival flaps varied across all institutions; over time, there was a decrease (10-20 procedures) in the rates of gingival flaps by alumni of universities B and C and no differences were noted for the alumni of university A.

Gingival Flap Procedure (1-3 teeth) (4241) (Figure 97). In the early time period, 2003-5, there were differences in the rates of gingival flaps performed; however between 2006-8, there was a 6 fold increase by graduates of university B in the rates of gingival flaps performed. Among the two other universities there were slight increases in the rates of gingival flaps with time.

Osseous Surgery (4+ teeth) (4260) (Figure 98). There were differences in rates of osseous surgery between 2003-5. Over time, there were decreases in the rates of osseous surgery by providers at all universities.

Osseous Surgery (1-3 teeth) (4261) (Figure 99). There were differences in the early time period (2003-6) in the number of sextants of osseous surgery performed among training
institutions. Over time there were increases in the rates of osseous surgery for two universities and no change for university A.

*Scaling and Root Planing (4+ teeth) (4341)* (Figure 100). There was no clear trend in the rates of SRP over time. University A had a slight decrease, University B had an increase, and University C had a decrease in the rates of SRP over time.

*Scaling and Root Planing (1-3 teeth) (4342)* (Figure 101). The mean number of SRP between 2003-5 varied by training locations; over time, there were increases in the rates of SRP performed at all universities.

*Endosteal Implant (6010)* (Figure 102). The rates of implant placement varied by training location (20-80); however, over time, there was an increase in the rate of implant placement across all universities.

*Extraction of Erupted Tooth (7140)* (Figure 103). The amount of extracted teeth varied among universities between 2004-6. Over time, there were decreases in the rates of extractions for two schools, while there was an increasing trend toward extraction by graduates of university B.

A comparison by procedures

Soft tissue regeneration is typically accomplished by connective tissue grafts and free gingival grafts. There is a general trend toward an increase in number of periodontal plastic surgery procedures (4271, 4273) over the 10 year period, with a three-fold
increase in 4273 compared to 4271. These trends also held true when these procedures were subclassified by gender, membership, and urban versus rural location.

Use of Membranes

In general over the 10 year period, there was an increased use of resorbable membranes over nonresorbable membranes. This was consistent across all subcategories including urban and rural locality, gender, experience level, and all states except New Mexico.
Chapter 4: Discussion

This study found the range of utilization rates of periodontal therapy (selected 4000-4999 CDT codes) in the last five years by adults enrolled in Delta Dental in five states varied from a high of 414% between states to a low of 4% between urban and rural communities. When differences in educational backgrounds of providers were examined, the rates differed by 189%; differences in most and least experience varied by 42%; gender by 49%; and differences in organized dentistry by 62%. When individual codes were examined, there was considerable variability noted between urban and rural locality. Over time, there were significant increases in treatment provided looking at both geographic parameters. One must use caution when interpreting the results of this analysis as the rate did not adjust for patient volume. Consequently, the rate derived from the data may represent the number of patients of a dental insurance company being treated by a specific dentist, rather than the true rate of procedures a dentist delivers.

Periodontists in Michigan tended to perform dramatically more non-surgical (e.g. scaling and root planing, periodontal maintenance) and surgical procedures (e.g. crown lengthening, gingival flaps, bone replacement grafts, nonresorbable barriers, connective tissue grafts, implants) than periodontists in the other states examined in this study. These variations in practice patterns between states were similar to those reported in the medical literature. For example, Wennberg et al. noted that while the rates of
tonsillectomies was on average 43 per 10,000 persons in the state of Vermont, the variation among 13 hospital service areas ranged from 13 to 121 per 10,000 persons. One of the limitations as noted by Welch et al.\textsuperscript{32} in examining practice patterns at a state level is that variations in the types of patients being treated makes it nearly impossible to establish a typical practice style. One parameter examined within the patient population of this study was age, which has been reported in the periodontal literature to be a risk indicator for periodontitis. When periodontists were subcategorized by provider characteristic and the patients they treated were examined by age, ages of patient populations were similar (Table 13). Additionally, within a periodontal practice, a variety of procedures may be performed. Patients may seek treatment from a periodontist due to periodontal disease, mucogingival problems, esthetic issues, or pre-prosthetic reasons, such as for crown lengthening or placement of a dental implant. The increased rate of provision of services among providers in the state of Michigan may be attributed to a larger proportion of privately insured population seeking dental care. At this time, there were no means to estimate at a state level the extent of private dental insurance coverage. Nonetheless, the differences in the rates of services between states was surprising as disease patterns were assumed to be similar among geographic regions within the United States. The differences in utilization between the states may be of interest to public health policy and licensing committees to ascertain why treatment planning differs so dramatically between regions.

Urban and rural communities appeared to practice periodontics differently. There were generally more non-surgical (prophylaxis) and surgical procedures being performed in urban than rural areas, except for crown lengthening and free gingival grafts where
there were similar or a reverse trend was noted. There was also an increase in the amount of scaling and root planing (1-3 teeth), bone replacement grafts, biological materials, and simple extractions in rural areas over time compared with urban locations of practice. Although it is thought that rural communities face challenges in providing access to oral and dental care, the differences noted between urban and rural practitioners in this study were in agreement with those of Pettinato et al.\textsuperscript{21} These investigators reported a significant interaction between practice setting location and procedure type. The group reported that rural dentists provided fewer diagnostic, less preventive, and more corrective procedures than metropolitan providers among a Virginia Medicaid children’s population; however, the results of our study contrast those reported by Byck et al.\textsuperscript{20} who found no significant relationship between utilization rates of urban and rural status after controlling for dental supply and population factors among a children’s Medicaid population in Illinois.

Differences in providers who were members and non-members suggested that members tended to perform more surgical procedures than non-member. We were currently unable to draw any conclusions from differences in membership. Practice guidelines and periodontal parameters of care were available to all members of the community, regardless of membership. The differences between members and non-members may be the result of members of the American Academy of Periodontology benefiting from access to current literature describing new therapies and techniques as well as continuing education seminars at meetings.
There were large variations in the types of procedures performed when examining trends associated with location of training. Advanced dental education programs were subject to accreditation by the American Dental Association Commission on Dental Accreditation, which maintains and applies standards that ensure the quality and continuous improvement of dental and dental-related education and reflect the evolving practice of dentistry. Once accredited, post-doctoral programs should train specialists with the basic fundamentals common to periodontics. There was no method to account for wide variations in practice styles based on training location.

The policy change occurring effective January 1, 2003 where ADA codes distinguishing between 1-3 teeth and 4 or more teeth for scaling and root planing and periodontal surgery resulted in no change or decreases in the rates of 4 or more teeth and increases in 1-3 teeth over time. Following the policy change in 2007 when dental implants became a standard benefit, there was an increase in the rate of implants being placed in both urban and rural areas but not across states. These changes did not appear to correlate with the number of simple extractions, suggesting that no additional teeth were extracted as a result of the policy change. As the clinical decision to extract or save a tooth is guided by multiple considerations, it is difficult to conclude whether the policy change would have an effect on the decision to extract questionable teeth. The increases noted in implant fixtures may also necessitate the use of pre-implant bone grafting, which may involve the use of membranes (4266) or the simultaneous use of bone grafting (4263) at the time of implant placement. Consequently, changes in the rates of 4263 and 4266 may be correlated to trends over time with implants, but it is difficult to conclude any significance from this set of data.
There were certain limitations to these data and inferences that can be drawn from this study. First, the analysis was limited by the data available. While the total number of providers included in this study was 351, these providers, depending on the state, represent 47–89% of periodontists within each state. Estimates of the number of periodontists by state were obtained from state dental boards or state dental associations. Unlike medical claims data, dental claims do not submit diagnostic codes. Consequently, there was no means to determine the extent and severity of periodontal disease or estimate the amount of types of treatment required from the claims data. The underlying assumption was that disease prevalence among states was similar as inferred by the similar ages of patient when patients were divided according to provider characteristic; in theory, there should be no variation in treatment patterns at the state level.

The results of this study were limited to a privately insured population with the five states who seek care from participating periodontists of Delta Dental. It may not represent the care provided for the entire United States, especially since it was estimated that private insurance represents a small proportion of sources of funding for dental care. There are currently no studies examining the influence of dental insurance on periodontal care. Moreover, these trends on non-surgical and surgical treatment only represent those provided by periodontists. Estimates of periodontal (both non-surgical and surgical) treatment by general dentists were not available in the literature.

Periodontal treatment is largely referral based, and the associations reported may actually reflect referral patterns between general dentist and periodontists. Zemanovich et al.\textsuperscript{48} reported demographic variables including female gender, practicing with one
other dentist, employing two or more hygienists, and being >5 miles away from the nearest periodontist had statistical influence on the number of referrals by a general practitioner to a periodontist. Betof et al.\textsuperscript{49} reported that increased knowledge of periodontology had a significant effect on dentists’ willingness to treat periodontal patients. Younger dentist (<31 years) with more current knowledge levels were more likely to treat periodontal disease in their practice, while practitioners ages 31-45 years were more likely to refer patients for treatment. Older dentists (≥ 46 years) referred fewer patients and 60% of this age group reported treating periodontal diseases. Other factors that may influence referral a periodontal patient may be related to the perceived difference in skill, availability and affordability of services obtained from a specialist or generalist.\textsuperscript{50}

Another limitation of this study was by virtue of the claims data, we were unable to draw any inferences into a given provider’s workload. There was no indication from claims data whether providers worked full-time or part-time and how much time was allotted to a given procedure. It has been estimated almost 1 in 5 periodontists practices part-time.\textsuperscript{2} Moreover, Brown et al.\textsuperscript{2} reported that between 1993 to 1998, there was a declining trend toward number of hours worked per week in office (38.2 to 36.9), decreased hours spent treating patients (34.2 to 31.6), and an increase in the average appointment length from 53.9 to 56.7 minutes.\textsuperscript{2} The trends noted in this study suggest that changes have been occurring in the 2000s with respect to the way periodontists practice. The overall trends that males seem to be performing more periodontal procedures compared to females may be due to the fact that females may be working less hours or maintain a part time schedule. Similarly the decrease in rates of procedures
performed by those with the most experience may be as a result of working fewer hours with a gradual transition to retirement.

This study presented an effort to better understand and explain differences in dental care utilization by adults in a privately insured population across states and across urban and rural communities. Our results suggest considerable variation in the treatment of periodontal problems, particularly across urban and rural communities.

One of the fundamental assumptions for this study population that periodontists were guided by standards of care described the American Academy of Periodontology clinical guidelines. The differences in practice patterns over geographic distribution underscored the need for updated evidence-based practice guidelines and regulatory means to standardize the provision of care.

It was evident that significant differences in practice patterns among periodontists exist by geographic location when examining providers by state and urban and rural localities. Additionally, provider characteristics appeared to correlate with the provider rates in certain patterns of care. There is currently an additional need for further studies examining these trends to better understand why variations in dental care exist.
### Table 1. ICD-9-CM Codes Associated with Dental-Related Emergency Office Claims by Physician and Physicians linked to Emergency Department Claims: Maryland, 1991-1995, Medicaid Claims Data\(^8,9\)

<table>
<thead>
<tr>
<th>Diagnosis: ICD-9-CM Code</th>
<th>Number of Physician Claims</th>
<th>Percent</th>
<th>Number of Physician Claims Linked to ED Claims</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gingival/periodontal disease 523.0</td>
<td>707</td>
<td>10.0</td>
<td>6</td>
<td>0.25</td>
</tr>
<tr>
<td>Acute gingivitis 523.0</td>
<td>244</td>
<td>3.4</td>
<td>59</td>
<td>2.41</td>
</tr>
<tr>
<td>Chronic gingivitis 523.1</td>
<td>631</td>
<td>8.9</td>
<td>90</td>
<td>3.68</td>
</tr>
<tr>
<td>Gingival recession 523.2</td>
<td>9</td>
<td>0.1</td>
<td>3</td>
<td>0.12</td>
</tr>
<tr>
<td>Acute periodontitis 523.3</td>
<td>195</td>
<td>2.8</td>
<td>54</td>
<td>2.21</td>
</tr>
<tr>
<td>Chronic periodontitis 523.4</td>
<td>176</td>
<td>2.5</td>
<td>18</td>
<td>0.74</td>
</tr>
<tr>
<td>Periodontosis 523.5</td>
<td>25</td>
<td>0.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accretions on teeth 523.6</td>
<td>6</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other specified periodontal diseases 523.8</td>
<td>74</td>
<td>1.0</td>
<td>14</td>
<td>0.57</td>
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<tr>
<td>Gingival/periodontal disease, unspecified 523.9</td>
<td>186</td>
<td>2.6</td>
<td>12</td>
<td>0.49</td>
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<tr>
<td><strong>Total</strong></td>
<td>2253</td>
<td>31.8</td>
<td>256</td>
<td>10.47</td>
</tr>
</tbody>
</table>

### Table 2. Adults with a Dental Visit, by Dental Plan Procedure and Insurance Plan\(^23\)

<table>
<thead>
<tr>
<th>Dental Procedure</th>
<th>Delta Dental Plan of Iowa</th>
<th>Iowa Medicaid (Title XIX)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of Users</td>
<td>% of Users</td>
</tr>
<tr>
<td>Preventative Dental Services</td>
<td>204,756</td>
<td>91.5</td>
</tr>
<tr>
<td>Periodontal Service</td>
<td>13,769</td>
<td>6.2</td>
</tr>
<tr>
<td>Tooth extraction</td>
<td>15,892</td>
<td>7.1</td>
</tr>
</tbody>
</table>

Table 2. Adults with a Dental Visit, by Dental Plan Procedure and Insurance Plan\(^23\)
<table>
<thead>
<tr>
<th>District 1</th>
<th>D0180</th>
<th>D1110</th>
<th>D4240</th>
<th>D4241</th>
<th>D4260</th>
<th>D4261</th>
<th>D4273</th>
<th>D4341</th>
<th>D4910</th>
<th>D6010</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>40</td>
<td>5</td>
<td>20</td>
<td>6</td>
<td>43</td>
<td>100</td>
<td>0</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>District 2</td>
<td>23</td>
<td>23</td>
<td>4</td>
<td>20</td>
<td>5</td>
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<td></td>
</tr>
<tr>
<td>District 3</td>
<td>30</td>
<td>19</td>
<td>4</td>
<td>20</td>
<td>5</td>
<td>25</td>
<td>115</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>District 4</td>
<td>27</td>
<td>24</td>
<td>6</td>
<td>20</td>
<td>6</td>
<td>32</td>
<td>100</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>District 5</td>
<td>25</td>
<td>10</td>
<td>4</td>
<td>13</td>
<td>5</td>
<td>20</td>
<td>74</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>District 6</td>
<td>30</td>
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<td>4</td>
<td>20</td>
<td>6</td>
<td>25</td>
<td>100</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>District 7</td>
<td>20</td>
<td>23</td>
<td>5</td>
<td>20</td>
<td>3</td>
<td>40</td>
<td>100</td>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Median Number of Procedures Performed by Periodontists on a Monthly Basis by Geographic Location

<table>
<thead>
<tr>
<th>Procedures</th>
<th>General</th>
<th>Periodontist</th>
<th>Other</th>
<th>Expenditures</th>
<th>General</th>
<th>Periodontist</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnosis and prevention</td>
<td>90.9%</td>
<td>1.0%</td>
<td>8.1%</td>
<td>Diagnosis and prevention</td>
<td>90.8%</td>
<td>1.3%</td>
<td>7.9%</td>
</tr>
<tr>
<td>Periodontics</td>
<td>78.3%</td>
<td>20.5%</td>
<td>1.2%</td>
<td>Periodontics</td>
<td>63.5%</td>
<td>35.6%</td>
<td>0.9%</td>
</tr>
<tr>
<td>Oral surgery and adjunctive services</td>
<td>48.2%</td>
<td>2.6%</td>
<td>49.2%</td>
<td>Oral surgery and adjunctive services</td>
<td>27.3%</td>
<td>2.0%</td>
<td>70.7%</td>
</tr>
</tbody>
</table>

Table 4. Percentage of Procedures and Expenditures Reported by Generalists, Periodontists, and Other Specialists for the ADA Service Categories, 1999

<table>
<thead>
<tr>
<th>Age</th>
<th>D0180</th>
<th>D1110</th>
<th>D4240</th>
<th>D4241</th>
<th>D4260</th>
<th>D4261</th>
<th>D4273</th>
<th>D4341</th>
<th>D4910</th>
<th>D6010</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 or less</td>
<td>30</td>
<td>20</td>
<td>5</td>
<td>20</td>
<td>6</td>
<td>25</td>
<td>60</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>41-50</td>
<td>25</td>
<td>12</td>
<td>5</td>
<td>20</td>
<td>6</td>
<td>30</td>
<td>100</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>51-60</td>
<td>28</td>
<td>30</td>
<td>4</td>
<td>20</td>
<td>5</td>
<td>33</td>
<td>120</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over 60</td>
<td>27</td>
<td>59</td>
<td>10</td>
<td>62</td>
<td>8</td>
<td>33</td>
<td>144</td>
<td>7</td>
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</table>

Table 5. Median Number of Procedures Performed by Periodontists on a Monthly Basis by Age

<table>
<thead>
<tr>
<th>Gender</th>
<th>D0180</th>
<th>D1110</th>
<th>D4240</th>
<th>D4241</th>
<th>D4260</th>
<th>D4261</th>
<th>D4273</th>
<th>D4341</th>
<th>D4910</th>
<th>D6010</th>
</tr>
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<tbody>
<tr>
<td>Male</td>
<td>30</td>
<td>25</td>
<td>5</td>
<td>20</td>
<td>5</td>
<td>30</td>
<td>100</td>
<td>8</td>
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<tr>
<td>Female</td>
<td>25</td>
<td>10</td>
<td>2</td>
<td>15</td>
<td>6</td>
<td>20</td>
<td>65</td>
<td>6</td>
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</table>

Table 6. Median Number of Procedures Performed by Periodontists on a Monthly Basis by Gender
<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>IN</td>
<td>376</td>
<td>5,225</td>
<td>5,433</td>
<td>6,054</td>
<td>7,155</td>
<td>7,625</td>
<td>8,320</td>
<td>8,541</td>
<td>8,908</td>
<td>7,499</td>
<td>65,136</td>
<td>6</td>
</tr>
<tr>
<td>MI</td>
<td>4,538</td>
<td>78,731</td>
<td>77,154</td>
<td>81,650</td>
<td>82,303</td>
<td>83,920</td>
<td>92,899</td>
<td>93,037</td>
<td>92,662</td>
<td>83,583</td>
<td>770,477</td>
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<tr>
<td>NM</td>
<td>1</td>
<td>84</td>
<td>1,311</td>
<td>5,891</td>
<td>5,487</td>
<td>6,590</td>
<td>6,696</td>
<td>7,288</td>
<td>7,266</td>
<td>6,457</td>
<td>47,071</td>
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<tr>
<td>OH</td>
<td>1,300</td>
<td>16,109</td>
<td>15,169</td>
<td>17,136</td>
<td>17,367</td>
<td>20,389</td>
<td>21,471</td>
<td>22,202</td>
<td>23,744</td>
<td>21,988</td>
<td>176,875</td>
<td>16</td>
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<tr>
<td>TN</td>
<td>436</td>
<td>4,881</td>
<td>5,242</td>
<td>6,486</td>
<td>7,319</td>
<td>8,475</td>
<td>8,615</td>
<td>9,722</td>
<td>10,025</td>
<td>8,554</td>
<td>69,755</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>6,651</td>
<td>105,030</td>
<td>104,309</td>
<td>117,217</td>
<td>119,631</td>
<td>126,999</td>
<td>138,001</td>
<td>140,790</td>
<td>142,605</td>
<td>128,081</td>
<td>1,129,314</td>
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Table 7. Distribution of Claims Data by Year and by State
<table>
<thead>
<tr>
<th>Preventative</th>
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</thead>
<tbody>
<tr>
<td>1110</td>
<td>adult prophylaxis</td>
</tr>
<tr>
<td>1320</td>
<td>tobacco counseling</td>
</tr>
<tr>
<td>1330</td>
<td>OHI</td>
</tr>
<tr>
<td>Radiographs / Diagnostic Imaging (Including Interpretation)</td>
<td></td>
</tr>
<tr>
<td>0210</td>
<td>intraoral - complete series (including bitewings)</td>
</tr>
<tr>
<td>0220</td>
<td>intraoral - periapical first film</td>
</tr>
<tr>
<td>0230</td>
<td>intraoral - periapical each additional film</td>
</tr>
<tr>
<td>0240</td>
<td>intraoral - occlusal film</td>
</tr>
<tr>
<td>0250</td>
<td>extraoral - first film</td>
</tr>
<tr>
<td>0260</td>
<td>extraoral - each additional film</td>
</tr>
<tr>
<td>0270</td>
<td>bitewing - single film</td>
</tr>
<tr>
<td>0272</td>
<td>bitewings - two films</td>
</tr>
<tr>
<td>0273</td>
<td>bitewings - three films</td>
</tr>
<tr>
<td>0274</td>
<td>bitewings - four films</td>
</tr>
<tr>
<td>0277</td>
<td>vertical bitewings - 7-8 films</td>
</tr>
<tr>
<td>0290</td>
<td>posterior - anterior or lateral skull or facial bone survey film</td>
</tr>
<tr>
<td>0310</td>
<td>Sialography</td>
</tr>
<tr>
<td>0320</td>
<td>TMJ arthrogram, including injection</td>
</tr>
<tr>
<td>0321</td>
<td>other TMJ films, by report</td>
</tr>
<tr>
<td>0322</td>
<td>tomographic survey</td>
</tr>
<tr>
<td>0330</td>
<td>panoramic film</td>
</tr>
<tr>
<td>0340</td>
<td>cephalometric film</td>
</tr>
<tr>
<td>0350</td>
<td>oral/facial photographic images</td>
</tr>
<tr>
<td>0360</td>
<td>cone beam ct - craniofacial data capture</td>
</tr>
<tr>
<td>0362</td>
<td>cone beam - 2D image reconstruction using existing data, including multiple images</td>
</tr>
<tr>
<td>0363</td>
<td>cone beam - 3D image reconstruction using existing data, including multiple images</td>
</tr>
<tr>
<td>Periodontics</td>
<td></td>
</tr>
<tr>
<td>4210</td>
<td>gingivectomy or gingivoplasty - 4 or more contiguous teeth or bounded teeth spaces per quadrant</td>
</tr>
<tr>
<td>4211</td>
<td>gingivectomy or gingivoplasty - 1-3 contiguous teeth or bounded teeth spaces per quadrant</td>
</tr>
<tr>
<td>4230</td>
<td>anatomical crown exposure - 4+ contiguous teeth per quadrant</td>
</tr>
<tr>
<td>4231</td>
<td>anatomical crown exposure - 1-3 teeth per quadrant</td>
</tr>
<tr>
<td>4240</td>
<td>gingival flap procedure, including root planing - 4 + contiguous teeth or bounded teeth spaces per quadrant</td>
</tr>
<tr>
<td>4241</td>
<td>gingival flap procedure, including root planing - 1-3 contiguous teeth or bounded teeth spaces per quadrant</td>
</tr>
<tr>
<td>4245</td>
<td>apically positioned flap</td>
</tr>
<tr>
<td>4249</td>
<td>clinical crown lengthening - hard tissue</td>
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</table>

Table 8. CDT Codes and Procedures Selected for Initial Examination

Continued
Table 8 continued

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>4260</td>
<td>osseous surgery - 4+ contiguous teeth or bounded teeth spaces per quadrant</td>
</tr>
<tr>
<td>4261</td>
<td>osseous surgery - 1-3 contiguous teeth or bounded teeth spaces per quadrant</td>
</tr>
<tr>
<td>4263</td>
<td>bone replacement graft - first site in quadrant</td>
</tr>
<tr>
<td>4264</td>
<td>bone replacement graft - each additional site in quadrant</td>
</tr>
<tr>
<td>4265</td>
<td>biologic materials to aid in soft and osseous tissue regeneration</td>
</tr>
<tr>
<td>4266</td>
<td>guided tissue regeneration - resorbable barrier per site</td>
</tr>
<tr>
<td>4267</td>
<td>guided tissue regeneration - nonresorbable barrier per site (includes</td>
</tr>
<tr>
<td></td>
<td>membrane removal)</td>
</tr>
<tr>
<td>4268</td>
<td>surgical revision procedure, per tooth</td>
</tr>
<tr>
<td>4270</td>
<td>pedical soft tissue graft procedure</td>
</tr>
<tr>
<td>4271</td>
<td>free soft tissue graft procedure</td>
</tr>
<tr>
<td>4273</td>
<td>subepithelial CT graft, per tooth</td>
</tr>
<tr>
<td>4274</td>
<td>distal or proximal wedge procedure</td>
</tr>
<tr>
<td>4275</td>
<td>soft tissue allograft</td>
</tr>
<tr>
<td>4276</td>
<td>combined CT and double pedicle graft, per tooth</td>
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Nonsurgical periodontal services

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>4320</td>
<td>provisional splinting intracoronar</td>
</tr>
<tr>
<td>4321</td>
<td>provisional splinting extracoronar</td>
</tr>
<tr>
<td>4341</td>
<td>SRP 4+</td>
</tr>
<tr>
<td>4342</td>
<td>SRP 1-3</td>
</tr>
<tr>
<td>4355</td>
<td>full mouth debridement</td>
</tr>
<tr>
<td>4381</td>
<td>localized antimicrobial delivery</td>
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Other Periodontal Services

<table>
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<tr>
<th>Code</th>
<th>Description</th>
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<tr>
<td>4910</td>
<td>periodontal maintenance</td>
</tr>
<tr>
<td>4920</td>
<td>unscheduled dressing change</td>
</tr>
<tr>
<td>4999</td>
<td>unspecified procedure</td>
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Implant

<table>
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<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6010</td>
<td>endosteal implant</td>
</tr>
</tbody>
</table>

Oral Surgery

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<tr>
<td>7111</td>
<td>extraction deciduous</td>
</tr>
<tr>
<td>7140</td>
<td>extraction erupted tooth</td>
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<tr>
<td>7210</td>
<td>surgical removal of erupted tooth</td>
</tr>
<tr>
<td>7220</td>
<td>removal impacted tooth - soft tissue</td>
</tr>
<tr>
<td>7230</td>
<td>removal impacted tooth - partially bony</td>
</tr>
<tr>
<td>7240</td>
<td>removal impacted tooth - completely bony</td>
</tr>
<tr>
<td>7241</td>
<td>removal impacted tooth - completely bony, unusual surgical complications</td>
</tr>
<tr>
<td>7250</td>
<td>surgical removal of residual tooth roots</td>
</tr>
<tr>
<td>7280</td>
<td>surgical access of unerupted tooth</td>
</tr>
<tr>
<td>7285</td>
<td>biopsy of oral tissue – hard</td>
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</table>

Continued
### Table 8 continued

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7286</td>
<td>biopsy of oral tissue – soft</td>
</tr>
<tr>
<td>7310</td>
<td>alveoloplasty w/ extractions 4+</td>
</tr>
<tr>
<td>7311</td>
<td>alveoloplasty w/ extraction 1-3</td>
</tr>
<tr>
<td>7320</td>
<td>alveoloplasty no extraction quadrant</td>
</tr>
<tr>
<td>7321</td>
<td>alveoloplasty no extraction 1-3</td>
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</tbody>
</table>

#### Preventative

<table>
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<tr>
<th>Code</th>
<th>Description</th>
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<tr>
<td>1110</td>
<td>adult prophylaxis</td>
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</tbody>
</table>

#### Periodontics

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4240</td>
<td>gingival flap procedure, including root planing - 4+ contiguous teeth or bounded teeth spaces per quadrant</td>
</tr>
<tr>
<td>4241</td>
<td>gingival flap procedure, including root planing - 1-3 contiguous teeth or bounded teeth spaces per quadrant</td>
</tr>
<tr>
<td>4249</td>
<td>clinical crown lengthening - hard tissue</td>
</tr>
<tr>
<td>4260</td>
<td>osseous surgery - 4+ contiguous teeth or bounded teeth spaces per quadrant</td>
</tr>
<tr>
<td>4261</td>
<td>osseous surgery - 1-3 contiguous teeth or bounded teeth spaces per quadrant</td>
</tr>
<tr>
<td>4263</td>
<td>bone replacement graft - first site in quadrant</td>
</tr>
<tr>
<td>4265</td>
<td>biologic materials to aid in soft and osseous tissue regeneration</td>
</tr>
<tr>
<td>4266</td>
<td>guided tissue regeneration - resorbable barrier per site</td>
</tr>
<tr>
<td>4267</td>
<td>guided tissue regeneration - nonresorbable barrier per site (includes membrane removal)</td>
</tr>
<tr>
<td>4271</td>
<td>free soft tissue graft procedure</td>
</tr>
<tr>
<td>4273</td>
<td>subepithelial CT graft, per tooth</td>
</tr>
<tr>
<td>4341</td>
<td>SRP 4+</td>
</tr>
<tr>
<td>4342</td>
<td>SRP 1-3</td>
</tr>
<tr>
<td>4910</td>
<td>periodontal maintenance</td>
</tr>
</tbody>
</table>

#### Implant

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6010</td>
<td>endosteal implant</td>
</tr>
</tbody>
</table>

#### Oral Surgery

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7140</td>
<td>extraction erupted tooth</td>
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### Table 9. CDT Codes and Procedures Selected for Further Examination
### Table 10. Distribution of Periodontist Provider Characteristics

<table>
<thead>
<tr>
<th>State (N=351)</th>
<th>N</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indiana</td>
<td>33</td>
<td>9.4</td>
</tr>
<tr>
<td>Michigan</td>
<td>114</td>
<td>32.5</td>
</tr>
<tr>
<td>New Mexico</td>
<td>22</td>
<td>6.3</td>
</tr>
<tr>
<td>Ohio</td>
<td>131</td>
<td>37.3</td>
</tr>
<tr>
<td>Tennessee</td>
<td>51</td>
<td>14.5</td>
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</table>

<table>
<thead>
<tr>
<th>Urban vs. Rural (N=350)</th>
<th>N</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>325</td>
<td>92.9</td>
</tr>
<tr>
<td>Rural</td>
<td>25</td>
<td>7.1</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Gender (N=346)</th>
<th>N</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>292</td>
<td>84.4</td>
</tr>
<tr>
<td>Female</td>
<td>54</td>
<td>15.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AAP Membership (N=341)</th>
<th>N</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>283</td>
<td>83.0</td>
</tr>
<tr>
<td>No</td>
<td>58</td>
<td>17.0</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Location of Training (N=351)</th>
<th>N</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>University A</td>
<td>55</td>
<td>15.7</td>
</tr>
<tr>
<td>University B</td>
<td>56</td>
<td>16.0</td>
</tr>
<tr>
<td>University C</td>
<td>26</td>
<td>7.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Experience (N=294)</th>
<th>N</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>≤ 10</td>
<td>86</td>
<td>29.3</td>
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<tr>
<td>11-20</td>
<td>68</td>
<td>23.1</td>
</tr>
<tr>
<td>21-30</td>
<td>73</td>
<td>24.8</td>
</tr>
<tr>
<td>31-40</td>
<td>56</td>
<td>19.0</td>
</tr>
<tr>
<td>41-50</td>
<td>11</td>
<td>3.7</td>
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</table>

### Table 11. Number of Patients, Providers, and Claims by State

<table>
<thead>
<tr>
<th>State</th>
<th>Number of Providers</th>
<th>Number of Patients</th>
<th>Number of Visits</th>
<th>Number of CDT codes</th>
<th>Number of claims</th>
</tr>
</thead>
<tbody>
<tr>
<td>IN</td>
<td>33</td>
<td>13,241</td>
<td>60,754</td>
<td>76,221</td>
<td>65,136</td>
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<tr>
<td>MI</td>
<td>114</td>
<td>125,878</td>
<td>694,308</td>
<td>916,276</td>
<td>770,477</td>
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<tr>
<td>NM</td>
<td>22</td>
<td>11,437</td>
<td>43,690</td>
<td>59,180</td>
<td>47,071</td>
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<tr>
<td>OH</td>
<td>131</td>
<td>46,114</td>
<td>162,670</td>
<td>218,419</td>
<td>176,875</td>
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<tr>
<td>TN</td>
<td>51</td>
<td>18,060</td>
<td>64,833</td>
<td>90,052</td>
<td>69,755</td>
</tr>
<tr>
<td>Total</td>
<td>351</td>
<td>214,730</td>
<td>1,026,255</td>
<td>1,360,148</td>
<td>1,129,314</td>
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<tr>
<td>State</td>
<td>IN</td>
<td>MI</td>
<td>NM</td>
<td>OH</td>
<td>TN</td>
</tr>
<tr>
<td>-------------</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>Number of Providers</td>
<td>27</td>
<td>65</td>
<td>11</td>
<td>67</td>
<td>36</td>
</tr>
<tr>
<td>Rate of Procedures</td>
<td>1428.98</td>
<td>3677.53</td>
<td>716.01</td>
<td>745.71</td>
<td>772.36</td>
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Table 12: Yearly Rate of Combined 4000-4999 Codes of Interest by Provider and Geography

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<th>Parameter</th>
<th>Mean</th>
<th>SD</th>
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<tr>
<td>Graduation Date</td>
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<tr>
<td>41-50 years</td>
<td>65.42</td>
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<tr>
<td>31-40 years</td>
<td>62.97</td>
<td>0.02</td>
</tr>
<tr>
<td>21-30 years</td>
<td>61.20</td>
<td>0.02</td>
</tr>
<tr>
<td>11-20 years</td>
<td>60.05</td>
<td>0.02</td>
</tr>
<tr>
<td>10 years</td>
<td>59.81</td>
<td>0.03</td>
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<tr>
<td>State</td>
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<tr>
<td>Indiana</td>
<td>59.70</td>
<td>0.04</td>
</tr>
<tr>
<td>Michigan</td>
<td>62.67</td>
<td>0.01</td>
</tr>
<tr>
<td>New Mexico</td>
<td>57.14</td>
<td>0.05</td>
</tr>
<tr>
<td>Ohio</td>
<td>59.34</td>
<td>0.02</td>
</tr>
<tr>
<td>Tennessee</td>
<td>56.24</td>
<td>0.04</td>
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<td>Location</td>
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<tr>
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<td>61.22</td>
<td>0.01</td>
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<td>Rural</td>
<td>61.85</td>
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<td>Gender</td>
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<td>Male</td>
<td>61.36</td>
<td>0.01</td>
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<tr>
<td>Female</td>
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<td>University</td>
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<td>60.77</td>
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<td>University B</td>
<td>62.84</td>
<td>0.01</td>
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<td>University C</td>
<td>59.25</td>
<td>0.03</td>
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<td>Membership</td>
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<td>Yes</td>
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<tr>
<td>No</td>
<td>61.41</td>
<td>0.03</td>
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</table>

Table 13. Mean Age of Patient by Provider Characteristic
Appendix B

Figures

Figure 1. Distribution of Periodontists by Age
Figure 2. 1110 - Adult Prophylaxis by State
Figure 3. 4249 – Crown Lengthening by State
Figure 4. 4263 – Bone Replacement Graft by State
Figure 5. 4265 – Biologic Materials by State
Figure 6. 4266 – Guided Tissue Regeneration – Resorbable Barrier by State
Figure 7. 4267 – Guided Tissue Regeneration – Nonresorbable Barrier by State
Figure 8. 4271 – Free Soft Tissue Graft by State
Figure 9. 4273 – Subepithelial CT Graft by State
Figure 10. 4910 – Periodontal Maintenance by State
Figure 11. 4240 – Gingival Flap Procedure (4+ teeth) by State
Figure 12. 4241 – Gingival Flap Procedure (1-3 teeth) by State
Figure 13. 4260 – Osseous Surgery (4+ teeth) by State
Figure 14. 4261 – Osseous Surgery (1-3 teeth) by State
Figure 15. 4341 – SRP (4+ teeth) by State
Figure 16. 4342 – SRP (1-3 teeth) by State
Figure 17. 6010 – Endosteal Implant by State
Figure 18.  7140 – Extraction of Erupted Tooth by State
Figure 19. 1110 - Adult Prophylaxis by Geography
Figure 20. 4249 – Crown Lengthening by Geography

Average Number of Procedures

2000 - 2004
2005 - 2009

Urban
Rural
Overall

Figure 20. 4249 – Crown Lengthening by Geography
Figure 21. 4263 – Bone Replacement Graft by Geography
Figure 22. 4265 – Biologic Materials by Geography
Figure 23. 4266 – Guided Tissue Regeneration – Resorbable Barrier by Geography
Figure 24. 4267 – Guided Tissue Regeneration – Nonresorbable Barrier by Geography
Figure 25. 4271 – Free Soft Tissue Graft by Geography
Figure 26. 4273 – Subepithelial CT Graft by Geography
Figure 27. 4910 – Periodontal Maintenance by Geography
Figure 28. 4240 – Gingival Flap Procedure (4+ teeth) by Geography
Figure 29. 4241 – Gingival Flap Procedure (1-3 teeth) by Geography
Figure 30. 4260 – Osseous Surgery (4+ teeth) by Geography
Figure 31. 4261 – Osseous Surgery (1-3 teeth) by Geography
Figure 32. 4341 – SRP (4+ teeth) by Geography
Figure 33. 4342 – SRP (1-3 teeth) by Geography
Figure 34. 6010 – Endosteal Implant by Geography
Figure 35. 7140 – Extraction of Erupted Tooth by Geography
Figure 36. 1110 - Adult Prophylaxis by Gender
Figure 37. 4249 – Crown Lengthening by Gender
Figure 38. 4263 – Bone Replacement Graft by Gender
Figure 39. 4265 – Biologic Materials by Gender
Figure 40. 4266 – Guided Tissue Regeneration – Resorbable Barrier by Gender
Figure 41. 4267 – Guided Tissue Regeneration – Nonresorbable Barrier by Gender
Figure 42. 4271 – Free Soft Tissue Graft by Gender
Figure 43. 4273 – Subepithelial CT Graft by Gender
Figure 44. 4910 – Periodontal Maintenance Graft by Gender
Figure 45. 4240 – Gingival Flap Procedure (4+ teeth) by Gender
Figure 46. 4241 – Gingival Flap Procedure (4+ Teeth) by Gender
Figure 47. 4260 – Osseous Surgery (4+ teeth) by Gender
Figure 48. 4261 – Osseous Surgery (1-3 teeth) by Gender
Figure 49. 4341 – SRP (4+ teeth) by Gender
Figure 50. 4342 – SRP (1-3 teeth) by Gender
Figure 51. 6010 – Endosteal Implant by Gender
Figure 52. 7140 – Extraction of Erupted Tooth by Gender
Figure 53. 1110 – Adult Prophylaxis by Years of Experience
Figure 54. 4249 – Crown Lengthening by Years of Experience

[Bar chart showing the average number of procedures by years since graduation for two time periods: 2000-2004 and 2005-2009. The bars are grouped by years since graduation: 0-11, 12-21, 22-31, 32-41, 42-51, and overall.]
Figure 55. 4263 – Bone Replacement Graft by Years of Experience
Figure 56. 4265 – Biologic Materials by Years of Experience
Figure 57. 4266 – Guided Tissue Regeneration – Resorbable Barrier by Years of Experience
Figure 58. 4267 – Guided Tissue Regeneration – Nonresorbable Barrier by Years of Experience
Figure 59. 4271 – Free Soft Tissue Graft by Years of Experience
Figure 60. 4273 – Subepithelial CT Graft by Years of Experience
Figure 61. 4910 – Periodontal Maintenance by Years of Experience
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Figure 84: 4342 – SRP (1-3 teeth) by AAP Membership

The graph shows the average number of procedures for different membership categories over two time periods, 2003-2005 and 2006-2008. The categories are Member, Nonmember, and Total. The y-axis represents the average number of procedures, ranging from 0 to 120. The x-axis represents the time periods.
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