2006

Knowledge, attitudes, and behaviors of federal service and civilian dentists concerning minimal intervention dentistry

Elizabeth Bowles Gaskin
University of Iowa

KNOWLEDGE, ATTITUDES, AND BEHAVIORS OF FEDERAL SERVICE AND CIVILIAN DENTISTS CONCERNING MINIMAL INTERVENTION DENTISTRY

by

Elizabeth Bowles Gaskin

A thesis submitted in partial fulfillment
of the requirements for the Master of
Science degree in Dental Public Health
in the Graduate College of
The University of Iowa

July 2006

Thesis Supervisor: Professor Steven M. Levy

Graduate College
The University of Iowa
Iowa City, Iowa

CERTIFICATE OF APPROVAL

_____

MASTER'S THESIS

_____

This is to certify that the Master's thesis of

Elizabeth Bowles Gaskin

has been approved by the Examining Committee for the thesis requirement for the Master of Science degree in Dental Public Health at the July 2006 graduation.

Thesis Committee: _____
Steven M. Levy, Thesis Supervisor

_____
Deborah V. Dawson

_____
Jane M. Chalmers

_____
Sandra Guzmán-Armstrong

To Ingram

ACKNOWLEDGMENTS

I express my sincere appreciation to the United States Navy for providing the opportunity for training in Operative and Preventive Dentistry. Through the insight of Graduate Program Directors, Dr. Steven Levy from the Department of Preventive and Community Dentistry, and Dr. Marcos Vargas and Dr. Deborah Cobb, from the Department of Operative Dentistry, I was able to pursue a joint degree program, resulting in two Master's degrees, one in Dental Public Health and one in Operative Dentistry, and for this I am extremely grateful.

I'd also like to express my appreciation to the Dental Public Health thesis committee members, Dr. Steven Levy, Dr. Deborah Dawson, Dr. Jane Chalmers, and Dr. Sandra Guzman-Armstrong, for providing feedback, reviewing documents and their continual support of the project. Dr. Guzman-Armstrong was a member of both Dental Public Health and Operative Dentistry thesis committees. Dr. Steven Levy, research committee chairman, encouraged me from the beginning of the three-year program to consider a project, which could be an extension of my Operative Dentistry thesis project. The completion of this project is due, in large part, to Dr. Levy's direction and motivation. Thanks are also extended to Delta Dental and Dr. Ed Schooley, for awarding the Department of Preventive & Community Dentistry a Graduate Thesis Award to help defray costs of the project; Ms. Barbara Broffitt for assistance with SAS code; Ms. Helen Wilson and Ms. Kimberly Scott for printing and bulk mailing of questionnaires; Ms. Sheri O'Rourke for questionnaire transportation services; and Mr. Rick Paulos for data entry services. The project also received financial assistance from HRSA, Bureau of Health Professions Dental Public Health Specialty Training Grant and Dr. Steven Levy's Wright-Bush-Shreves Endowed Professor of Research Fund.

The views expressed in this article are those of the author and do not necessarily reflect the official policy or position of the Department of the Navy, Department of

Defense, nor the U.S. government. I am a military service member (CDR, DC, USN). This work was prepared as part of my official duties. Title 17, USC, §105 provides that 'Copyright protection under this title is not available for any work of the United States Government.' Title 17, USC, §101 defines a U.S. government work as a work prepared by a military service member or employee of the U.S. Government as part of that person's official duties.

TABLE OF CONTENTS

LIST OF TABLES

Table

LIST OF FIGURES

Figure

CHAPTER I

INTRODUCTION

The practice of dentistry has benefited from new technologies, the development of adhesive restorative materials, and more comprehensive knowledge of cariology. The paradigm shift that is presently occurring in dental practice is likely a result of these developments. Caries prevention and early detection, now a primary focus, have become an important part of dental practice. This focus on prevention and early caries detection created Minimal Intervention Dentistry (MID). Minimal Intervention Dentistry (MID) is a treatment philosophy that emphasizes assessment of caries risk, identification of early lesions, and remineralization of small lesions. This treatment philosophy also emphasizes protection of existing tooth structure, and placement of adhesive restorations with minimal cavity preparation. Disease elimination and regular follow-up care are core components of MID, a treatment philosophy based on the "Medical Model". The treatment philosophy a dentist adopts is most likely a result of dental school training practice experience, and continuing education.

The traditional restorative approach, in practice for over 100 years, followed the concepts of G.V. Black and "extension for prevention". This surgical approach was not tooth preserving, removing large amounts of tooth structure to accommodate the restorative material choice. Modern restorative approaches use an evidence-based medical model. The medical model emphasizes the science of caries, prevention, new technologies for caries detection, and adhesive restorative materials that bond to tooth structure. Modern restorative approaches are minimally invasive, retaining as much tooth structure as possible. The development of adhesive materials lessened the need for extension of cavity preparations. Previous studies have determined that the repair of restorations is a viable treatment option.

The Atraumatic Restorative Technique (ART) is a restorative approach developed from field trials to improve restorative access in remote regions of the world. Its distinguishing feature is removal of carious tissue with only hand instruments, typically a spoon excavator. Glass ionomer cements are the restorative material of choice for ART. Some dental schools have used a modified form of ART for rampant caries patients as a disease control treatment. Other areas of use include nursing homes and pediatric populations for definitive restorations. It is part of MID because of its tooth preservation emphasis and use of adhesive restorative materials. There is literature describing the use of ART among dental practitioners in general dental practice in several countries, but not within the United States. Studies addressing general dentists' knowledge, attitudes and behaviors toward ART would be a step toward its inclusion in evidence-based dental practice.

The scientific literature clearly indicates that dental caries is major reason for the placement and replacement of most restorations. The lesion often begins as an area of demineralization on the coronal or root surface. The demineralization/remineralization equilibrium determines the course of the lesion. Topical fluorides shift the equilibrium toward remineralization, whereas frequent exposure to sugary foods and drinks, poor salivary flow, and use of xerostomic medications shift the equilibrium toward demineralization.

There are differences between civilian dentists and federal service dentists. Federal service dentists are unique because they must develop both clinical skills and skills related to federal service, simultaneously. The federal service dentist, recruited from all regions of the United States, has little control over his or her practice location, practice philosophy, material purchases or patient population. Federal service dentists often are required to relocate frequently. Barriers to information might exist for the federal service dentists that are not present for the civilian dentist. Mission readiness dictates treatment priorities for the federal service dentist.

This study will be important in providing information to allow us to understand how dentists from the federal and civilian sectors have incorporated MID into their practices and it could provide useful information for additional studies on this topic. As treatment philosophies change, standards need to be established in federal service organizations where the patient base is mobile and providers responsive to short notice transfers. Newer treatment philosophies might be more easily accepted if they are endorsed by recognized professional organizations.

Despite these trends toward more conservative treatment, little is known about federal and civilian dentists' familiarity with these new concepts. To date, there are no published studies that evaluate the knowledge, attitudes and behaviors concerning Minimal Intervention Dentistry among federal service and civilian dental practitioners. This study could provide valuable information in this area.

The aims of this study were to determine the knowledge, attitudes, and behaviors concerning Minimal Intervention Dentistry among United States' dentists overall, between federal and civilian dentists, and among federal service dentists in the United States Air Force, Army, Navy, and Public Health Service. Additionally, this study was planned to determine the factors that influenced dentists' knowledge, attitudes and behaviors concerning Minimal Intervention Dentistry.

There were six research questions:

1. What were the knowledge, attitudes and behaviors of dentists overall toward Minimal Intervention Dentistry?
2. What factors influenced dentists' knowledge, attitudes and behaviors concerning Minimal Intervention Dentistry?
3. Do federal service general dentists and civilian general dentists have similar knowledge, attitudes, and behaviors concerning Minimal Intervention Dentistry?

4. What factors influenced federal service and civilian general dentists' knowledge, attitudes and behaviors concerning Minimal Intervention Dentistry?
5. Do Air Force, Army, Navy, and Public Health Service dentists have similar knowledge, attitudes, and behaviors concerning Minimal Intervention Dentistry?
6. What factors influenced Air Force, Army, Navy, and Public Health Service dentists' knowledge, attitudes, and behaviors concerning Minimal Intervention Dentistry?

The main emphasis of the study was to compare findings concerning federal service and civilian dentists. The hypotheses tested were that federal service and civilian dentists had similar knowledge, attitudes and behaviors concerning Minimal Intervention Dentistry and possessed similar characteristics that influenced their selection. A written questionnaire was the survey instrument.

CHAPTER II

REVIEW OF LITERATURE

The topics that will be discussed in this review include philosophies of restorative care, dental practice in the United States involving both civilian and federal dentists, and knowledge, attitudes, and behaviors of dentists concerning Minimal Intervention Dentistry. A summary at the end of this chapter discusses what is known up to this point, gaps in knowledge, and future directions.

Philosophies of Restorative Care

Overview

The restorative procedures taught in dental schools and used by dentists in clinical practice were based primarily on a textbook written by Dr. G. V. Black in 1908 titled, A Work on Operative Dentistry (Summit & others, 2001). Dr. Black related the science known at the time to the clinical practice of dentistry, and contributed to the foundation of the dental profession (Roberson & others, 2002). The tooth preparation classifications designed by Dr. Black more than one hundred years ago have been in use for most of the 20th century (Tyas & others, 2000). Many of the original concepts have been modified to more conservative, tooth-preserving procedures, creating a wider range of restorative options (Summit & others, 2001). For example, Mount and Hume (1997) proposed an alternative classification for carious lesions based on the site of the lesion and its size. More recently, there has been greater emphasis placed on also using interventions other than solely restorative techniques to treat the carious lesion (Roberson & others, 2002).

Restorative therapy is indicated when nonsurgical means of treating caries will not suffice (Summit & others, 2001). Restorative intervention does not remove the factors that caused the initial disease, but primarily repairs the damage, which could have a preventive effect by reducing the number of microorganisms involved in the disease

(Roberson & others, 2002). The restoration of teeth continues to command the most attention, although the primary problem with dental caries is control of the microflora (Mount and Ngo, 2000a).

Minimal Intervention Dentistry (MID) emerged from a better understanding of the caries process, tooth structure's potential for remineralization, and the introduction of restorative materials with better physical properties (Tyas & others, 2000). Remineralization therapy will lead to a decrease in restorative need for early lesions and strengthen tooth surfaces to resist future carious attacks (Roberson & others, 2002).

This section will review traditional restorative practice and Minimal Intervention Dentistry (MID). The primary components of MID will also be discussed.

Traditional Restorative Dentistry

Management of caries at the tooth level is termed traditional or surgical treatment, whereas management at the total patient level is called the medical model of treatment (Roberson & others, 2002). G.V. Black classified carious lesions and tooth preparations by their location in permanent teeth (Summit & others, 2001). This classification defined a series of designs based on the requirements for specific restorative materials (Mount and Ngo, 2003). These designs supported a surgical approach; carious lesions were completely removed and the tooth preparation extended into caries-resistant areas (Tyas & others, 2000). Dr. Black's classification did not consider the size and complexity of the lesion, and therefore, needs to be updated to manage modern caries challenges (Mount and Hume, 1997). The greatest problem faced by dentists in G.V. Black's time was their lack of understanding of how rapidly the lesion progressed through enamel and dentin, which led to the surgical removal of healthy tooth structures, along with the carious lesion (Mount and Ngo, 2003). Mount and Ngo (2003) suggested that the use of surgical correction as the primary approach to eliminate a bacterial disease needed to be re-evaluated.

A better term for the traditional surgical approach is “maximal intervention”, because it leads to the destruction of sound tooth structure in order to completely remove diseased tissue and retain the restoration (Mount and Ngo, 2000b). The surgical approach was a necessary approach at the time of its development since no valid alternative existed (Mount and Ngo, 2000b). The caries process was then thought to be irreversible; once enamel demineralization began, surgical excision was required to remove diseased tissue (Tyas & others, 2000). However, the surgical approach was highly destructive. Weakening of the tooth crown from large cavity designs often led to further restorative procedures (Mount and Ngo, 2000b). Each replacement restoration was bigger than the previous one and the majority of a clinician’s time was occupied in replacement dentistry (Mount and Ngo, 2000b).

Patients with carious lesions were assumed to be at high-risk for disease progression and new lesion formation, with restorations sometimes planned at the first appointment (Tyas & others, 2000). Restorations that were in poor condition were totally replaced rather than repaired (Tyas & others, 2000). The decision to place a restoration has traditionally occurred upon radiographic evidence of demineralization in enamel or to the dentinoenamel junction (Summit & others, 2001).

Minimal Intervention Dentistry

The MID approach is based on a refined model of dental care which consists of more accurate caries diagnosis; classification of the caries severity using radiographs and other tools; assessment of individual caries risk; arresting active lesions; remineralizing and monitoring cavitated arrested lesions; placement of restorations in teeth with cavitated lesions, using minimal cavity designs; and assessing disease management (Tyas & others, 2000). MID’s most important principle is to delay operative intervention “until the disease is controlled and operative intervention has become essential because of cavitation, patient discomfort, unacceptable form or function or poor esthetics” (Tyas &

others, 2000)" Minimal Intervention Dentistry is sometimes called Preservative Dentistry (Tyas & others, 2000), Conservative Dentistry (Summit & others, 2001), or Minimally Invasive Dentistry (Ericson & others, 2003).

Tyas & others (2000) described the first principle of MID as knowledge of the caries process. This knowledge of caries as an infectious disease supersedes the surgical approach with a biological or therapeutic one. Alteration of the oral environment to alter bacterial composition, minimize demineralization with application of agents like chlorhexidine and topical fluoride are two examples of the biological approach.

To fulfill the description of Minimal Intervention Dentistry, four basic principles must be applied (Mount and Ngo, 2000a):

1. Control the disease through reduction of cariogenic flora;
2. Remineralize early lesions;
3. Perform minimal intervention surgical procedures, as required; and
4. Repair, rather than replace, defective restorations.

Mount and Ngo (2000a) outlined the essential aspects of diagnosis and treatment planning in a minimal intervention approach emphasizing correct diagnosis of factors for at-risk individuals and instituting preventive therapies that heal, or remineralize the lesion. A surgical approach is necessary only at the point of surface cavitations and then only after there was adequate control of the disease. An important factor is whether the patient understands the caries process and is willing to combat it. The intent is also to preserve tooth structure with minimal invasion, limiting removal of defective restorations by repair rather than replacement, and use of biomimetic materials. Biomimetic materials are those materials that reproduce one or more natural phenomena within a biologic situation and are biocompatible.

Evidence-based dentistry (EBD) involves searching for valid and reliable evidence to provide answers to questions about patient-related problems, then using critical appraisal to determine whether the information is credible (Sutherland, 2001).

Critical appraisal offers a rapid assessment of the quality or relevance of research studies (Sutherland, 2001). Burt and Eklund (2005) described Evidence-based Dentistry (EBD) as doing the right thing, for the right patient, at the right time. Its three essential components are the scientific base for decision-making, the clinical expertise of the practitioner, and the patient's values (Burt and Eklund, 2005). The primary focus in the Medical Model of caries treatment is identifying and eliminating the causative factors for caries, along with repairing damage caused by caries (Roberson & others, 2002). This is a departure from the traditional surgical model because the disease is viewed as an infection rather than as a lesion and its treatment objective is to reduce or eliminate pathogens (Fiset and Grembowski, 1997). The medical model synthesizes knowledge of the disease process into a simple conceptual model using new technologies (Fiset and Grembowski, 1997).

A greater emphasis on evidence-based practice stems from changing socio-demographic patterns, knowledgeable healthcare consumers, rapid technical advances and the electronic assess to research evidence (Ismail and Bader, 2004). Allison and Bedos (2003) attributed lack of evidence supporting present treatment and a scarcity of good quality research as the driving forces behind encouraging evidence-based health care (Allison and Bedos, 2003).

A distinction between clinical practice and clinical research forms the basis for providing evidence for clinical decision-making (Gordon and Dionne, 2005). Although both involve patients, therapeutic interventions and assessment of outcomes, clinical practice is based on a subjective evaluation of outcomes, with clinical success judged qualitatively; clinical research attempts to make objective assessments without knowledge of treatments received by patients to control bias, therapeutic efficacy is quantified, and findings are analyzed statistically (Gordon and Dionne, 2005).

Allison and Bedos (2003) mailed questionnaires to 17,648 registered dentists in Canada to investigate their views on the utility (Are the results of dental research useful

to you?), accessibility (Are the results of dental research easily available to you?), and possible funding priorities in Canada. They received 2,797 responses (15.8%). Fewer clinicians (63.3% compared to 87.0% for teachers) and generalists (61.6% compared to 81.3% for specialists) claimed research results were easily available to them and this result was statistically significant ($p<0.001$). The majority of the sample (95.8%) reported altering an aspect of their clinical practice based on some form of research. Generalists more often reported altering use of a dental material ($p<0.001$), medical treatment ($p=0.035$), or educational message ($p=0.006$) than did specialists. Specialists ($p=0.002$) and teachers ($p<0.001$) reported changing a management strategy more than generalists or clinicians did. Altering a treatment technique was associated with male gender ($p<0.001$).

Iqbal and Glenny (2002) assessed the current knowledge, attitudes, and use and barriers to use of Evidence-Based Practice by 300 general dental practitioners in the north west of England in January 2001, using a self-reported questionnaire. The response rate was 69.6%. When asked what practitioners did when faced with clinical uncertainties, 60% turned to friends, 12% consulted a textbook, and 2% consulted an electronic database. Eighty-seven percent of dentists claimed to alter an aspect of their practice after reading a research article with highly significant results. Respondents perceived barriers to Evidence-Based Practice as lack of time, financial constraints, availability of resources, and attitudes of patients to change.

Dental caries is an infectious disease that causes tooth demineralization. Acid-forming bacteria in dental plaque cause destruction of tooth structure, beginning on the outer tooth surface and progressing through the dentin to the pulp (Guzman-Armstrong, 2005). The microorganisms most often associated with caries initiation are mutans streptococcus (Streptococcus mutans and Streptococcus Sobrinus), while lactobacilli contribute to caries progression (Summit & others, 2001). A high count of mutans streptococci in saliva (>1 million colony-forming units, CFU, per ml saliva) means that

many tooth surfaces are subjected to increased caries risk (Thylstrup and Fejerskov, 1999). Those with a high risk for carious lesions have levels 10^5 CFU/ml or above for mutans streptococci and 10^3 CFU/ml or above for lactobacilli (Featherstone & others, 2003). Once cariogenic bacteria are removed, noncariogenic bacteria predominate, with less cariogenic potential (Roberson & others, 2002).

The identification of individual and population level risk factors are important for early detection and prevention of disease as well as identification of relevant conditions that lead to tooth decay (Guzman-Armstrong, 2005). Dental caries is a dynamic process with alternating periods of demineralization and remineralization, so assessment of caries activity as either arrested or active is just as important as identification of the lesion (Summit & others, 2001). Criteria used to determine caries activity include past caries experience, progression of the lesions over time, and the appearance of the lesions, their structure, consistency, moistness and color (Summit & others, 2001). Other parameters for caries activity consist of the location of the lesion and the presence of plaque (Summit & others, 2001).

One of the best defenses against dental caries is fluoride, but the benefits need to be balanced with the risks of dental fluorosis (Levy, 2003). Selected as one of the ten greatest public health achievements of the 20th century by the U.S. Centers for Disease Control and Prevention (CDC, 1999), fluoridation of drinking water has substantially reduced the prevalence and incidence of childhood caries in the United States. Fluoridated water is available to 60% of the United States population, but substantial additional expansion is not expected due to continuing controversies about fluoridation (Levy, 2003). Those in non-fluoridated communities might consume fluoride in foods processed with fluoridated water (Winston and Bhaskar, 1998). In adults, water fluoridation benefits are more complicated because adults are not surveyed as often, they have more varied fluoride histories and other dental problems such as trauma or periodontal diseases that might cause tooth loss or restorations (CDC, 2001). Fluoride

can be delivered either topically or systemically. Pre-eruptive and post-eruptive are more recent terms for fluoride exposures, since most methods of fluoride delivery, which include rinses, dentifrices, water, foods and beverages, have both topical and systemic effects (Levy, 2003). The foundation of fluoride delivery for all is water and toothpaste (Levy, 2003). The main actions of post-eruptive fluoride are reducing demineralization and enhancing remineralization (Levy, 2003). Currently available toothpastes, mouthrinses and topical fluoride applications have a relative shortcoming; the low concentration of calcium and phosphate often available in saliva limits their ability to remineralize enamel (Winston and Bhaskar, 1998).

New technologies are targeted at correcting this shortcoming by delivering fluoride with calcium and phosphate ions, as well as supplemental use of amorphous calcium phosphate (Winston and Bhaskar, 1998). Derived from the milk product casein, casein phosphopeptide/amorphous calcium phosphate complexes (CPP/ACP) exhibit anticariogenic activity. Its mode of action is stabilizing calcium phosphate in solution and increasing the level of calcium and phosphate in dental plaque as non-ionic calcium phosphate (Reynolds, 1998). Reynolds & others (2003) compared the ability of CPP/ACP with other forms of calcium to be retained in dental plaque and to remineralize enamel. The investigators determined that an unstabilized calcium phosphate mouthrinse did not increase plaque calcium and phosphate levels, whereas 2% and 6% CPP/ACP containing mouthrinses significantly increased plaque calcium and phosphate levels in a dose dependent manner. Non CPP/ACP chewing gums with added calcium phosphate/calcium carbonate contained 5-13 times the total level of calcium as CPP/ACP gums; however, pellet and slab CPP/ACP chewing gums had the highest level of enamel subsurface lesion remineralization. Remineralization with the six gums was significantly correlated with the level of water-soluble calcium phosphate per piece of gum per treatment ($p<0.01$). This study demonstrated that CPP/ACP incorporated into

supragingival dental plaque and significantly increased plaque levels of calcium and inorganic phosphate to a superior level than other forms of calcium.

Anderson (2003) described the use of xylitol and chlorhexidine for caries management. A five-carbon sugar alcohol with a similar sweetening ability to sucrose, xylitol has been shown in several studies to control caries when placed in chewing gums. Xylitol creates an unfavorable metabolic environment for Streptococcus mutans, limiting the ability of the organism to utilize xylitol as an energy source. For the most part, xylitol use is considered safe, although large doses can cause osmotic diarrhea. An additional benefit of xylitol is its ability to reduce the frequency of otitis media in infants. Chlorhexidine attaches to intraoral surfaces and is slowly displaced by calcium ions in human saliva. This sustained release mechanism gives the drug substantivity. Its bactericidal effects are available up to six hours after rinsing with a 0.12% solution. Comparing xylitol and chlorhexidine, Anderson (2003) indicated that then current literature favored xylitol for caries control due to its ease of use, availability, and low cost.

Though caries rates have declined dramatically and there has been an increased emphasis on prevention, caries still affects a major percentage of the population (Winston and Bhaskar, 1998). Because of preventive therapies, the caries process has slowed down for many and now appears delayed through early adulthood (Simecek & others, 2005). The National Health and Nutrition Examination Surveys (NHANES) I conducted in 1971-1974 found a mean of 38.3 carious permanent surfaces, among adults ages 18 and 45, while NHANES III conducted 1988-1994 reported a mean of 27.9 carious permanent surfaces among the same age group (Brown & others, 2002).

Diagnosis can be described as a balancing act where the clinician uses interviews, clinical exams, and supplementary tests to express a probability of present and future occurrence of caries (Levato, 2005). The primary aims of the diagnosis of caries are to identify those lesions that require surgical (restorative) treatment vs. nonsurgical

treatment, and those at high-risk for developing carious lesions (Roberson & others, 2002). Patient history, clinical examination, nutritional analyses, salivary analyses and radiographic assessment are used as assessment tools for caries diagnosis (Roberson & others, 2002).

The traditional methods for identifying caries have been with a mirror, explorer, and radiography, which really detect well-advanced lesions (Abrams & others, 2005). Mount and Ngo (2000b) recommended examinations using a blunt explorer with light pressure because a sharp explorer could puncture an intact surface. An in-vitro pilot study investigating the effects of explorer probing of softened root surfaces on the remineralization of artificially created lesions in extracted teeth suggested that optimal remineralization efforts did not remove the defects caused by an explorer (Warren & others, 2003). The authors recognized that their in-vitro study might not be applicable to clinical situations, but recommended that clinicians pursue alternative means of diagnosing root caries (Warren & others, 2003).

Clinicians should interpret radiographs with caution since only 40% of radiographic proximal lesions in the outer half of dentin are actually cavitated (Mount and Ngo, 2000b). A limitation of radiography is its difficulty to detect early lesions. Other detection methods meant to augment caries diagnosis include transillumination, the electronic caries detector, and fluorescence devices such as DIAGNOdent®, although improvements are required before these devices can be relied on entirely (Mount and Ngo, 2000b). Quantitative Light Fluorescence (QLF) is another early caries detection device that is used to monitor remineralization and demineralization (Gonzalez-Cabezas & others, 2003). Magnification improves the ability to observe tooth structure and early lesions and could improve the field of vision during examinations (Levato, 2005) leading to more accurate diagnoses. Ozone, a gas that destroys bacteria and allows the saliva and normal remineralization process to work, is a future application and possible solution for dental caries (Levato, 2005).

Ismail (2004) reviewed the content validity of published articles on visual and visuo-tactile caries detection systems. Twenty-nine articles were selected that contained detailed descriptions of unique criteria for caries detection. The criteria systems were published in countries throughout Europe, the United States and Canada. Results suggested a gap existed between criteria systems used by European and United States researchers. European criteria systems favored the disease process, including early signs of dental caries. United States systems favored reliability and comparability, focusing on the cavitated stage or explorer sticks in teeth. The author concluded there was a need for one criteria system with content validity for visual and visuo-tactile detection of dental caries based upon both current scientific evidence and expert consensus. Ismail (2004) advised that contemporary content validity should be the guiding principle for any new caries diagnostic system in the 21st century, as long as it has a detailed protocol for calibration of examiners.

An optimal therapeutic regimen for the prevention, diagnosis and management of caries requires the use of risk assessment (Anusavice, 2001). Anusavice (2001) defined caries risk as the probability that new lesions will develop and/or a specific number of existing lesions will progress over a specified period. A caries risk assessment is needed for two reasons. The first is to tailor preventive measures for high-risk patients, those to gain the most benefit from preventive therapies. The second reason to perform a caries risk assessment is to delay restorations and prevent unnecessary surgical intervention in low-risk patients. A caries risk assessment might also avoid unnecessary preventive efforts in low-risk patients. Anusavice (2001) mentioned that whole mouth measurements of Strep mutans are probably inaccurate because caries is site specific, occurring on surfaces of teeth harboring cariogenic organisms. The best assessment tool recommended for private clinical practice is one that is simple.

The greatest predictor of caries risk is past caries experience. However, true caries risk might be underestimated due to lack of sensitivity of diagnostic aids (Anusavice,

2001). An overall review of factors that contribute to development of caries could identify those at risk in order to implement preventive or restorative treatment. A list of risk assessment criteria is presented in Table 1.

Table 1. Risk Assessment Criteria*

Past caries experience
Plaque accumulation and oral hygiene
Dietary habits
Attitude and health beliefs
Presence of physically, mentally, or socially compromising conditions
Fluoride exposure
Tooth morphology
Socioeconomic status
Oral environment

*Adapted from Guzman-Armstrong (2005)

These criteria help establish causes of the infection and whether the clinician should use a medical, surgical or combination model of intervention (Abrams & others, 2005). Caries risk identification is an effective way to predetermine those in need of adjunctive regimens (Barber and Wilkins, 2002). Complex decision-making is required in order to change from the traditional model of caries detection and diagnosis to a risk-based model (Levato, 2005).

An individual is given a risk level based on weighting of protective and destructive factors. In the review article examining caries risk by Anusavice (2001), the DMFS score outweighed most other factors as the most important in determining caries risk. In addition, protective factors include adequate salivary flow rate and buffering capacity, and fluoride and chlorhexidine exposures. Destructive factors encompass

plaque, microorganism types and concentrations, tooth position and morphology, and the frequency and amount of fermentable carbohydrates ingested (Anusavice, 2001). A caries risk assessment can be made with a reasonably high level of confidence using bacterial assays, fluoride levels, saliva flow, and dietary factors, along with the DMFS.

Approaches to Caries Prevention and Treatment

In this section are descriptions of minimally invasive approaches that are part of Minimal Intervention Dentistry. These approaches include sealants, use of adhesive restorative materials, and conservative operative cavity preparations. Atraumatic Restorative Treatment is included in this section since it conserves tooth structure and thus was a precursor to MID. This section ends with a discussion of the survival and longevity of restorations.

Bader & others (2001) undertook a systematic review of selected caries prevention and management methods applied to high-risk individuals and the efficacy of professionally applied methods to arrest or reverse non-cavitated carious lesions. Twenty-nine evaluations of preventive interventions for carious lesions were found in 22 adult studies, 9 for fluorides, 6 for chlorhexidine, 6 for combinations of fluoride, chlorhexidine or sealants, and 6 for other agents. Fluoride varnish was the only fluoride agent with sufficient evidence of efficacy. The evidence for efficacy of chlorhexidine was insufficient due to the small number of studies. The evidence was generally suggestive of efficacy for combined treatment approaches. There was insufficient evidence of efficacy for six studies reporting evaluations of an antibiotic, occlusal sealant, an alum rinse, use of a high-risk protocol for providers, and two concerning the effects of gum, although the gum-based interventions were suggestive of efficacy. Their search identified seven studies describing nine evaluations in children for non-cavitated lesions. The evidence was insufficient for all methods evaluated. Bader & others (2001) recommended future studies in these areas.

Axelsson & others (2004) also conducted a systematic review of controlled clinical trials for combinations of caries preventive methods in children and adults. They concluded that there was moderate scientific evidence of preventive effect combinations of treatments involving fluoride for children, although evidence for combinations of treatments in adults was inconclusive.

There is only a small amount of published evidence supporting the use of oral health assessment tools by residential care staff for older adults with dementia (Chalmers and Pearson 2005). The special needs populations of dependent and cognitively impaired adults with reduced physical dexterity, impaired sensory functions, cognitive deficits and communication and behavior problems present many challenges in the provision of preventive care. Chalmers and Pearson (2005) reviewed the best practice evidence for the oral health maintenance of adult residents in residential facilities. The types of participants included in these studies were residents in residential aged care facilities, community-dwelling adults with dementia, staff working within these facilities, and other adults with special needs. Cross-sectional and longitudinal studies reported that older adults with dementia had higher coronal and root caries incidence compared to those without dementia and staff carers, the primary providers of oral hygiene services, experienced behavior and communication difficulties while providing preventive oral hygiene care. Their review found that some effective and appropriate oral hygiene care interventions currently exist for cognitively impaired, institutionalized older adults. These interventions included use of topical and systemic fluorides, salivary stimulants and substitutes, chemical management of microorganisms with chlorhexidine gluconate, as well as, dietary sugar substitutes and restrictions. The authors recommended further studies in this area.

The Cochrane Collaboration published a systematic review of pit and fissure sealants for preventing dental decay in the permanent teeth of children and adolescents in 2004 (Ahovuo-Saloranta & others, 2004). Pit and fissure sealants were introduced in the

1960s to prevent decay from developing in pits and fissures of caries susceptible teeth. There are resin-based sealants and glass ionomer sealants that are self-cured or visible light-activated, and some contain fluoride. The authors' two primary objectives were to evaluate the caries prevention by molar and premolar sealants in general and then to compare the effectiveness of resin-based to glass ionomer cement sealants in caries prevention in children and adolescents. The outcome measure was the incidence of caries on the occlusal surfaces of permanent molar teeth in dentin, expressed as caries present or absent. Sixteen studies were eligible for inclusion in the review. In five studies comparing resin fissure sealant versus control at 12, 24, 36, 48, and 54 months the reductions in caries ranged from 86% at 12 months to 57% at 48 to 54 months. Glass ionomer versus resin sealant were compared in three studies, one study favored glass ionomer for caries prevention (RR 0.19), and two studies significantly favored resin sealant (RR 2.29, DFS mean difference -0.47). Follow-up retention rates were 79% to 92% at 12 months, 71% to 85% at 24 months, and 61% to 80% at 36 months for resin sealants. Glass ionomer cement sealants were less retentive, with rates from one study reporting <1%, and another 9% at 36 month follow-up. The authors recommended resin sealants for caries prevention on occlusal surfaces of permanent molars, but were less convinced about glass ionomer sealants.

Sealants are used for adults as well as children because, contrary to previously held beliefs, an increase in post-eruptive age does not decrease a tooth's susceptibility to dental caries (Simecek & others, 2005). The first longitudinal study of dental sealants in an adult population, which involved Navy recruits, demonstrated a sealant retention rate of 87.8% after an average follow-up period of 35 months (1997-2001). This high retention rate occurred although practitioners with different levels of experience placed the sealants under nonstandardized conditions (Simecek & others, 2005). The authors found that sealant placement was significantly related to the caries risk status ($p=0.009$);

a greater proportion of high-risk subjects (29.1%), and moderate risk (34.8%) subjects had sealants placed than low risk subjects (22.8%) did (Simecek & others, 2005).

From a cost and time perspective, placing sealants on high-risk rather than low-risk children is more effective, although savings might not be evident for several years (Weintrab, 2001). Heller & others (1995) evaluated outcomes of sealing sound tooth surfaces and those with incipient carious lesions of 113 children in a school-based sealant program. Most children were caries-free; however, there were multiple lesions in those children with a caries history. Sealed surfaces in initially incipient surfaces had an odds ratio of 8.88 versus an odds ratio of 1.63 in nonsealed surfaces for getting caries ($p=0.0015$). These results indicated that the association between sealant status and caries outcome depended upon the status of the initial tooth surface. The authors recommended targeting teeth with incipient caries for sealants, as sound tooth surfaces did not benefit greatly from the application of sealants.

Bhuridej & others (2005) retrospectively evaluated the natural history of treatment outcomes of permanent first molars with and without sealants four years after presumed eruption in 6-year old children. During the study period, 47.5% of the first molars were without treatment. For teeth that had received sealants, 88.0% of maxillary first molars and 86.5% of mandibular first molars had no other treatment during the period of the study. Sealed maxillary first molars (4.0%) received a one-surface restoration less often than non-sealed maxillary first molars (18.0%) did. A one surface restoration was completed in 4.5% of sealed mandibular molars compared with 18.0% in non-sealed ones. Nonsealed teeth received restorative treatments before sealed teeth did.

Folke & others (2004) evaluated the sealant success rates by provider type-dentist, registered dental hygienist (RDH), and registered dental assistant (RDA), while controlling for patient, tooth and treatment variables likely to alter success rates. The aim of this study was to evaluate the value of using auxiliary personnel in sealant placement over a ten-year period. Using a retrospective cohort review of 6,000 patient

records from a private pediatric dental office, they demonstrated that mean survival time in years for sealants placed by dentists (3.45) and RDAs (3.65) were less than the survival time in years of sealants placed by RDHs (7.71). Sealant failure was highly correlated to no fluoride exposure at placement ($p<0.003$), and previous caries experience ($p<0.003$). The authors concluded that all groups had sealant success, with significantly less risk of failure for sealants placed by RDHs ($p<0.001$).

Mertz-Fairhurst & others (1998) presented a report of the observed results for three restorative approaches followed over a 10-year period. They placed 77 localized sealed (AGS) and 79 unsealed (AGU) conventional amalgam restorations, and 2 groups of bonded and sealed composite restorations over caries (n=77, n=79), (CompS/C), in 131 molar pairs and 25 premolar pairs. Using a four-cell study design, each patient was paired with one of the amalgam restorations and a sealed composite. The sealant and composite restorative materials were chemically cured. There were 41 AGU, 44 AGS, and 85 CompS/C restorations available for evaluation at 10 years. Complete sealant retention for 10 years was AGS (25%), CompS/C (16%), and partial retention with no open margins for CompS/C (54%), and AGS (57%). The AGS group and CompS/C group had significantly fewer open margins than did the unsealed amalgam group ($p=0.009$, $p=0.003$). Caries occurred at the margin of one CompS/C and AGS restoration over the 10 year period, however, seven AGU restorations failed due to caries. The authors concluded that sealants should be adopted in placing Class I amalgam restorations as a means of maintaining marginal integrity. Their study demonstrated that bonded and sealed composite restorations placed over frank cavitated lesions arrested the progress of these lesions over a period of ten years. The superiority of sealed restorations from unsealed restorations stems from their protection of margins, prevention from recurrent caries, and by prolonging restoration survival (Mertz-Fairhurst & others, 1998). Sealant restorations were more conservative and performed as well as amalgam restorations (Hassall and Mellor, 2001).

The major categories of adhesive restorative materials are composites and glass ionomer cements. Hybrids of glass ionomer cements include giomers, resin modified glass ionomer cements and compomers. Composites resin restorative materials are a continuous polymeric or resin matrix in which inorganic filler is dispersed. A composite with good mechanical properties has a strong bond between the organic resin matrix and the inorganic filler. Composite classifications can be based on filler content (microfill, hybrid, nanofill), matrix content (BIS-GMA or UDMA), method of polymerization (self-cure or light cure), or by its handling properties. (Roberson & others, 2002). Glass ionomer cements are an aluminosilicate glass powder and copolymers of acrylic acid (Wilson & Kent, 1972). Glass ionomer cements most significant benefit is its ability to bond directly to tooth structure (Reinhardt & others, 1993). As a fluoride releasing restorative material, it is popular among practitioners in treating high-caries risk patients that require restorations. Table 2 presents the advantages and disadvantages of composite resin and glass ionomer adhesive restorative materials.

Table 2. Adhesive Restorative Materials used for MID Techniques

Material	Composite Resin	Glass Ionomer
Advantages*	Esthetic Conservative Bonds to tooth structure Repairable	Release fluoride Charge and recharge fluoride# Bonds to tooth structure Available in modified forms (resin modified glass ionomer, giomers, and compomers)
Disadvantages*	Gap formation Technique sensitive More costly than amalgam Wear in areas of high occlusal stress	Low wear resistance Low strength

*Roberson & others (2002) / #Strother & others (1998)

Hamilton & others (2002) conducted a 5-year randomized controlled trial evaluating the efficacy of early treatment of questionable carious lesions in pits and fissures of posterior teeth and reported their results after 2 years. The ninety-three participants ranged in age from 12 to 36 years. Three teeth were the maximum evaluated per participant. Participants were assigned to a control group (110 teeth) and early treatment group (113 teeth). Questionable pits and fissures in the early treatment group were prepared with air abrasion and restored with a sealant, if the preparation was entirely within enamel or a flowable composite if the preparation was within dentin. Polyvinylsiloxane impressions were taken for the early treatment group if the preparation extended into dentin and this was weighed as a surrogate measure of lost tooth volume. Recall examinations occurred at six-month intervals using Modified Ryge Evaluation Criteria. Modified Ryge Evaluation Criteria examine color match, marginal discoloration, marginal adaptation, anatomical form, surface smoothness, and sealant presence. Statistical analysis included chi-square and logistic regression, with generalized estimating equations for clustered data. The weights of the preparation impressions were compared by t-tests for independent samples. For the control group, 89 teeth were re-examined; 9 with caries after one year, 5 found carious the second year. Carious control teeth that extended into dentin also had polyvinylsiloxane impressions. There were less control teeth diagnosed with caries by 24 months compared to the number of teeth with dentinal caries in the early treatment group at the start of the study ($p<0.001$). The weights of the impressions of the control group (0.281 g) and early treatment group (0.260 g) were not significantly different ($p=0.390$). The results indicated that early treatment of questionable carious lesions in posterior teeth did not conserve tooth structure.

Fifty to seventy percent of all operative treatment on adults is comprised of replacement of restorations due to some diagnosis related to marginal defects (Ericson & others, 2003). Secondary caries was found most commonly, regardless of the restorative

material (Ericson & others, 2003). An assumption made when repairing restorations rather than replacing them is that there is no carious tissue beneath the present restoration. This is a reasonable assumption for a low-risk patient, but might not be well justified in a high-risk patient (Tyas & others, 2000). The conservative principles of cavity preparation, professional judgment of benefits versus risks, and the patient's risk for caries are the basis for choice of repair as a treatment option (Tyas & others, 2000).

McComb (2001) conducted a systematic review of the literature for three specific conservative, operative caries-management strategies, the proximal tunnel restoration, proximal box-only restoration, and the occlusal preventive resin restoration. The intent of the review was to provide evidence concerning the relationship between cavity preparation extension and restoration survival in permanent and primary teeth. The proximal tunnel restoration accesses proximal caries through a sound occlusal pit while preserving the proximal marginal ridge. In permanent teeth, this conservative strategy caused a high incidence of early re-restoration due to residual caries, recurrent caries and/or progression of demineralized enamel. It was not recommended for routine use. There is no occlusal dovetail or occlusal extension in a proximal box-only restoration. Available clinical trials supported use of the proximal box-only or slot restoration for the permanent dentition. The proximal box-only restoration met or surpassed the longevity of conventional Class 2 composite or amalgam restorations. A preventive resin restoration (PRR) is an occlusal composite restoration that replaces a localized area of dentinal caries, which is excavated, restored with composite, and has a sealant placed within surrounding pits and fissures (Summit, 2002). In addition to preservation of sound tooth structure, the PRR in permanent teeth was at least as successful as amalgam up to five years in two of the trials reviewed. Although loss of sealant was a universal problem in most studies, it is an effective conservative treatment for occlusal dentinal decay in localized areas. In primary dentition, conservative operative procedures, such as the proximal "box-only" restoration, have not been uniformly successful (McComb, 2001).

Atraumatic Restorative Treatment (ART) is a technique that uses only hand instruments for tooth preparation and caries excavation. Teeth are restored with adhesive materials, most often glass ionomer cements. Frencken & others (2004) evaluated studies where single surface ART restorations and amalgam restorations were compared in a meta-analysis containing five clinical trials. Amalgam restorations survived longer in the earlier studies; in later studies, ART restorations survived longer than amalgam restorations did in the earlier studies. Mjor & Gordan (1999) recommended ART for treatment of children with management problems, the mentally and physically disabled, and the elderly. Honkala & Honkala (2002) placed and evaluated 25 ART restorations in a homebound elderly population in Finland. After one year, they labeled 68% of the restorations as good, 11% as marginal and 16% as acceptable in the elderly population. In a pediatric population, the two-year follow-up success rate for ART restorations was 89.6%, with the failure rate of comparable pairs of ART and amalgam restorations at 5.7% (Honkala & others, 2003).

Burke & others (2000) surveyed dentists in the United Kingdom concerning their reasons for placing and replacing restorations. They considered factors such as oral hygiene, caries susceptibility, occlusal function, gender, and age. Restoration materials included amalgam, composite, glass ionomer, and compomers. This clinical study found that the primary reason for placement and replacement of a restoration was a diagnosis of caries. The mean replacement age of restorations in this study was 20.6 years for gold, 8.3 years for amalgam, 5.7 years for composite, 3.9 years for glass ionomer, and 2.8 years for compomers.

Hawthorne & Smales (1997) evaluated restoration survival and factors that influenced survival in their clinical study of three dental practices in Adelaide, Australia. The factors that appeared to influence restoration survival most were the experience of the dentist; the patient's age and their frequency of visits; whether it was an initial or replacement restoration; and a change of dentist (Hawthorne & Smales, 1997). This study

determined the median survival times for crowns as 26 years, amalgam as 22.5 years, and resin composites as 16.7 years.

The aim of the study by Burke & others (2005) was to provide preliminary understanding of the treatments that general dental practitioners in the United Kingdom, 300 dentists from West Midlands, England and with 300 from Scotland, use in the treatment of multi-surface carious cavities in primary teeth. A self-reported questionnaire was the study instrument used. The questionnaire contained color illustrations of carious lesions and respondents were asked to draw their preferred cavity outline for two separate clinical cases, which were briefly described. The lesions presented were ideal cases for use of Atraumatic Restorative Treatment (ART). Three hundred ninety questionnaires were returned for a response rate of 65%. Most respondents (75%) drew the outline around the carious lesion, or some slight additional preparation beyond the caries.

Summary

Restorative treatment includes non-operative procedures for remineralization of early lesions and prevention. Non-operative and operative treatment choices sometimes can be chosen from evidence-based clinical studies of effectiveness.

Recent restorative treatment such as ART, bonded restorations, sealants, and use of adhesive restorative materials highlight the paradigm shift to the medical model of caries management, Minimal Intervention Dentistry. A caries risk assessment is one of the most critical steps in caries management.

Dental Practice in the United States

Overview

The practice of dentistry in the United States occurs through the delivery of services by private and public dental practices, academic institutions, and with the assistance of administrators, industry, and related occupations in the Armed Forces (FDI

World, 2000). Careers in dentistry include private practice, salaried practice, federal service, and academia (Burt & Eklund, 2005). There were approximately 166,049 U.S. dentists in the year 2000 (Beazoglou & others 2002). Over two-thirds of these dentists were professionally active, with fifty-six percent in private practice (Health Workforce Personnel Factbook, Table 301). Approximately one-third were retired, administrators, in academia or industry (Health Workforce Personnel Factbook, Table 301).

The American Dental Association (ADA) is the largest and most influential dental organization in the United States and represents approximately seventy percent of the nation's dentists (Burt and Eklund, 2005). Membership in the ADA consists of tripartite membership in a local component, state or territorial constituent and the national ADA, with exceptions made for students and federal service dentists (Burt and Eklund, 2005). The ADA is a cohesive, well-organized association that promotes the public image of dentistry (Burt and Eklund, 2005).

Oral Health Care Workforce

The primary career choice for dentists in the United States is private practice (Burt and Eklund, 2005). Private practice is a small business where considerable capital is invested in land, buildings, equipment and furnishings to attract patients (Burt and Eklund, 1999). Some of its advantages are choice of practice location, good income, autonomy, and high status in the community. Disadvantages include overhead costs, equipment maintenance, and adherence to government regulations (Burt and Eklund, 2005). Private practice dentists are general practitioners or specialists and can operate as a group practice or as solo practitioners. Specialists generally earn higher incomes than general dentists do. Dentists owning private practices might employ other dentists. These associates are paid a salary and/or some percentage of gross production (Burt and Eklund, 2005). Other salaried dentists include federal service dentists, dentists in academic positions, and administrators of state, county, and local organizations. Oral

pathologists and public health dentists constitute two specialties that usually work in salaried positions (Burt and Eklund, 2005).

Most of the dental care provided in the United States occurs in private dental offices. From 1990 through 1995, it was estimated that over 90% of private practitioners owned their practices, with 70% being privately owned solo practices (Brown & Lazar, 1998). These percentages were similar in 1998; an estimated 92% owned their practice and 76.5% were sole proprietors (Mertz and O'Neill, 2002). There was an increase of 38.4% in the number of active private practitioners from 1976 through 1997 (Brown & Lazar, 1999).

The predominance of individual practices and subsequent lack of large institutionalized practice settings is a contributing factor to the complexity of dental workforce planning (Krause & others, 2005). Brown and Lazar (1999) stated that, since the late 1970s, there has been little change in the selection of solo practice as the predominant type of dental practice. Generalists comprised over 80% of active private practitioners. Sixty-seven percent (67.3%) of general dentists were solo practitioners in 1998. Sixty-two percent (61.5%) of dental specialists, in 1998, were solo practitioners (Mertz and O'Neill, 2002). Specialists accounted for approximately 18% in 1982, with little change through 1997 (Brown & Lazar, 1999). General dentists accounted for 81% of all patient visits in 1996 (Mansik and Moeller, 2002). Dentists worked in one office (90%) most often (Mertz and O'Neill, 2002).

Private practitioners in 1998 spent an average of 36.5 hours in their offices per week (Mertz and O'Neill, 2002). A trend has emerged toward more part-time work; however, most dentists work full-time (Mertz and O'Neill, 2002). Dental hygienists were more likely to be employed in group settings or practices (Mertz and O'Neill, 2002). Over ninety percent (93.4%) of solo practitioners employed at least one dental assistant (Mertz and O'Neill, 2002).

Private practice patients were of all ages: 21.5% were children under the age of fourteen, 58.4% were ages of fifteen to sixty-four, and 20.2% were sixty-five years of age or older in 1998 (Mertz and O'Neill, 2002). Considering that their representation in the population was only 12.7%, a very high percentage of seniors visited a private dental practice in 1998 (Mertz and O'Neill, 2002).

Compared to the physician workforce, the dentist workforce is smaller. It also tends to be more middle-aged and male, and is growing at a slower rate than is the general population (Mertz and O'Neill, 2002). Dentistry is also among the health professions with the least diverse racial ethnic distribution (Mertz and O'Neill, 2002).

The percentage of female dentists has increased over the years, being 2.6% of active private practitioners in 1982, and 12.8% in 1997 (Brown and Lazar, 1999). Today, women total 16.5% of professionally active dentists (Weaver & others, 2005a). A study examining the practice patterns among male and female general dentists in a Washington state population reported that women were approximately 14% of practicing dentists in 2002 (del Aquila & others, 2005). Female dentists were younger than their male counterparts were because their increase in the dental workforce has been recent (Brown and Lazar 1999). In 1997, ten percent of male dentists were younger than 35 years of age compared to thirty-three percent of female practitioners (Brown and Lazar, 1999). Female dentists were, on average, 7.9 years younger than male dentists were in the Washington state study (del Aguila & others, 2005). In 2004, women comprised 42.4% of first-time dental school enrollees (Weaver & others, 2005a).

Projections through 2020 indicate that male active private practitioner numbers will decline from 120,740 in 1997 to 110,229 in 2020, whereas female active private practitioner numbers will increase from 17,692 to 43,579 during the same period (Brown and Lazar, 1999). The Washington state study concluded that male and female dentists had generally similar practice patterns, although females treated 10% fewer patients, worked 10% fewer hours and performed 10% fewer procedures (del Aguila & others

2005). Seldin (2001) stated that the women differed from men primarily by women's greater percentage of part-time practice. There are indications that women spend less time in practice during a career (Burt and Eklund, 2005). A 2% reduction in output based on productivity was estimated with the current gender composition, and a less than 5% reduction in workforce output projected to 2020, when women would comprise 29.2% of the dentist workforce (Weaver & others, 2005a). Women are 29% of full-time dental school faculty, and ten of fifty-six dental school deans or interim deans (Weaver & others, 2005a).

An annual survey of the 2004 class of dental school seniors conducted by the American Dental Education Association (ADEA), which inquired about practice and postdoctoral education plans following graduation, found that 50.4% of graduating seniors planned to enter private practice, 4.1% with immediate plans to enter solo practice, 6.0% planned to enter a partnership or group, and 40.3% planned to become an associate or employee (Weaver & others, 2005b).

Dentists in the United States are an aging workforce. In comparison to physicians, there are fewer young dentists in practice and fewer older dentists remaining in practice past age 65 (Mertz and O'Neill, 2002). The age distribution of professionally active dentists had a significant peak at 40 to 44 years of age in the late 1990s, with 57.7% of dentists in the 30- to 49-year-old age group (Brown and Lazar, 1999). There will be a more diffuse age distribution by 2010, with 30- to 49-year-olds accounting for 44.4% of professionally active dentists and more dentists in older age groups than in 1997 (Brown and Lazar, 1999).

Walton & others (2004), using 21 years of cross-sectional national survey data from the U.S. Bureau of Labor Statistics to assess dentists' work patterns, found that age had a significant effect on the number of hours a dentist worked. The authors reported age as younger than 35 years, 35 to 55 years, and older than 55 years. Younger dentists worked four or five hours more per week than dentists who were 55 years or older

($p<0.01$). Women worked fewer hours than men did for each age category ($p<0.001$). The average number of hours worked by all dentists was 40 hours per week. In the younger age groups, 20% of women and 32% of men worked more than 42 hours per week. Dentists in the younger age groups involved in part-time (<32 hours) work included 25% of female dentists and 10% of male dentists. The percentage of part-time dentists rose to 30% for men older than 55 years.

State practice acts form the legal basis for dental practice in the United States (Burt and Eklund, 2005). Individual state practice acts have been blamed for the misdistribution of dentists, who are not evenly distributed throughout the United States (Burt and Eklund, 2005). Geographic imbalances exist in the dental workforce across the country and in specific communities (Seldin, 2001). The number, types and locations of educational programs could influence the geographic distribution of dentists (Neumann, 2004). There were declines in the dentist-population ratio in Minnesota, Missouri, Michigan, Nebraska, and Wisconsin. The number of dentists did not keep pace with the growth of populations in Arizona, Georgia, and, Nevada (Seldin, 2001).

> "Factors that must be considered when evaluating the adequacy of the work force in any geographic area include the socioeconomic status, race and ethnicity, disability status and disease patterns of the population. Other factors that affect the capacity of the dental work force are productivity, efficiency, extent of duties of allied personnel, new technology and techniques, and emerging research that alters the manner of diagnosis and treatment (Seldin 2001)."

The South has the most unfavorable dentist/population ratio of all of the geographic areas (Burt and Eklund, 2005).

Reasons for the unequal distribution of dentists include choice of practice location, dental school location, and the demand for services (Burt and Eklund, 2005). Regional board examinations have made movement of dentists easier. The Northeast (NERB), Southern (SRTA), Central (CRDTS), and Western (WREB) regional board examinations have made movement easier because they allow a dentist to apply for

licensure in a number of states, usually within five years after passing the original regional examination (Burt and Eklund, 2005).

Ranney & others (2003) sent a written sixteen-question survey with one open-ended question soliciting comments concerning licensure issues to deans of all dental schools in the United States and Puerto Rico. They obtained an overall response rate of 89%. Fifty of fifty-six schools returned the survey. Dental schools that responded were grouped by region and "seventeen (34%) were from the NERB region, eight (16 %) from CRDTS, seven (14%) from SRTA, six (12%) from WREB, and twelve (24%) from states with independent testing agencies (Ranney & others, 2003)." Ninety-two percent thought their state's licensure process should change. Eighty-two percent thought clinical testing for licensure did not provide a valid basis for licensure decisions. There were statistically significant regional differences. The Northeast region preferred a national examination; the western region favored a regional level evaluation. The greatest numbers of open-ended responses were recommendations to remove live patients from the examination process.

Dental Education

Pre-doctoral Education

The formation of the Baltimore College of Dental Surgery in 1840 marked the establishment of formal education in dentistry in the United States (Schulein, 2004). The number of dental schools increased slowly until the later part of the 1800s, and then grew at a more rapid rate through 1902, replacing the traditional preceptorship method of training (Schulein, 2004). In 2003, there were 56 accredited predoctoral dental education programs in 34 states, the District of Columbia, and Puerto Rico, with three of these new dental schools opening within the previous six years (Neumann, 2004). Thirty-five of these are public and 21 private dental schools (Schulein, 2004). Alaska, Arkansas, Delaware, Hawaii, Idaho, Maine, Montana, New Hampshire, New Mexico, North

Dakota, Rhode Island, South Dakota, Utah, Vermont, and Wyoming are states with no history of dental colleges (Schulein, 2004). The traditional educational program leads to a Doctor of Dental Surgery (DDS) or a Doctor of Dental Medicine (DMD) degree after four years. The DDS and DMD are equivalent degrees. Thirty-seven dental schools award the D.D.S. degree, which was first used by the Baltimore College of Dental Surgery, and 19 award the D.M.D. that was first used by Harvard Dental School (Schulein, 2004).There are private and public dental schools found in all regions of the country.

An important role of dental schools is to anticipate needs for dental personnel and attempt to manage the supply of dentists (Neumann, 2004). The number of dental school applicants increased over the last three years from 7,412 to 9,433, an increase of 27.3%, possibly the result of a positive occupational outlook for dentistry and reported rates of return on a dental education (Weaver & others, 2005a). The major areas of study for predoctoral applicants to dental school and enrollees were the biological, chemical, and physical sciences or predentistry/medicine (Weaver & others, 2005a). A report examining the enrollment, cost and academic admission criteria of U.S. dental schools by geographic region and institution type found significant regional differences in total expenses for dental schools; southern schools had lower costs than did central or northeastern schools in 2000-2001 (Markiewicz, 2004). The percentage of in-state enrollment was the only significant difference noted for private dental schools compared to public schools; there was higher enrollment of in-state students for western schools (73%) than either northeastern (27%) or southern schools (20%) (Markiewicz, 2004). Other findings were that students matriculating in public schools had a significantly higher Grade Point Average (GPA) and Dental Admissions Test (DAT) than private schools did, and that southern public dental schools had lower four-year expenses compared to the central region, and the highest in state enrollment compared with any other region (Markiewicz, 2004). The average graduating debt of dental students

reported in 2004 was $122,263 (Weaver & others, 2005b). Individual or state regional board examinations, which qualify dentists to apply for licensure in a state or region, are usually completed just before or soon after graduation. Regional boards include several states within a specific geographic area.

Dentists who seek additional training might continue their education in a specialty, General Practice Residency, or Advanced Program in General Dentistry. Table 3 presents a list of nine specialties recognized by the American Dental Association. Most states require continuing education courses to maintain licensure, but requirements vary by state.

Table 3. Recognized Specialties of the American Dental Association

Specialty
Dental Public Health
Endodontics
Oral and Maxillofacial Pathology
Oral and Maxillofacial Radiology
Oral and Maxillofacial Surgery
Orthodontics
Pediatric Dentistry
Prosthodontics
Periodontics

Post-doctoral General Dentistry Training

Postgraduate general dentistry programs (PGD) are General Practice Residency (GPR) and Advanced Education Programs in General Dentistry (AEGD) programs. Most general dentistry education programs are sponsored by hospitals and the military (Neumann, 2004). Generally, GPRs are hospital based and AEGDs are dental school-based and more general dentistry focused (Mito & others, 2002).

Over 60% of respondents to a survey of 2,018 dental school graduates that examined PGD training and its impact on general dentist practice patterns, stated they were encouraged to participate in postdoctoral dental education (66% female and 64% male) (Atchison & others 2002a). The three top reasons for participating in a PGD program were "needed more experience to increase speed (69%), needed more experience with special and/or medically compromised patients (66%), and wanted hospital experience (56%) (Atchison & others, 2002a)." The three most common reasons not to participate in a PGD program were "ready to start practice (50%), great dental practice opportunity (32.5%), and excessive student debt (28.7%) (Atchison & others, 2002a)."

Mito & others (2002) sent a survey to 316 civilian AEGD and GPR program directors to assess differences between Health Resources Services Administration (HRSA) funded and unfunded PGD programs during the years 1985 through 1998. The response rate was 63%. The authors were not able to assess nonfunded AEGD programs due to the small pool of respondents. Mean numbers of first year AEGD positions (6.3) were significantly greater ($p=0.0140$) than GPR positions (4.6). AEGD programs (7.5) had a higher mean number of residents than GPR (5.3) programs ($p=0.0019$). AEGD programs treated more healthy adults (mean 2.3 vs. 1.9) and insurance/private pay individuals than did GPR programs. Regarding patient populations, GPR programs treated more children (mean 4.2 vs. 3.2), and more medically intensive (mean 6.5 vs. 5.8) patients than did AEGD programs. GPR programs serviced lower fee populations ($p<0.0001$). Mean GPR annual stipends ($32,002) were significantly greater than were mean AEGD stipends ($22,119) ($p<0.0001$).

Title VII, Section 747's Grant Program for General Dentistry has been responsible for creating and expanding new general dentistry programs and training positions (Mito & others, 2002). More AEGD dental programs recently sought Medicare Graduate Medical Education (GME) funding sources for resident stipends and program

support, while for decades GPR programs have been a part of GME funding. AEGD programs provide comprehensive patient care similar to that found in most general dental offices while GPR programs enable dental school graduates to gain experience treating the elderly and medically compromised patient (Atchison & others, 2002a).

Regarding responses of graduating dental school seniors about practice plans immediately following graduation in 2004, 50.4% planned to enter private practice, 38.6% planned to pursue advanced education, 7.5% planned to enter government service, and 0.5% planned to enter academia (Weaver & others, 2005b). Debt played an important role in students' decisions to pursue advanced education. Students with no debt pursued advanced education more often than debted seniors did (Weaver & others, 2005b). Over thirty percent (30.5%) of graduating seniors applied to a General Practice Residency (GPR) or Advanced Education in General Dentistry (AEGD) program, 25.4% to accredited specialty programs, and 140 students to non-accredited advanced education programs (Weaver & others, 2005b). The development of sophisticated general dentists is the goal of postgraduate general dentistry (PGD) training programs (Atchison & others, 2002).

A survey sponsored by the Health Resources Services Administration (HRSA) through the University of California at Los Angeles assessed the short- and long-term impact of general dentistry training on practice characteristics and related professional activities emphasizing gender (Atchison & others, 2002b). They mailed 7,387 survey questionnaires in 2001 to a pool of dentists who completed postgraduate training in general dentistry ten, five, or one year previously. The survey contained questions about occupation, demographics, types of services provided, and community and professional activities. Their response rate was 30%. They received questionnaires from 986 (48.8%) general dentists with no postdoctoral training, 137 (6.8%) with Advanced Education in General Dentistry (AEGD) training, 419 (20.8%) with General Practice Residency (GPR) training, and 476 (23.6%) with training in one of the nine accredited specialties. There

were 743 (36.8%) females and 1,275 (63.2%) male respondents. PGD-trained dentists were more likely to choose other career paths besides private practice, referred less to specialists than non-PGD trained general dentists, although female dentists referred to specialists more than did male dentists, and were more likely to be involved in volunteer activity. Female PGD-trained dentists were more likely to work in government, hospital care or dental education than male PGD-trained dentists did.

Continuing Education

A major factor in the maintenance of a dental license in the United States is mandatory continuing education requirements (Schleyer and Dodell, 2005). State boards determine the acceptable number of continuing education hours required for license maintenance as well as the types of courses. Some state dental boards have separate minimum and maximum requirements for clinical, defined as directly related to patient care, and nonclinical credit hours (Schleyer and Dodell, 2005). Forty-five of the 50 states and the District of Columbia required CE for relicensure as of 2002 (Schleyer and Dodell, 2005). The states of Colorado, Connecticut, Vermont, Wisconsin, and Wyoming had no CE requirement as of 2002 (Schleyer and Dodell, 2005). Table 4 is an adaptation from Schleyer and Dodell (2005) titled Summary of CE Requirements by Jurisdiction.

According to Schleyer and Dodell (2005), thirty jurisdictions limited independent study course hours, 28 states mandated certification in CPR, and infection control training was required in eight states. Diplomate status in an ADA-recognized specialty awarded 50 non-clinical hours of CE credit in Missouri, while Massachusetts included audiocassettes, educational television, correspondence courses, and home study courses in their definition of self-instruction courses. CE credits have also been granted for holding a faculty position, producing scientific papers or presenting a paper or table clinic (Schleyer and Dodell, 2005).

Table 4. Average Annual Continuing Education Requirements Per Year*

State	Credit hours	State	Credit hours	State	Credit hours	State	Credit hours
AL	20	IN	10	MT	20	PA	15
AK	28	IA	15	NE	15	RI	20
AZ	24	KS	30	NV	12	SC	14
AR	20	KY	15	NH	20	SD	20
CA	25	LA	20	NJ	20	TN	15
DE	25	ME	20	NM	20	TX	12
DC	13	MD	13	NY	15	UT	15
FL	15	MA	20	NC	15	VA	15
GA	20	MI	20	ND	14	WA	21
HI	16	MN	15	OH	20	WV	10
ID	15	MS	20	OK	36		
IL	16	MO	25	OR	20		

*Based on the renewal period

Source: Schleyer T, Dodell D (2005). Continuing dental education requirements for relicensure in the United States. Journal of American Dental Association 136(October): 1450-1456.

Note: Colorado, Connecticut, Vermont, Wisconsin and Wyoming do not require CE for relicensure.

The impact of dental CE on practice has not been evaluated extensively in the literature. Bullock & others (1999) distributed questionnaires to general dental practitioners six weeks after attendance at three short courses in the West Midlands Area of the United Kingdom. One course was a large lecture course with 42 participants, the second a small, hands-on course with 9 participants, and a third medium-sized discussion with 20 participants. The questionnaire had four questions that evaluated the impact of the course on their practice and whether their practice had changed because of the courses. The response rate for the lecture course was 36%, for the discussion course was 95%, and for the smaller course was 89%. Most respondents (93% small, 84% medium, and 93% large) thought that the courses had improved their understanding, but fewer

thought that, as a result of the course, they would have changed their practice (25% small, 29% medium, and 64% large) (Bullock and others, 1999).

Financing Oral Health Services

Sources of financing oral health services include a two-party system, which is a private contract between the provider and patient, and a third-party system where outlays for health care services by a provider to a patient are paid through a private or government organization (Burt and Eklund, 2005). The two-party, fee-for-services system has the longest history with payment made directly from a patient to the provider (Burt and Eklund, 2005). This system works well for those with the resources to pay. The two-party system could serve as a barrier to utilization for the economically disadvantaged. The poor, near poor, medically disabled, and geographically isolated have lower utilization rates than more affluent groups (Beazoglou & others, 2002).

Third-party payments are provided through not-for-profit and private insurance plans, and by public insurance plans such as Medicare and Medicaid. Private insurance plans are individually purchased and employer-sponsored plans (Damiano, 2001). High premiums and limited benefits are two of the characteristics of individual policies (Burt and Eklund, 2005). A major difference between dental insurance, also called dental prepayment plans, and other health insurance is that it spreads the financial load of dental care over a group and over time (Burt and Eklund, 2005). Premiums contain the expected reimbursable cost of care and administrative expenses (Burt and Eklund, 2005).

Burt and Eklund (2005) described currently used forms of third-party reimbursement as usual, customary, and reasonable fee (UCR), table of allowances, fee schedule, discounted fee (preferred provider organizations [PPOs]), and capitation. A UCR is a fee that is frequently charged that considers the severity of condition along with a level set by an administrator. A table of allowances has a dollar amount for a list of covered services. This might not represent full payment. A fee schedule also sets a

dollar amount to a list of services but represents full payment. A discounted fee is a fee a dentist agrees to accept that is lower than their usual fee. In a capitation plan, a dentist receives a monthly payment based on the number of assigned patients, whether care is provided or not. A capitation plan is less common in dentistry than in medicine (Burt and Eklund, 2005). Dentistry has fought incorporation into larger systems of managed care and capitation that are common in medicine, and has remained largely a "cottage industry" (Mertz and O'Neill, 2002).

Socioeconomic factors, such as lack of dental insurance or the inability to pay, are major barriers to oral health (Shepherd, 2004). From a societal and individual perspective, a desirable consequence of having insurance is the greater utilization of preventive services (Damiano, 2001).

Delta Dental is a dental service corporation that developed from union requests to set up their own dental clinics in Washington State in the mid-1950s (Burt and Eklund, 2005). Delta Dental is a not for profit dental plan.

> "A dental service corporation is a legally constituted not-for-profit organization, incorporated on a state-by-state basis, which negotiates and administers contracts for dental care. The original dental service corporations, now known as Delta Dental Plans in most states, were sponsored by the constituent dental societies in each state where they were initially formed. A service plan is a program in which payment is meant to represent full payment, with no additional charge to the patient allowed beyond a preestablished co-payment or deductible. Following the success of the early Delta plans, Blue Cross and Blue Shield organizations also began organizing dental plans in many states, which usually also were organized as not-for-profit service corporations (Burt and Eklund, 2005)."

More people have commercial insurance carriers than any other type of carrier. These plans do not necessarily charge higher rates. Reimbursement occurs through a fee profile developed by the commercial insurance company and cash payments are made directly to the provider (Burt and Eklund, 2005).

Managed care is a general term that defines arrangements, usually Health Maintenance Organizations (HMO) and Preferred Provider Organizations (PPO), through which people receive their health care from providers who are formally connected to the organization (Burt and Eklund, 2005). Patient costs are generally lower using this method. Point-of Service Plans allow enrollees to receive care from providers out of the managed care providers. In direct reimbursement, a form of payment endorsed by the American Dental Association, the employee is responsible for paying expenses for treatment and the employer reimburses the employee according to rules established prior to use of dental services (Burt and Eklund, 2005).

The passage of the first Social Security Act of 1935 created a system to provide income maintenance for the elderly based on financing from employee-employer contributions (Burt and Eklund, 2005). The 1965 amendments to the Social Security Act, Title XVIII, Medicare, and Title XIX, Medicaid, provided health care services to those aged 65 and over, and health care services to the indigent and medically indigent, respectively (Burt and Eklund, 2005). Medicaid (Title XIX) is a part-federal, part-state program (Sweet and others, 2005). In the State of Iowa, Medicaid is a fee-for-service program without dental managed care options (Sweet and others, 2005). To qualify for Medicaid financing, states must cover a set of basic services for all children who are receiving financial assistance (Burt and Eklund, 2005). Another amendment to Medicaid occurred in 1968 with the introduction of Early and Periodic Screening, Diagnosis, and Treatment (EPSDT), which provides mandatory medical, dental, vision, and hearing services to needy children through age 20 (Burt and Eklund, 2005). Title XXI, an amendment introduced in 1997, created the State Children's Health Insurance Program (SCHIP). Federal funds are provided to states for Medicaid and SCHIP. SCHIP guidelines stipulate that state funds provide payment for children's health care for families with income greater than those qualifying for Medicaid did, but less than that sufficient to purchase private health insurance (Burt and Eklund, 2005). Low dentist

participation, lower reimbursement rates compared to the UCR fee, and perceived programmatic challenges exist as barriers for utilization of the Medicaid program (Sweet & others, 2005).

Sweet and others (2005) compared the demographic characteristics and use of dental services for enrollees in a private insurance and public prepayment plan in Iowa, by evaluating Iowa claims data from the Delta Dental Plan of Iowa and Medicaid for fiscal year 1998. Delta Dental of Iowa offers more than 200 plan options to employers. Iowa Medicaid has no dental managed care options and is entirely fee-for-service. The authors demonstrated that 69.3% of Delta Dental enrollees with claims and 27.2% of Medicaid enrollees with claims used dental services in 1998. Medicaid enrollees who used dental services were predominantly female. Most Delta Dental enrollees were older than 31 years of age (84.4%), whereas 54.3% of the Medicaid population were 30 years of age or younger. The Medicaid population used more tertiary care dental services, that is, endodontic services (9.9% versus 5.0%) and extraction services (27.4% versus 7.1%), than the Delta Dental population. These results might signify trends found in other states.

Publicly financed programs of dental care are also available through the Public Health Service, community and migrant health centers, Maternal and Child Health Services (MCHS) block grants, the Health Care for the Homeless Program and the National Hemophilia Program (Burt and Eklund, 2005). Services are provided through safety-net dental clinics.

"Safety-net dental clinics are community based providers located in low-income areas and serving diverse populations that face various access barriers, often including a limited ability to pay for services (Byck & others, 2005)." Community health centers and local health departments are the largest groups of dental safety-net clinics (Byck & others, 2005). Veterans are eligible for dental care through the Department of Veterans Affairs, and military personnel through various branches of the military. TRICARE provides a dental plan for military family members (Burt and Eklund, 2005).

Summary

Private practice remains the primary method of dental care delivery in the United States. The type of practice mode a graduating dentist selects is based on many factors, including debt from dental school training and earlier education loans. For those who select advanced training, general dentistry training programs are selected most often. Women are entering the dental profession in greater numbers than in the past, with relatively little change in dental productivity, although women are more likely to pursue part-time work. Changes have also occurred in private and public financing of dental care. The cost of oral health care can present a barrier to those unable to pay. A responsive, competent, and elastic work force is the key to meeting the public's needs (Seldin, 2001).

The Federal Services

Overview

The United States Air Force, Army, and Navy/Marine Corps teams are parts of the Department of Defense (DOD) and, along with the Coast Guard, represent the United States military or armed forces. The President of the United States is the Commander in Chief of the armed forces. The Secretary of Defense, appointed by The President of the United States, directs the DOD. There are three departments within the DOD, each headed by a secretary: the Department of the Air Force, the Department of the Army, and the Department of the Navy.

The armed forces are composed of enlisted and officer categories. There is an active component and a reserve component. Sixty-three percent of all service members are in the active component (GAO, 2005). Many factors influence the decision to join the military. These factors are a combination of personal, demographic, family, and societal factors, and economic and educational incentives (GAO, 2005). One of the greatest challenges facing the United States military since it authorized an all-volunteer

force in 1973 has been maintaining an adequate number of trained personnel to meet mission requirements (GAO, 2005). The retention rate is the proportion of enlisted and officer military members who continue their military service past their service obligation. Retention rates for the years 2000, 2002, and 2004 were 85% to 87% for the active component enlisted personnel and 90% to 93% for active component officers (GAO, 2005).

The United States Public Health Service (USPHS) is a part of the Department of Health and Human Services (DHHS). The United States Public Health Service protects and promotes the public's health (Kleinman & others, 2003). The PHS commissioned corps is different from the military services because it is an all-officer organization (USPHS, 2006). The key agencies of the USPHS are listed in Table 5. The PHS provides clinical care primarily to merchant seamen, the Coast Guard, Native Americans, and federal prison residents (Burt and Eklund, 2005).

Table 5. Key Agencies of the USPHS

Agency
Agency for Healthcare and Research Quality
Agency for Toxic Substances and Disease Registry
Centers for Disease Control and Prevention
Food and Drug Administration
Health Resources and Services Administration
Indian Health Service
National Institutes of Health

Source: Kleinman D, Hickey DJ, Lipton JA (2003). Promoting the public's oral health: the department of health and human services, U.S. public health service, and the U.S. public health service commissioned corps. Journal of the American College of Dentists 70(2): 16-21.

The rank structure of the federal services is shown in Table 6. Traditionally, PHS officers are referred to by their U.S. Navy equivalent rank, except for the proper PHS titles and abbreviations of the Assistant Secretary for Health (O-7), Surgeon General (O-8), and Deputy Surgeon General (O-8) (USPHS, 2006).

Table 6. Rank Structure of the Federal Services

Rank	Air Force	Army	Navy	PHS
O-3	Captain	Captain	Lieutenant	Lieutenant
O-4	Major	Major	Lieutenant Commander	Lieutenant Commander
O-5	Lieutenant Colonel	Lieutenant Colonel	Commander	Commander
O-6	Colonel	Colonel	Captain	Captain
≥O-7	General	General	Admiral	Admiral*

*Titles and abbreviations reserved for Assistant Secretary for Health, Surgeon General and Deputy Surgeon General

The Military Workforce

Female officers represented 21% of new officer accessions in fiscal year 2003 (Office of the Undersecretary, 2003). The highest representation of women in the military was found in the Air Force; the Marine Corps had the lowest representation of females (GAO, 2005) and the total workforce is younger (GAO, 2005). Another report written by the Government Accounting Office noted changes in the active duty military:

> "The percentage of personnel over age 25 increased from about 40 percent of the active duty force in 1974 to nearly 55 percent in 2000. The proportion of enlisted personnel with at least a high school diploma increased from about 80 percent of the enlisted force in 1974 to about 95 percent in 2000. During that time, the percentage of officers attaining a degree beyond a bachelor's degree increased from 25 percent to 43 percent of all officers. The proportion of minority service members increased from 20 percent to 35 percent of the active duty force between 1974 and 2000, and the proportion of female service members increased from 4 percent to 15 percent (GAO, 2002)."

Military Workforce Compared to the Civilian Workforce

The Government Accounting Office (GAO, 2005) issued a report that compared 2.2 million active and reserve service members to a nationally representative sample of civilian workers, 18-49 years of age. There were racial, gender, age, and geographic differences from the U.S. civilian workforce. The military has proportionately fewer White (67% military compared to 71% civilian), more African-Americans (17% military compared to 11% civilian), fewer Hispanic (9% military compared to 11% civilian), fewer Asian (3% military compared to 5% civilian), and comparable 1% American Indian/Alaskan Native representation (GAO, 2005). There were fewer women in the military than in the civilian workforce (16% military compared to 48% civilian) (GAO, 2005). Proportionately more enlisted recruits (45% military compared to 52% civilian) came from a rural community (GAO, 2005). Table 7 presents differences between military and civilian populations. Generally, military service members were younger than their civilian counterparts were (GAO, 2005). Married service members accounted for half of the active duty component .

Military Healthcare System Organization

The Army, Navy, and Air Force operate three separate medical departments, which differ in some aspects by service (Hosek and Cecchine, 2001). The Navy Medical Department includes healthcare for both the Navy and Marine Corps. Surgeon Generals lead the Army and Navy medical commands through a regional command structure of medical treatment facilities and other activities (Hosek and Cecchine, 2001). Only medical units that deploy in the Army and Navy are integrated within their support organizations (Hosek and Cecchine, 2001). The Air Force integrates both its medical

treatment facilities and deployable units. The Air Force Surgeon General has the same authority as the other Surgeon Generals of the Army and Navy. (Hosek and Cecchine, 2001). TRICARE contractors handle health care to family members of active duty personnel.

Table 7. Military and Civilian Population Comparisons (%)

Characteristic	Military	Civilian
Racial		
White	67	71
Black	17	11
Hispanic	9	11
Asian	3	5
Native-American	1	1
Women	16	48
Rural community	45	52

Source: Government Accountability Office (2005). Military Personnel Reporting additional servicemember demographics could enhance congressional oversight. G. A. Office.

Federal Services Dental Corps

Overview

Federal service dentists have a role in both the delivery of health care and professional military officer responsibilities (U.S. Navy Medical Department Officer Career Guide, 1991). There are many routes of accession to federal service. Dentists can enter the federal service by direct procurement, the Armed Forces Health Professions Scholarship Program (AFHPSP), reserve recall, or interservice transfer (U.S. Navy Med Department Officer Career Guide, 1991). Most dentists entering the federal services are recent dental school graduates, although many are from private practice. Federal service

dentists are members a commissioned corps and are called dental officers. In most cases, dentists must be licensed in one of the fifty states, or one of the possessions of the United States. A rank structure based on experience, years of service and level of responsibility is common to all of the commissioned services (Table 6). Dentists in the USPHS are commissioned officers of the federal government and as such have the same privileges as their armed services counterparts (Burt and Eklund, 2005).

United States Air Force

The Air Force Dental Service (AFDS), within the Air Force Medical Service, is composed of 1100 dentists. The Air Force Dental Service provides comprehensive dental care services to active duty members. Other responsibilities of the AFDS include graduate dental education, forensic dental services, expeditionary dentistry, and the Air Force Inspection Agency (Murray & others, 2003).

> "Eligible beneficiaries for dental care in Air Force facilities by law include all active duty Department of Defense members, retired military members, and family members overseas and within the continental United States in specific cases, active reserve component members, and designees selected by the Secretary of Defense (Murray & others, 2003)."

There are 85 treatment facilities worldwide. Most treatment facilities are group practices ranging from two to more than fifty dentists. Dental treatment facilities are under an Air Force Major Command (MAJCOM). The dental facility reports to Chief of Staff of the Air Force. The Office of the Surgeon General and Assistant Surgeon General for Dental Services are not in the direct reporting chain, but rather maintain an advisory role. Dental officer assignments average two to four years (Murray & others, 2003).

The AFDS offers training opportunities for dentists in fully accredited programs of the nine ADA recognized specialties, Advanced Education for General Dentistry and General Practice Residency, along with providing fellowships in Dental Materials, Maxillofacial Prosthodontics, Pain Management, and Air Staff Administration. Local

clinics and off-site locations, both military and civilian, provide continuing education opportunities. The Air Force Dental Service offers simple and complex hands-on dental continuing education training (Murray & others, 2003).

The Air Force initiated a loan repayment program in 2002, in an attempt to attract new graduates to the dental service. It also offered two and four year scholarships through the Health Professions Scholarship Program. Other incentives included competitive benefits, training opportunities, and an accession bonus of $30,000.00 (Murray & others, 2003).

The Dental Investigation Service (DIS) evaluates the materials and equipment used in dental treatment facilities. Civilian and military professionals have access to reports that the service issues. Initial research in development of the high-speed dental handpiece was the work of this organization (Murray & others, 2003). DIS is located at Great Lakes Naval Station, which is also the location of dental research services for the Army and Navy. Air Force policy provides only emergency care for recruits until they complete basic training (Moss and others, 2004).

United States Army

The Army Dental Care System is the oldest dental commissioned corps in the United States. This corps provided dental services to Air Force personnel prior to the creation of the Air Force Dental Service (Murray & others, 2003). The Army Dental Care System provides care for active duty, reserve and National Guard units. The Army Dental Care System integrates disease prevention and health promotion. Army dentists compete equally for academic, command, and administrative positions (Webb, 2003). Postgraduate dental education is a primary recruitment tool (Webb, 2003). Army dentists serve in hostile environments in areas around the world. Research developments in radiology, field equipment and new technologies contribute to delivery of cost-effective care (Webb, 2003). The Army Dental Care System provides emergency care to new recruits until they have been on active duty for 184 days (Moss and others, 2004).

United States Navy

Created by an Act of Congress in 1912, the Naval Dental Corps celebrated 93 years of service in 2005. There were 35 officers in 1917. Dental officers operated from 160 shore-based facilities and aboard 156 ships in the beginning of the 1960s. In 2003, dentists served worldwide supporting Naval and Marine personnel aboard 60 ships at sea, assisting in humanitarian missions, and defining their role in Homeland Defense (Woofter & others, 2003).

Career development depends on continual learning, with education and training through individual studies, short courses, seminars, service college courses and service sponsored or self-funded postgraduate education (U.S. Navy Medical Department, 1991). Postgraduate education programs meet the dental corps' need for officers in various disciplines to practice, teach, and conduct research (U.S. Navy Medical Department, 1991). The United States Navy Dental Corps provides dental care for Marine Corps and Navy recruits during their basic training period to prepare them immediately for operational readiness (Moss and others, 2004).

United States Public Health Service

The United States Public Health Service Commissioned Corps was formally established in 1889; however, a dental component was not included until the early 1900s. The Indian Health Service was established in 1955. Employment of dentists in the USPHS occurs by two routes, as a civil servant or as a uniformed member of the USPHS Commissioned Corps.

The USPHS commissioned corps' mission is "to protect, promote, and advance the health and safety of the nation" (Beato and Carmona, 2005). The Surgeon General of the USPHS commands the USPHS commissioned corps, which is composed of eleven officer categories. Eighty percent of the dental workforce is assigned to clinical services in the Indian Health Service, Bureau of Prisons, or Coast Guard (Kleinman & others,

2003). USPHS assignments are listed in Table 8. In the USPHS, a recent graduate may be selected for the dental corps without a dental license if licensure is obtained within one year from the date of their initial appointment (USPHS, 2005).

Table 8. USPHS Dental Assignments*

Agency	Percent
Indian Health Service	50
Bureau of Prisons	25
U.S. Coast Guard	10
Health Resources and Services Administration (HRSA)	3

*Dentist information in the commissioned corps retrieved from www.usphs.gov/html/dentist/html 9/26/05

Treatment Needs of the Federal Services

Identifying dental disease early and correcting it before progression is thought to promote dental readiness (Callison, 2005). Active and reserve components of the uniformed services need a yearly dental examination (Callison, 2005). Upon entry into the federal service, service members are placed into one of four dental readiness categories. The categories are (Moss & others, 2004): Class 1-Do not require dental treatment, worldwide deployable; Class 2-Require non-urgent treatment unlikely to cause a dental emergency within 12 months, worldwide deployable; Class 3-Urgent or emergent care required, not worldwide deployable; and Class 4-Require periodic dental examinations, not worldwide deployable. New recruits are designated Class 4 until they complete a dental examination. The 2002 DOD Survey of Department of Defense policy indicates that military personnel must maintain Class 1 or 2 statuses (Moss and others, 2004).

Moss & others (2004) examined the way the oral health of recruits changed during 4 years immediately after entry to active duty. Their goal was to determine what percent achieved Class 1 status and the length of time they stayed in that classification. The original recruit study occurred in 1994. Servicemembers from the Air Force, Army and Navy were represented in the 1,101 recruit records that were retrieved in 1998 and merged with data from the 1994 Tri-Service Comprehensive Oral Health Survey. Approximately sixty-one percent (CI 58.4-64.0) achieved Class 1 status at some time in the four-year period. There was a significant difference for the Air Force. Air Force recruits achieved Class 1 about 89.5% of the time; Army, Navy, and Marine Corps percentages were in the range of 50% to 60%. The average time a service member stayed in Class 1 status did not differ among the services, at 19.8 months (CI 18.9-20.7). The authors stated that 31.8% of recruits were in Class 1 status sometime during their first four years of service, 60.8% in Class 2, and 7.4% in Class 3 with only the Air Force showing 53.7% of their recruit time in Class 1.

The Dental Treatment Needs of Active Duty Military Personnel 1994 and 2003 Study was a combination of data from a 1994 study, a 2003 study, and an electronic databank (York & others, 2004). The 1994 study was a random sample of 13,050 Army, Navy, and Air Force members at 26 clinics. The 2003 Army and Air Force Dental Treatment Requirements Study was a study of 4,800 randomly selected service Army and Air Force members from 33 clinics. The final data were extracted from the Navy's Dental Common Access System (DENCAS), an electronic system that maintained patient treatment needs information. Results were grouped as operative treatment needs, extraction treatment needs, endodontic treatment needs, fixed prosthodontics treatment needs, and periodontal treatment needs. Extraction needs declined over time by 60% per thousand active duty (AD) members who required extraction. Army AD had four times as much unmet extraction needs as the Air Force and twice as much as the Navy/Marine Corps AD. Endodontic treatment needs also declined. There were significantly fewer

fixed prosthodontics treatment needs in 2003 compared to 1994, although the authors mentioned that the decline could be due to different methods in the 1994 and 2003 study. Operative treatment needs declined by 67% since 1994, with the Army active duty (AD) having four times as much unmet restorative need compared to Air Force AD, and three times as much as Navy/Marine Corps AD. There was a significant increase in the percentage of AD without restorative needs. A Periodontal Screening and Recording (PSR) score records the periodontal condition of service members. Its scale is 0-4, with 0 depicting the healthiest condition, and 4 indicating probing depth greater than 5.5 mm. There were statistically significant decreases in severe periodontal disease (PSR=4) since 1994 for the Army and Navy/Marine Corps. The Air Force had a decrease as well, but it did not reach statistical significance.

A study of health-related behaviors among 12,756 military personnel in the Air Force, Army, and Navy, by Bray & others (2002), found that almost ninety percent of military service personnel had a dental examination in the previous year. Thirty-four percent required dental treatment before deployment. In 1998, 16% needed dental treatment before deployment. Frequently cited reasons for those not receiving an examination within the previous year were long waits at the military dental clinic (32%), not being able to get an appointment (30%) and a dislike of going to the dentist (29%) (Bray and others, 2002).

Postgraduate Training Opportunities in the Federal Services

VA or military AEGD and GPR programs account for one-third of all programs available to recent graduates (Atchison & others, 2002c). The primary goal of these programs is to ensure quality care for groups with limited access to providers. These programs are also a recruiting tool for dentists into the services, improve clinical skills, and support the military and VA emphasis on education and training (Atchison & others,

2002c). Public Health Service dentists are eligible for advanced training through civilian or military training programs.

Robinson (2000) examined postgraduate training opportunities in the federal services. In 2000, the three military services, Air Force, Army, and Navy had 469 postgraduate training opportunities that included one-, two-, three-, and four-year training positions. The total number of training positions designated to each service was Air Force-145, Army-107, and Navy-217. Training programs emphasized two areas, programs to meet the needs of recent graduates (PGY-1), General Practice Residencies, and Advanced Education in General Dentistry, and specialty programs leading to board certification. Of the 84 positions held by the Navy for PGY-1 training, 24 were General Practice Residencies. Specialty programs for the three services totaled 220 positions (Air Force-91, Army-37, and Navy-97) at military or civilian institutions. The specialty programs included one- and two-year fellowships, and two-, three-, or four-year residencies. An Advanced Clinical Program in General Dentistry was also available for dentists already in practice for several years.

Atchison & others (2002c) compared characteristics of PGD training programs sponsored by the military services and VA. The authors mailed surveys to sixty-six VA and forty-two military programs with one follow-up mailing and telephone calls to nonresponders. They requested information about program infrastructure, emphasis, resident preparation, patients served and services provided. Chi-square analysis and t-tests, multiple regression, and logistic regression were performed. The response rate was 75%. Thirty of forty-two military programs responded (twenty-three AEGD and seven GPR programs). All of the fifty-one VA programs that responded were GPR training programs. The VA programs had more resources than did military programs. VA programs reported resources from dental schools (16 of 51), hospitals (17), and the military (2), while military programs reported resources from one dental school, six hospitals and two VA programs along with military resources.

Atchison & others (2002c) also found that AEGD programs had more full-time faculty ($p<0.0001$), full-time staff ($p<0.025$), first-year residents ($p<0.0001$), and higher first-year stipends compared to combined military and VA GPR programs. In this study, AEGDs treated more children and healthy adults ($p<0.0001$), whereas military GPR programs had more experience with medically compromised patients ($p=0.023$). Program emphasis over a five-year period (1995-2000) for military AEGDs included a 58% increase in oral diagnosis and treatment planning, and a 63% increase in esthetic dentistry. More military GPRs reported a greater percentage of the curriculum devoted to preventive dentistry ($p=0.0002$). VA directors reported a decline in conducting dental research. Military directors reported inadequate preparation in operative dentistry more often than did VA directors, and this result was statistically significant ($p=0.0149$). The difficulty reported in filling residency positions (10 of 30 military directors, 28 of 51 VA directors) was related to the amount of the stipend ($p=0.043$). Both VA and military directors reported less emphasis on pediatric dentistry and more emphasis on implantology.

Fifty-three recent dental school graduates throughout the United States were asked about their perceived level of competence before and after completion of a 1-year Air Force AEGD program that began in 1999, using an anonymous mail survey in May 2000 (Dixon & others, 2002). An identical survey was sent to 59 incoming AEGD residents in August 2000. Subjects were asked to rate themselves in 60 competencies. The competencies were the dependent variables. Independent variables were the perception responses. The response rate was 92% (48 of 53 exiting residents, 55 of 59 entering residents). The authors compared the data sets from both. A broad spectrum of dental school experiences were represented in each sample. An anonymous mail survey was sent using the ADA model set of competencies. Both exiting and entering residents reported competencies in most areas. There were significant differences between the groups for 15% of the competencies ($p<0.05$). Recent dental school graduates rated

themselves higher than residency-trained dentists did. All respondents felt competent in only 5 of 60 areas: establishing rapport, identifying chief complaints, head and neck examination, selecting and interpreting diagnostic information, and obtaining informed consent. About half of post-residency dentists felt incompetent in four of 60 areas at graduation: managing hospital patients, managing occlusal or temporomandibular disorders, performing implant procedures, and managing complex orthodontic problems. More than 20% of both groups reported perceived incompetence in 13 of 60 competencies. The authors concluded that recent graduates might desire additional training before entering practice.

Summary

Health care in the federal services is not fee-based. Dentists in the federal services receive their undergraduate dental education in civilian institutions. Dentists who are recruited from all states and territories of the United States serve throughout the world. Federal service dentists receive postgraduate training in civilian and military institutions. The organization of the Air Force, Army, Navy, or Public Health Service influences the philosophy of practice, location of practice and schedule of practice for the provider.

Surveys of Knowledge, Attitudes, and Behaviors Concerning Minimal Intervention Dentistry

Overview

This section describes the results from questionnaire surveys sent to dental clinicians to assess their knowledge, attitudes, and behaviors concerning individual aspects of Minimal Intervention Dentistry. Key articles pertaining to prevention, risk assessment, and restorative practices are included in this section.

Different Approaches to Survey Research

Saw and Ng (2001) reviewed aspects of the design and assessment of questionnaires in clinical research. Questionnaires are commonly used for collecting health-related information in clinical studies (Saw and Ng, 2001). An important consideration in questionnaire design and administration is that meaningful results depend upon the outcome measure being valid and reliable. Sensitivity and specificity are ways to quantify parts of validity.

The steps for designing a questionnaire were outlined by Williams & others (2004). The first was to specify the research question based on the aims and objective of the study. Then, decide whether the questionnaire will be self-completed by research subjects (or surrogates), conducted via telephone, or face-to-face with an interviewer. They recommended writing short, unambiguous, and specific questions, with the most general questions asked first, leaving demographic questions till the end. Closed-ended questions were viewed as faster for subjects to complete and easier to code and analyze than were open-ended questions. A well-presented, easy to answer, and attractive questionnaire is more likely to be completed by subjects. Finally, the authors recommended pilot testing and use of methods to maximize the response rate, like using short questionnaires, colored paper, personalized letters, and follow-up reminders.

Questionnaires are inexpensive (Saw and Ng, 2001) in comparison to other research tools, and are able to measure many health outcomes. Often, questionnaires are the only financially viable option when information from large, geographically dispersed populations is being collected (Edwards & others, 2002). Edwards & others (2002) conducted a systematic review of randomized controlled trials about increasing response rates to postal questionnaires. They examined 75 strategies to increase response rates in 292 eligible randomized controlled trials, including 258,315 participants, averaging 1,091 participants per trial. One-third of the trials were medical, epidemiological, or health

related; one-quarter were psychological, educational, or sociological; and two-fifths were marketing, business, or statistical.

In the systematic review (Edwards & others, 2002), about half of the trials displayed substantial heterogeneity among the results. Pooled odds ratios in a random effects model were estimated, along with chi-square tests, and regression analysis. The odds of response were influenced by incentives (odds ratio 2.02), short questionnaires (1.82), use of colored ink (1.39), use of stamped return envelopes (1.26), follow-up contact (1.44), and providing a second copy of the questionnaire (1.41). Questionnaires of interest to participants (2.44) and originating from universities (1.31) were returned more often than questionnaires that contained sensitive questions (0.92), or originated from commercial organizations (1.31). There was significant heterogeneity among results for offering incentives ($p<0.0001$) and questionnaire length ($p<0.00001$). The regression model predicted that the odds of response with a $1 incentive would be twice that with no incentive, and the odds of response from a single page would be twice that with a three-page questionnaire

The effects of nonresponse bias caused by sociodemographic, behavioral, and other differences between responders and nonresponders will be reduced by striving for very high response rates (Parashos & others, 2005). Methods employed to improve response rates are important because non-response reduces the effective sample size and affects the validity of epidemiological studies (Edwards & others, 2002).

Prevention in Federal Service and Civilian Practices

Fiset and Grembowski (1997) surveyed dentists in Washington state in 1995, to determine if and when they began using elements of the medical model of caries treatment, to distinguish earlier medical model adopters from later adopters, and to assess the adoption of the model into everyday practice. Surveys were sent to 532 dentists, selected from a 1995 list of licensed dentists, with a response rate of 70%. Dentists were

asked to consider when they had learned each of four caries control innovations (fluoride varnishes, chlorhexidine rinses, adult pit-and fissure sealants, and salivary functioning tests), when they first tried each of the innovations, and when each was adopted in their practice. Data analysis included descriptive statistics and bivariate statistical tests with the Bonferroni correction. A multivariate analysis was not performed because the number of significant independent variables was small. They did not perform analysis for salivary function tests because only 2% of respondents were using them. The response rate to the survey was 70%. Respondents were in solo practice for a mean of 10 years. Early adopters for use of chlorhexidine rinse were more likely to enjoy experimenting with new things before they had been established ($p=0.024$), and have friends who were using the innovation ($p=0.016$). Early adopters for adult pit-and fissure sealants were more likely to have friends using the innovation ($p<0.001$). Early adopters for fluoride varnish were less likely to hold membership in professional organizations ($p=0.001$) than late adopters were. Early adopters of fluoride varnish gave almost twice as many correct answers as late adopters regarding 29 true statements about fluoride varnishes (20.8 vs. 11.8 statements; $p=0.000$). Forty-two percent of nonusers indicated they were not aware of the existence of fluoride varnish before receiving the survey; 18% were aware of the service but unclear of the cost/benefit relationship; 19% stated they questioned the cost/benefit relationship; 17% indicated their patients were at low caries risk; and 17% indicated patient rejection prevented them from using fluoride varnishes regularly. Cost was cited most often as the reason for not using fluoride varnishes. For pit-and fissure sealants, 72% indicated they did not use them regularly; 64% believed there was little clinical rationale for using them in adults; 22% favored use of alternative procedures, like composite resins; and 20% did not believe their adult patients would accept the procedure. Coverage by dental insurance would make 90% of fluoride varnish non-users and 63% of adult pit-and-fissure sealant non-users start using the services for caries

prevention. The authors found a non-uniform knowledge base about the innovations discussed in this survey.

Fiset & others (2000) sent a survey to 460 Washington state dentists to determine whether dentists used fluoride varnish more often after a major insurance carrier approved reimbursement for adult patients. The survey also obtained information on dentists' use of fluoride varnish, chlorhexidine rinses and pit-and fissure sealants in adults as a part of caries control. The response rate was 70.9%. Results showed that, while 32% of dentists used fluoride varnishes in 1995, that percent had increased to 44% in 1997. More dentists (74%) were aware of fluoride varnish and its benefits than were dentists (58%) in the 1995 study. Many of the respondents to this survey (81.8%) also had completed the survey by Fiset and Grembowski (1997). Of the respondents who completed both surveys, there was a 16-percentage point increase in use of fluoride varnish from the 1995 survey to the 1997 survey period. Many of the respondents who were not fluoride varnish users intended to consider regular use in the future. The authors concluded that, while reimbursement increases the use of preventive services, more is necessary to improve utilization rates for innovative caries control services.

Both civilian and military Army dentists (n=1100) assigned to full-time clinical duties were sent a mail survey in 1997, requesting information on the frequency with which they delivered 19 promotional and preventive dentistry services (Chisick & others, 2000). Preventive services included fluoride education (63%), professionally applied fluoride treatment (43%), sealant education (28%), and sealant placement (25%). Oral hygiene instruction (88%) was performed most often in comparison to other services. The low use of preventive services might indicate that some of these services are delegated to ancillary personnel. Concerning delegation, the authors pointed out that dentists might not be "capitalizing on their ability to influence patient behavior through the respect, credibility, and authority that their status as a dentist confers on them in the eyes of their

patients." They concluded that preventive dentistry services are not being delivered frequently enough in the Army Dental Care System.

Caries Risk Assessment

The heart of the medical model is the ability to identify those who are at high risk for caries (Fiset and Grembowski, 1997). The key assumptions made with risk-based promotion strategies are that high-risk patients can be identified and that those identified will receive appropriate preventive treatment (Bader & others, 2003). Bader & others (2003) reported on ways dental practices approached risk-based prevention for caries and periodontal disease. During this pilot study, the authors worked with a national insurance carrier to tailor dental plans to high-risk patients, test communication methods from practitioner to the carrier, and examine the risk levels and proposed preventive treatment plans of practitioners. The study subjects were from dental practices that submitted at least 20 claims per month, and were located in four urban areas. Study participants agreed to assess the risk of new carious lesions and progression or initiation of periodontitis, indicate reasons for selecting elevated risk, and indicate planned treatments for high-risk patients. Patients were scored as low, moderate, or high-risk for both caries and periodontitis. Participants were asked to indicate three disease risk indicators, from a list supplied by the investigators, used to help explain why they assessed their patients as moderate or high-risk. The investigators requested a risk assessment each time a patient enrolled by the insurance carrier received a periodic oral examination. Combined data from all participating offices was included in the descriptive analyses. The authors addressed the two key assumptions by examining past restorative and periodontal care patterns for low and elevated risk levels and whether the planned treatment was appropriate. Data from 15 dental offices were available for analysis. The mean among practices at high-risk for caries was 4%, ranging from 0 to 18% across offices; moderate-risk was 29%, ranging from 7 to 88% across offices; and the remaining two-thirds of

patients were assessed as low-risk patients. Lack of specific criteria for determining moderate risk and a general lack of clinical experience in working with trichotomous classifications were the reasons mentioned for the interoffice variations.

Bader & others (2003) named multiple restorations as the most frequently noted risk indicator. The risk indicator most frequently cited for high-risk patients was multiple carious lesions; multiple restorations and exposed root surfaces were most often cited for moderate-risk patients. Multiple restorations, multiple carious lesions, poor oral hygiene, and exposed root surfaces were the most common risk factors cited for moderate and high-risk patients. The most common preventive caries treatments planned for high-risk patients were oral hygiene/dietary counseling (56%), professionally applied topical fluoride (53%), more frequent prophylaxis/recall (35%), and other (21%). The "other" category represented use of an electric toothbrush, more brushing or disclosing tablet use. A lower percentage of patients were to receive prescription fluoride (21%), prescription antimicrobial rinse (12%), over-the-counter fluorides (9%), and calcium phosphate dentifrice (3%). No high-risk patient was to receive fluoride varnish (0%). The data collected supported the first key assumption that clinicians identified patients at heightened risk. The first key assumption was evaluated by examining the number of restorative procedures received by high (1.62) and moderate (1.04) risk patients three years before the pilot study. To test the second key assumption that patients would receive appropriate treatment, the authors calculated the percentage of patients with multiple carious lesions planned to receive fluoride treatment of any type, and the percentage for those with poor oral hygiene. The percentages were 51% for those to receive fluoride, and 73% for those with poor oral hygiene. The authors concluded that, while practitioners were performing risk assessment, and planning heightened preventive therapies, their preventive treatments were incomplete and underutilized. Bader & others (2005) general study based on the 2003 study previously described, demonstrated

convincingly that dentists using general risk assessment guidelines could categorize patients by level of need for caries-related restorative treatment.

Restorative Treatment

Dentists' Restorative Treatment Decisions

Clinical decision making is a complex process as the treatment provided by dentists might be a reflection of interactions among practice, patient, and provider (Brennan and Spencer, 2002). Australian dentists were asked to choose treatment, given six pairs of substitutable services, in the study by Brennan and Spencer (2002), and to identify factors that influenced their decisions. For choosing a preventive intervention instead of a restoration in a posterior tooth with an initial carious lesion on an occlusal surface, 22% of dentists responded that background was an important factor to consider, as were patient factors (15.1%), caries (14.4%), and mouth status (12.7%) (Brennan and Spencer, 2002). This study found that, in private general practice, cost was a major determinant of treatment choice. A range of factors influences dentist treatment choices.

Sundberg & others (2000) sent a pre-coded questionnaire to 923 dentists in Sweden. They found differences between private practitioners and Public Dental Health Service dentists regarding preparation techniques for approximal and occlusal carious lesions. They received responses from 651 dentists excluding 61 retired from practice, who were not included in the analysis. The Swedish Public Dental Health Service employed 52% of respondents, 42% were private practitioners and 6% were not in clinical practice. Children and young adults are treated in the Public Dental Health Service in Sweden, whereas adults use private practice facilities. For preparation techniques for approximal and occlusal carious lesions, 48% of dentists chose the tunnel preparation technique, 32% saucer-shaped preparations and 20% chose the traditional Class II preparations. Seventy-four percent of dentists chose removal of the carious part only as the most common preparation technique for restoring an occlusal carious lesion.

Private practitioners chose the traditional Class II preparation more than the tunnel or saucer-shaped preparations, while Public Dental Health Service dentists chose the tunnel and saucer-shape preparation more often ($p=0.004$). Younger dentists chose the saucer-shaped design more than older dentists did ($p<0.010$). Regarding treatment alternatives for minor/questionable occlusal carious lesions in teeth labeled A and B. For Tooth A, 50% would prepare and restore the carious part, and 27% would restore and seal with a sealant. One-third of dentists would not treat minor/questionable occlusal carious lesions, one third would provide fluoride treatment, and 17% would place fissure sealants in Tooth B. Composite resin was the material chosen most often and amalgam least often. Younger dentists chose the no treatment option more often than the older dentists did (>55 years). This study indicated that Swedish dentists are using tooth-saving procedures for primary approximal and occlusal carious lesions.

Traebert & others (2005) conducted a cross-sectional telephone survey of 840 Brazilian dentists concerning their restorative treatment decisions. Proximal lesions confined to the external half of the enamel would be restored by 31.5% of dentists; 54.3% would restore a lesion reaching the internal half of the enamel; 79% would restore a lesion up to the DEJ, and 96.9% would restore a lesion in dentin. Dark fissures would be restored by 21.8% of respondents. Most (96.7%) would not restore a small white lesion on the smooth surface of a permanent molar. The main outcome measure was a comparison of the number of years since qualification and attendance in postgraduate courses. Respondents with less than 10 years of experience were more conservative ($p<0.01$), as were those having taken postgraduate courses ($p<0.01$). However, the authors stated that some dentists had an interventionist attitude relating to overtreatment, mainly in cases of lesions in enamel and at the dentinoenamel junction. The investigators stated that knowledge of the conservative treatment approaches introduced into undergraduate and postgraduate courses might influence professional decision-making.

Tubert-Jeannine & others (2004) assessed the caries management strategies taught in French dental schools by sending a questionnaire to all teachers of Operative Dentistry affiliated with 16 French dental schools. In total, 88 teachers responded, for a response rate of 49.1%. Most (88.3%) respondents thought radiographs underestimated lesion depth compared with clinical findings. One in ten teachers thought it took less than six months for an approximal lesion to progress from enamel to dentin; one-third thought it took seven to twelve months; one-third, thirteen to twenty-three months; and one-quarter thought it took more than two years. A longitudinal analysis from bitewing radiographs of caries progression through human enamel by Shwartz & others (1984) estimated that it took approximately four years for a lesion to progress through the enamel of permanent teeth, recognizing the variability between individuals and lesions. Tubert-Jeannin & others (2004) found that thirty-nine percent of respondents would have prepared a cavity at the DEJ and 39.1% would wait until caries was within dentin. Over half of the respondents (67.4%) would monitor a lesion to assess its progression rate, compared to 8.6% who would not and 24% who were uncertain ($p<0.001$). More male teachers (25.0%) would restore an occlusal lesion confined to enamel more often than women teachers (8.7%) would. A wide disparity existed among French university teachers regarding the restorative treatment threshold (when to begin operative interventions) for approximal surfaces, attitudes towards the rate of lesion progression, and monitoring lesions near the DEJ. They recommended evidence-based teaching in dental cariology with standardized criteria for treatment decisions.

Lewis & others (1996) examined the relationships between the restorative thresholds of 16 Canadian dentists and both their restorative decisions and caries depth determinations. They were asked to describe at what point they would consider restoring a proximal carious lesion in a 16-year-old patient with moderate caries experience and oral hygiene levels. Their choices were 1) up to the outer half of the enamel, 2) to the inner half of enamel, but not yet at the dentinoenamel junction, 3) at the DEJ, but not yet

into the dentin, 4) into the dentin, or 5) well into dentin. Three dentists thought restoring the lesion in the inner enamel before it had reached the DEJ was an appropriate point for treatment, nine would restore when caries had reached the DEJ but not penetrated dentine, and four dentists thought caries had to extend into the dentin before it needed a restoration.

Kay & others (1992) conducted a study similar to that of Lewis & others (1996) with twenty dentists from Scotland. They used the 16-year-old with moderate caries experience as a model, with similar depth criteria. In this study, three dentists intended to restore all carious lesions further than one-half into enamel, eight would restore when it reached the DEJ, and nine would restore when the lesion was into dentine. In all, 55% of Scottish dentists surveyed for this study would restore before the lesion was into dentin, which was less than the 75% shown by Lewis & others (1996).

Atraumatic Restorative Treatment

Burke & others (2005) evaluated the acceptance of the Atraumatic Restorative Treatment and treatment of cavitated carious lesions in primary teeth. A questionnaire was sent to 300 randomly selected general dental practitioners in West Midlands, England and 300 general dental practitioners across Scotland. General dental practices were located in cities (54%), suburban locations (44%), and in rural areas (2%). Thirty-nine percent of respondents practiced in a fluoridated area. The mean number of years in practice was 12 years. Most dentists (99%) treated children in their general practices. A mean of 25% of their patients were less than 18 years of age. Forty-two percent of respondents (154/371) were aware of Atraumatic Restorative Treatment. The questionnaires provided patient details and color illustrations on two cavitated lesions that were considered representative of those encountered by general dental practitioners. Respondents were asked to draw a cavity preparation outline on the color illustrations and indicate proposed treatment. Three dentists assessed the cavity outlines, a general

dental practitioner, an academic, and a third dentist to arbitrate in cases of disagreement. The response rate was 65%. Most of the cavity outlines could be considered minimally invasive (75% for cavity 1, 86% for cavity 2), because they closely following the outline of the carious cavity. The first clinical scenario requested respondents to remove caries for a cavitated carious lesion in a 7 year-old undermined by one millimeter of caries. Ten percent indicated they would use an excavator, 47% a handpiece, 41% an excavator and handpiece and 2% an excavator, handpiece and chemical. Local anesthesia would be used by 30% of respondents. Respondents selected glass ionomer (51%) to restore the cavitation most often, followed by amalgam (13%) and a compomer (13%). To the second clinical scenario of a cavitated carious lesion in a 7-year-old undermined by 1.5 millimeters of caries, 7% would use an excavator, 50% a handpiece, 42% both an excavator and handpiece, and 1% a chemical solution with an excavator or handpiece. Fifty-two percent would use local anesthesia. Respondents' most commonly selected restorative materials for the second clinical scenario were glass ionomer (46%), amalgam (16%), and compomer (12%). Overwhelmingly, respondents would have used cotton rolls for isolation. Only 1% would use a rubber dam for each clinical scenario.

Based on the respondents' awareness of ART, there were no significant differences found in responses concerning whether glass ionomer was used to restore cavity 1 ($p=0.786$) or 2 ($p=0.586$). There were no significant differences found whether working in a fluoridated area influenced their material selection ($p=0.465$), nor any differences in responses among dentists working in fluoridated and non-fluoridated areas ($p=0.236$).

The results of this study indicated that, although more than half of the respondents had knowledge of ART, it was not fully adopted in its true form (removal of caries using only hand instruments and without anesthesia). Possible reasons discussed were the impression that ART was for non-industrialized countries, using a handpiece was faster, inadequate renumeration, or that respondents did not find the treatment method

appropriate for the scenarios presented. These results indicated a need for further research.

Repair of Restorations

A survey created to determine the types of direct and indirect posterior restorative materials used by general dentists in the United States found that resin-based composites were the direct restorative material of choice (Haj-Ali & others, 2005). A survey conducted by Forss and Widstrom (2004) obtained information on the restorations of 800 private dental practitioners provided for adult patients in Finland. They asked participants to record information on restorative treatment given to all of their patients during one ordinary working day. Findings were that 79% of restorations placed were composite resin, 7% glass ionomers, 5% amalgam, and 4% compomers. In 1993, the Finnish Ministry of Health made a recommendation to use other restorative materials besides amalgam for environmental reasons. Their survey results indicated that the main restorative material used in Finnish adults was composite resin. The reason for restorative therapy had an influence on the selection of the restorative material and this relationship was statistically significant ($p<0.001$). Treatment due to tooth fracture, filling or marginal leakage, or a lost restoration had a higher proportion of composite restorations than the mean (87% vs 79%). Sixty-five percent of all treatments were replacement restorations. The main difficulty when replacing resin based composite restorations is distinguishing the restorative material from sound tooth structure (Gordan & others, 2003).

Blum & others (2003) sent a fourteen question survey written in German and English to chairmen of operative/conservative dentistry departments in 58 dental schools in the United Kingdom and Ireland, Germany and Scandinavia (Norway, Sweden, Denmark, and Finland). The questionnaire asked about their experiences with resin based composite repair and teaching of repair, and specific reasons it was taught and

why. They calculated responses as percentages. The overall response rate was 83%. Most German respondents (92%) and all British, Irish, and Scandinavian respondents reported they repaired direct composite resins. Most dental schools taught repair of defective composites, with the exception of Germany. Fifty-percent of German schools did not teach the topic and 33% did not plan to teach it within the next 5 years. Reasons given were difficulty of teaching decision-making in relation to repair to inexperienced students, poor experiences, lack of evidence, and importance in comparison to other topics. Preservation of tooth structure and reduction of potentially harmful effects on the pulp were the most important reasons schools chose for repair of direct composite resins. The conservative ideology of tooth structure preservation by means of the repair of defective composite resins would appear, from the findings of the present study, to have been incorporated into many curricula despite the lack of available evidence of efficacy. The authors urged long-term clinical trials in this area.

Gordan & others (2003) presented a similar investigation about whether North American dental schools taught students how to repair resin-based composites (RBC) and compared results to surveys conducted in European dental schools. A 15-question survey was mailed to 64 dental schools in the United States, Canada and Puerto Rico. The survey inquired about respondents' experiences in repairing and teaching repair of resin-based composites. It sought information about the anticipated longevity, patient reaction and recall arrangements. Their overall response rate was 81%. Ninety-four percent stated they repaired RBC and 92% reported successful treatment. Seventy-one percent stated they taught undergraduate students repair techniques in order to preserve tooth structure and reduce harmful pulpal effects. Thirty-seven schools reported teaching repair and clinical experience was mentioned as the reason in 36 schools. The fifteen schools that did not teach repair reported they most likely would not teach the procedure within the next three years, citing lack of clinical evidence as the reason for not teaching repair. The average longevity for a repaired RBC was four years. Teaching amalgam repair

occurred in 62% of responding schools. Repair of defective restorations was considered a definitive measure and patients accepted repairs. The most common reasons for repair were correction of marginal defects (31%) and discoloration (27%). Only three schools reported actually using a resin sealant to repair RBC restorations, although half of the respondents recommended a resin sealant to repair degraded margins. Future clinical studies on the repair of resin-based composites would help establish guidelines, provide clinical evidence, and possible validate and encourage dental schools to teach repairs of RBC restorations. In both studies (Blum & others, 2003, Gordan & others, 2003), most teaching of RBC repair occurred at the clinical level, instead of formal lectures.

A national survey was conducted to determine the materials general dentists used for direct and indirect posterior restorations (Haj-Ali & others, 2005). Haj-Ali & others (2005) questioned whether dentists were really practicing an evidence-based approach when they found that 15% of dentists regarded moisture control, a critical element for RBC, as an insignificant factor when placing posterior composite restorations. The investigators remarked that this indicates a need for further emphasis on the implementation of evidence-based dentistry.

Summary

No presently available study has examined dentists' knowledge, attitudes, and behaviors concerning Minimal Intervention Dentistry. A few studies have evaluated specific aspects of MID in terms of diagnosis, risk assessment and treatment preferences. These studies focused on general dental practitioners in clinical practice in Europe and North America. They indicate that more and more dentists have knowledge of MID, and view MID practices as useful; however, the principles of Minimal Intervention Dentistry are not being utilized fully.

Summary

Knowledge Up to This Point

The use of evidence-based dentistry and the decline in caries rates changed the approach in clinical dentistry. New technologies, such as early caries detection devices, adhesive restorative materials, and chemotherapeutic agents designed to minimize operative intervention and maintain tooth structure, facilitated the introduction of Minimal Intervention Dentistry. Clinical and laboratory studies have demonstrated that dental caries is a preventable infectious disease.

Decision-making in dentistry is complex. The decisions that dentists make are often based on their knowledge from training experiences, anecdotal information from colleagues, and personal, patient, and practice factors. Much of what is known about oral health came from studies by researchers throughout the world. Sometimes, these studies were not optimally designed. Tradition has always been a large part of clinical dentistry. Evidence-based practice requires the use of validated and reliable evidence of effectiveness. A trend has emerged toward more evidence-based practice, using the best evidence available from randomized clinical trials and systematic reviews, when available.

Dentists are slowly transitioning from a surgical model to a medical model of caries control. The medical model recognizes the importance of treating the source of the infection rather than only the infection's consequence, a carious lesion. Practices of Minimal Intervention Dentistry support the medical model and it aims to save as much tooth structure as possible.

Well conducted clinical studies have shown that a carious lesion can be prevented, and/or remineralized, inactivated by use of agents like fluoride and calcium phosphates, sealants, sealing composite and amalgam restorations, and using glass

ionomer cement restorations. Restorative techniques like ART facilitate treatment of cavitated lesions with hand instruments and do not require anesthesia.

Present Gaps in Knowledge

Little is known about the patterns of knowledge, attitudes, and behaviors of dentists in the United States concerning Minimal Intervention Dentistry. In addition, little is known about differences among federal and civilian dentist populations. Several studies from countries outside of the United States indicated that public service dentists tended to be more conservative than private practitioners were in their restorative treatment thresholds. No such study exists for the United States.

This study was important as a first step in providing information on federal service and civilian dentists familiarity with MID, and to offer insight on future directions to take in this area.

Future Directions

Future studies are needed in the areas of evidence-based dentistry, Minimal Intervention Dentistry, and the clinical practice of dentistry in the United States. More studies that examine clinical issues are needed, as well as studies to validate present clinical practices. Studies evaluating the clinical effectiveness of new materials and technologies for caries prevention and treatment are required. Studies on the role of third party payers, manufacturers, and policy makers might encourage greater participation by dentists and encourage the practice of Minimally Intervention Dentistry.

CHAPTER III

MATERIALS AND METHODS

Introduction

The primary aims of this study was to determine whether knowledge, attitudes, and behaviors concerning Minimal Intervention Dentistry were similar between 1)federal service and civilian dentists and 2) among the four federal services. The study separately evaluated the characteristics associated with knowledge, attitudes and behaviors of federal service versus civilian dentists and among federal service subgroups. The survey instrument was a self-reported questionnaire. Names and addresses of participants were obtained from a current American Dental Association membership roster. All participants were active members of the American Dental Association. Appendix A is a copy of the survey instrument. Independent and dependent variables for this study are summarized in Appendix B.

Hypotheses

There were five hypotheses considered for this study. The hypotheses were:

1. There are no differences between federal service and civilian dentists' knowledge, attitudes, and behaviors (KAB) concerning Minimal Intervention Dentistry.
2. There are no differences among federal service subgroups' knowledge, attitudes, and behaviors concerning Minimal Intervention Dentistry.
3. There are no personal and professional characteristics that are associated with knowledge, attitudes, and behaviors concerning Minimal Intervention Dentistry.

4. There are no differences between federal service and civilian dentists in characteristics that are associated with knowledge, attitudes, and behaviors concerning Minimal Intervention Dentistry.
5. There are no differences among federal service subgroups in the characteristics that are associated with knowledge, attitudes, and behaviors concerning Minimal Intervention Dentistry.

Table 9 shows separate subhypotheses for knowledge, attitudes and behaviors, overall, between federal service and civilian dentists, and among federal service subgroups. Subhypotheses concerning the characteristics associated with each of these areas are also shown in Table 9.

Research Design

This was an observational, cross-sectional study of a sample of federal and civilian dentists. The research instrument was a pre-tested, twenty-one-question survey. Some questions on the survey contained subquestions, so that there were actually fifty-one required responses. The survey was pre-tested by eight faculty members (one full-time and seven part-time adjunct faculty) from the Department of Family Dentistry and six faculty members (four full-time and two part-time adjunct faculty) from the Department of Operative Dentistry at the College of Dentistry, University of Iowa during August 2005. Changes for clarity were made to the questionnaire following pre-testing. There were no substantive, scientific changes made to the survey. Institutional Review Board (IRB) approval was granted in September 2005.

Table 9. List of Hypotheses and Subhypotheses

Hypotheses	**Subhypotheses**
1. There are no differences between federal service and civilian dentists' knowledge, attitudes, and behaviors concerning Minimal Intervention Dentistry.	a. There are no differences in knowledge. b. There are no differences in attitudes. c. There are no differences in behaviors.
2. There are no differences among federal service subgroups' knowledge, attitudes, and behaviors concerning Minimal Intervention Dentistry.	a. There are no differences in knowledge. b. There are no differences in attitudes. c. There are no differences in behaviors.
3. There are no differences between federal service and civilian dentists in characteristics associated with knowledge, attitudes, and behaviors concerning Minimal Intervention Dentistry.	a. There are no characteristics associated with knowledge. b. There are no characteristics associated with attitudes. c. There are no characteristics associated with behaviors.
4. There are no differences between federal service and civilian dentists in characteristics that are associated with knowledge, attitudes, and behaviors concerning Minimal Intervention Dentistry.	a. There are no characteristics associated with knowledge. b. There are no characteristics associated with attitudes. c. There are no characteristics associated with behaviors.
5. There are no differences among federal service subgroups in characteristics that are associated with knowledge, attitudes, and behaviors concerning Minimal Intervention Dentistry.	a. There are no differences in characteristics associated with knowledge. b. There are no differences in characteristics associated with attitudes. c. There are no differences in characteristics associated with behaviors.

Study Population

A sample of federal service and civilian dentists comprised the study population. Nine-hundred federal service dentists, with DMD/DDS only and AEGD/GPR, Dental Public Health or Operative Dentistry training, and 600 civilian DMD/DDS , Dental Public Health or Operative Dentistry trained dentists were selected by stratified random

sampling of current members of the American Dental Association in August 2005. The American Dental Association maintains separate databases for federal service dentists. Federal service dentists included in the sample were ADA members from the United States Air Force, United States Army, United States Navy, and United States Public Health Service. The American Dental Association stated 685 Air Force dentists, 542 Army dentists, 731 Navy dentists, 235 Public Health Service dentists, and 118,208 general practitioners were active members of the ADA as of December 2004 (Personal communication with Debbie Gorski, ADA Membership, September 2005). Therefore, the sampling fractions were 32.8% for Air Force, 41.5% for Army, 30.8% for Navy, 95.7% for Public Health Service, and 0.51% for civilian dentists.

An equal number of dentists (n=225) were selected from each federal service. The civilian dentist target population defined as non-federal service dentists included ADA member dentists from all states, territories, and regions of the United States. The American Dental Association's Purchasing Department provided five separate random samples of the groups targeted to be involved in this study. The ages of dentists in the federal and civilian sectors ranged from 23-90 years.

A cover letter, signed by the principal investigator and the research chairperson, was mailed to potential participants in early November 2005 along with the questionnaire. The cover letter included the components required by the IRB to ensure that respondents understood that research participation was voluntary and any reports filed would not include identifiable information. Thus, a formal written consent form was not required and return of the completed questionnaire was the subject's consent to participate. Also included in the first mailing was a postcard that was to be returned confirming a desire for non-participation in the study. The original mailing included a pre-addressed postage-paid return envelope. In January 2006, ten weeks after the first mailing, a second mailing containing a duplicate questionnaire, return envelope, postcard,

and cover letter, was mailed to those who had not returned either the questionnaire or the non-participation postcard.

Inclusion and Exclusion Criteria

In this study, the sample consisted of 225 members from each of the four federal service groups and 600 from the general dentist population

Inclusion criteria included being an ADA member, and a general dentist or dentist trained in Dental Public Health or Operative Dentistry. Exclusion criteria included being a non-ADA member, a retired ADA member, federal dentist in the Veterans Administration or Civil Service, or dental specialist recognized by the ADA, other than Dental Public Health. Dentists with multiple specialties that included Dental Public Health and Dental Public Health administrators were included in the study.

Survey Instrument

The survey was divided into four sections (Appendix A). The first section asked about personal and practice characteristics. Knowledge was assessed in the second section (question #15). The third section addressed participant attitudes (questions 16 and 17), and the fourth section examined behaviors (questions 18 through 20) concerning MID. The raw scores for each subquestion were used to create composite scores for each of the series of subquestions for questions 15-18 and 20. Most questions were closed-ended, requesting that participants circle a response or specify a value. Four were open-ended questions. Several questions (15-18, 20) used Likert-type response categories.

Survey Procedures

A questionnaire was mailed to each potential subject's address on file with the American Dental Association. Along with the questionnaire was a personally signed and addressed introductory letter that explained the purpose of the study, the potential participant's rights, and study investigators' contact information in case there were

questions. The subjects were asked to return the completed form by United States mail. Return of the completed questionnaire was the subject's consent to participate. The subject had eight weeks to return the seven-page questionnaire. Then, one follow-up mailing was sent out ten weeks after the initial mailing as a reminder to complete the questionnaire or return the postcard indicating they did not want to participate. A personally addressed and signed cover letter was also used in the follow-up mailing to improve the response rate. Thus, the surveys were collected over a period of eighteen weeks. The questionnaire was in booklet form. The identification number was on the lower right hand corner of the last page.

Returned questionnaires and postcards were stored in a locked file cabinet in the Department of Preventive and Community Dentistry, College of Dentistry, University of Iowa. The mailing list and code were also stored in a locked cabinet. Once all questionnaires were received, and/or data-collection ended, the code that identified the participants was destroyed. Electronic copies of the main data were stored on removable disks.

The surveys were reviewed for completeness and clarity before submission for data entry. An outside contractor, the data entry component of the Biostatistics Unit, College of Public Health, University of Iowa, performed double data entry and verification for completed questionnaires.

Statistical Methods

SAS 9.1 was the statistical package used for data analysis of closed-ended questions. The level of significance was set at $p<0.05$ for bivariate and final multivariable analyses.

Power and Sample Size Considerations

Sample size calculations preceded the start of the study. Sample size calculations were based on the key question, #18d (How often would you monitor (and not restore) a

proximal carious lesion in the middle third of enamel, found on routine radiographic assessment of an upper left premolar of a 23-year-old, high caries risk patient with poor oral hygiene, inadequate fluoride exposures, and limited financial resources?) Based on the very limited data available and experts' estimates based on question 18d, the detectable group differences expected were on the order of 10% to 15%. Sample size/power calculations were based on a projected overall response rate of 60% after two mailings: 540 federal service dentists and 360 civilian dentists, for 900 total. With these expected returns, with two-sided testing and a Type I error level of 0.05, there was estimated to be 80% power to detect differences between federal and civilian dentists of 6.4% if the smaller proportion is about 10% (in the civilian group), increasing to 9.5% as that proportion increases to around 50%.

However, response levels were much lower than anticipated, with 465 respondents overall, including 327 civilian dentists and 138 federal service dentists. Given these numbers and retaining the level of significance of 0.05, the difference in proportions between these two groups, that is detectable with 80% power would be about 9.9% if the smaller proportion (in the civilian group) is about 10%, increasing to 14.1% as that proportion increases to around 50%.

Variables

Independent Variables

The key independent variables included in the analyses were provider group, gender, age, date of dental school graduation, years since graduation, postgraduate training and continuing education hours. Provider group was reported overall as federal versus civilian, or by federal service subgroup of Air Force, Army, Navy, or Public Health Service. Age, year of dental school graduation, and years since graduation were reported by their actual values on an interval scale. The categories were 0-4, 5-9, 10-14, 15-19, and ≥ 20 for continuing education hours earned in the past year. Gender and

postgraduate training were dichotomous, male or female, and yes or no, respectively. Appendix B lists the independent and dependent variables.

Dependent Variables

The three categories of dependent variables for this study were knowledge, attitudes, and behaviors concerning Minimal Intervention Dentistry. The dependent variables were reported from individual and combined participant responses to questions 15(a-How much do you know about ART?, and b-How much do you know about MID?); 16(Use of MID at: a-ship at sea, b-fixed military site in a remote location, c-Indian Health Service facility, d-Public Health Clinic, e-Private dental office); 17(Attitudes toward the following statements: a-fluoride is an effective remineralizing agent, b-G.V. Black's "extension for prevention" is still relevant in certain clinical situations, c-the use of adhesive restorative materials reduces the size of restorations, d-there is adequate time to conduct a caries risk assessment or every patient); 18(Behaviors: a-Restore and not extract a vital central incisor, b-Restore and not monitor a vital lower first molar, c-Replace and not monitor an intact stained non-carious composite restoration, d-Monitor and not restore a proximal carious lesion in the middle third of enamel); and 20(Behaviors: a-Caries risk assessment, b-Microbial testing, c-Remineralize with CPP/ACP, d-Remineralize non-cavitated carious lesions, e-Topical fluoride application, f-Prescribe chlorhexidine, g-Prescribe a high concentration fluoride dentifrice, h-Seal amalgam restorations with sealant, i-Seal composite restorations with sealant, j-Repair defective restorations, k-Slot and tunnel preparations, l-Redo existing restorations, m-Sandwich technique, n-Restore with glass ionomer cement, o-Atraumatic Restorative Treatment). Subquestions 18b and 18c were recoded so that the wording of all subquestions for Question 18 was in the same direction. Composite variables were constructed for Questions 15-18 and 20 using the sum of the responses to their subquestions, although only two composite variables, composite 18 and 20, were

considered for multivariable analyses. Questions 15b, 17a, 18d, and 20d were the key dependent variables for this study. Appendix A presents the questionnaire.

Data Analysis

Initial Analyses-Overall Analysis Plan

Each response was analyzed using descriptive statistics to profile knowledge, attitudes and behaviors and their associated characteristics concerning MID among all dentists, between federal and civilian dentists, and among the four federal services. All responders and these subgroups were profiled with respect to both outcome and potential explanatory variables. Associations among potential explanatory variables were also explored, since many variables had interrelationships. Collinearity diagnostic tests were performed, with particular attention given to age, years since graduation, and years of practice. These initial analyses were followed by formal bivariate analyses, as described below. Subsequently, quantitative outcomes (composite scores) and their relationship to federal/civilian status and other covariates were assessed using multiple linear regression methods. Throughout the modeling phase, careful attention was paid to assessment of the validity of model assumptions and issues such as collinearity and overfitting.

The primary analysis emphasis was on the comparison of federal and civilian dentist responses. Secondary aims were to make similar comparisons and assess factors influencing these responses among the four service affiliations within the federal service group. Identical statistical methods were used to compare the federal service subgroups, using the same sequence of univariate, bivariate and linear regression analyses to assess variable relationships.

Strong correlations among independent variables could result in multicollinearity. When multicollinearity occurs, there tend to be inflated standard errors and highly unreliable regression coefficients with possibly incorrect direction and magnitude, ultimately leading to incorrect inferences regarding dependent and independent variable

relationships. This was of particular concern because of the necessarily close relationships among age, years since graduation, and years of practice, and their resulting high degree of correlation. In this study, the two methods used to evaluate collinearity were tolerance and the Variance Inflation Factor (VIF). Tolerance is an indicator of how much collinearity a regression analysis can tolerate. VIF is the inverse of tolerance and is an indication of how much standard error could be inflated due to collinearity. A VIF <10 and Tolerance >0.1 are desirable (SAS 9.1).

Bivariate Analyses

The bivariate analyses were conducted for three general purposes, 1) to make comparisons between federal and civilian respondents, 2) to make comparisons among federal service subgroups in an analogous manner, and 3) to consider associations between each dependent variable and each of the explanatory variables.

In addition to compilation of frequency distributions and variable means for descriptive purposes, standard chi-square tests of homogeneity or Fisher exact tests[1], if needed, were used to evaluate possible relationships among pairs of nominal categorical variables. Ordinal scores, which comprised the majority of the outcome variables, were compared among groups using the Cochran-Mantel Haenszel test (CMH)[2]. The CMH is a mean score test that uses integer scores to denote the set of possible responses.

An alternative approach, called Ridit Analysis[3] was also used. The initials of the term ridit stand for "relative to an identified distribution"[2]. Ridit Analysis uses the overall distribution of scores as a reference group, assessing the differences in the pattern of responses in subgroups from the overall distribution. Ridit Analysis is related to a rank

---

[1] Mehta CR, Patel NR (1983). A network algorithm for performing Fisher's exact test in rxc contingency tables. J Am Statistical Assoc 78:427-434.

[2] Agresti A. Analysis of Ordinal Categorical Data. New York: Wiley, 1984.

[3] Bross IDJ. How to use ridit analysis. *Biometrics* 1958; 14:18-38.

order analysis and uses the CMH approach with ridit instead of integer scores. Relationships were assessed between two ordinal responses using Kendall's Tau-b[4], which is interpreted similarly to a correlation coefficient.

Differences in distributions between subgroups, such as a composite score between federal and civilian dentists, were assessed using the Wilcoxon Rank Sum Test or the Kruskal-Wallis Test, its analogue for more than two groups. The Kruskal-Wallis procedure was used when comparing the distribution of quantitative measures among the four subgroups of federal dentists.

Spearman Rank Correlations[5] were used to assess outcome associations between a quantitative response and ordinal response or between two quantitative responses, for example, age and a composite score. Specifically, correlations were assessed for variables age, years since graduation, and years of practice to explore the possibility of multicollinearity. Multivariate analysis of variance (MANOVA[6]) is used to test parameters of several dependent variables being fit to the same effects. MANOVA was used to compare federal service and civilian dentists in terms of the set of percentages describing the age distribution of their patient population groups, using the Wilks-Lambda statistic.

Multivariable Analyses

Two primary approaches were used for multivariable analyses. The first approach was multiple linear regression for quantitative outcomes, i.e. composite scores. The second approach was multiple logistic regression for binary outcomes for knowledge and

---

4 Koch GG, Beck JD. Statistical methodologies useful for the analysis of data from risk-assessment studies. Journal of Public Health Dentistry 1992;52(3):146-167

5 Koch GG, Beck JD. Statistical methodologies useful for the analysis of data from risk-assessment studies. Journal of Public Health Dentistry 1992;52(3):146-167

6 SAS 9.1. Help and documentation

behaviors as previously described. Multiple logistic regression analyses were not completed for this study due to time constraints. The primary analyses included the provider group for all respondents, or federal group, for federal service respondents, whether or not those variables met entry requirements for addition to the models. These variables were deliberately retained because the primary aim of the study was the comparison of groups. SAS® procedures used for multivariable analyses included Proc Regression and Proc GLM.

Variable Selection and Overfitting Considerations

The sample size must be sufficiently large in comparison with the number of candidate predictor variables in order for automatic variable selection procedures to yield reliable predictive models; otherwise, "overfitting" could result. Models cannot be expected to be valid or reproducible if overfitting occurs. For multiple linear regression analyses, the guidelines of Harrell & others (1985) were used, which specify that the number of variables entertained for multiple regression modeling of quantitative outcomes (e.g. by a stepwise procedure) must not exceed the sample size divided by 10. In linear regression models, using the entire sample of 465 respondents, the entire set of covariates of interest from the bivariate findings, could be entertained in multiple linear regression modeling. This could not be done for the modeling of the federal service subset due to its smaller sample size of 138 respondents. When the set of available variables exceeded the allowable number, those covariates with p-values <0.15 in bivariate assessment with the association with the outcome variable, were entertained in modeling. In addition, results of multicollinearity assessment and bivariate analyses were used as a basis of selection among the variables exhibiting collinearity, e.g., the variables age, years of practice, and years since graduation.

Multiple Linear Regression Modeling

For each model, three selection methods were performed, stepwise selection, forward selection, and backward elimination, as well as additional exploratory modeling guided by hypothesized relationships and the need for assessment of interaction.

SAS 9.1[7] describes the variable (effect) selection methods. In forward selection, variables that meet entry requirements are entered one at a time. Once entered, the effect is never removed. This process repeats until none of the remaining variables meet the specified level for entry or until the stop value is reached. Backward elimination starts with all variables of interest. The least significant effect not meeting the stay level is removed. In backward elimination, a variable that is removed cannot reenter the model. The process is repeated until no other effect meets the specified level for removal or until the stop level is reached. The stepwise selection method begins similar to the forward selection method, but it really combines forward and backward selection, using entry and exit levels. Thus, a forward selection step might be followed by backward elimination of an effect. This process ends when no other variable can be added, or the variable entered is the only effect removed in the subsequent backward elimination[7].

Two-way interaction terms involving significant variables ($p<0.05$) were entered and were used as appropriate as part of the final model (Schwarz & others, 1997). All possible two-way interactions of significant variables with provider status (federal service group in models confined to federal dentists) were also considered. Residual analyses and plots were also carried out to evaluate model assumptions, including linearity and variance homogeneity. The Shapiro-Wilk test was performed to evaluate normality. Data transformations were applied to address matters of non-normality. Where normality assumptions were not met, rank transformation and logbase10 transformation were

[7] SAS 9.1 Help and Documentation.

applied to the composite variable. Where the log transformation did not achieve completely satisfactory results, the rank transformation approach of Conover and Iman was applied. The rank transformation approach[8,9] which represents a bridge between parametric and nonparametric methods, is considered very robust.

---

8 Conover W, Iman R (1976). On some alternative procedures using ranks for the analysis of experimental designs. Commun Stat Theor Methods A5, 1349-1368.

9 Conover W, Iman RL (1981). Rank transformations as a bridge between parametric and nonparametric statistics. Am Stat 35, 124-129.

CHAPTER IV

RESULTS

Introduction

This study compared the knowledge, attitudes, and behaviors of federal service and civilian dentists concerning Minimal Intervention Dentistry. The response rate and analyses used for univariate, bivariate, and multivariate analyses are discussed in this chapter. There were differences between federal service and civilian dentists and among federal service subgroups.

Response Rates

Six hundred twenty two of 1,500 federal and civilian dentists responded to the survey after two mailings (Table 10). There were fifteen hundred dentists sent questionnaires for the first mailing, and one thousand twenty-seven dentists sent questionnaires for the second mailing. Approximately, five hundred two dentists responded to the first mailing and 123 dentists responded to the second mailing. Questionnaires received ten days after the second mailing were identified as responding to the second mailing, although overlap was possible. Overall, there were 512 questionnaires and 113 non-participation postcards returned. The overall response rate for this study was 41.7%. Table 10 presents the response rate.

Three questionnaires were excluded because three dentists completed two questionnaires, one from each mailing, which were forwarded to data entry services. For these respondents, only the responses from the first questionnaire were used during data analysis. Forty-four dentists who completed questionnaires were excluded because they were specialists trained in areas other than Dental Public Health or Operative Dentistry. Therefore, in all, 465 questionnaires were used for analysis, for an effective response rate

of 31.0%. A post-hoc power analysis was performed since responses were lower than expected (60.0%) after two mailings.

Table 10. Response Rate Overall [n (%)]*

Overall response	Questionnaires	Postcards	Effective response
622(40.6%)	509(33.9%)	113(7.5%)	465(31.0%)

*Responses from 1500 targeted questionnaires

Nine-hundred federal service dentists received questionnaires, 225 each in the Air Force, Army, Navy, and Public Health Service (PHS). Six hundred questionnaires were sent to civilian dentists. Table 11 presents the response rate for federal and civilian respondents and the federal service subgroups.

Table 11. Effective Full Response Rate by Provider Category [n (%)]

Group	Effective Response Rate
Overall	465 (31.0%)
Federal	138 (15.3%)
Civilian	327 (54.5%)
Air Force	39 (17.3%)
Army	42 (18.7%)
Navy	25 (11.1%)
Public Health Service	32 (14.2%)

Note: AF=Air Force, AR=Army, NA=Navy,
PHS=Public Health Service

In response to question #3, "Are you presently an active duty commissioned officer?", 128 dentists identified themselves as a member of a federal commissioned

service, 325 indicated they were not a member of a commissioned service, and 12 did not answer question #3. There were 39 dentists from the Air Force, 42 dentists from the Army, 25 from the Navy, and 32 were PHS dentists. Table 12 indicates that most federal dentists were the grade of O-3 (58.8%), which is equivalent to a Lieutenant in the Navy and PHS, or a Captain in the Air Force and Army. There were fewer respondents in other grades; 9.6% were O-4, a Lieutenant Commander or Major, 15.0% were O-5, a Commander or Lieutenant Colonel, and 19.8% were O-6, the equivalent of a Captain in the Navy and PHS, or a Colonel in the Air Force and Army. One respondent (0.7%) indicated they were an O-7, equivalent to an Admiral or General.

Table 12. Frequency of Rank of Federal Service Respondents' [n(%)]

Rank	Frequency (%)
O-3	80(58.8%)
O-4	13(9.6%)
O-5	15(11.0%)
O-6	27(19.8%)
O-7	1(0.7%)

Twelve respondents indicated an affiliation and rank associated with a federal service although they circled 'no' to active duty commissioned officer (Question #3). These dentists were considered federal service dentists. Two other respondents circled 'yes' to Question #3-active duty status, but did not indicate their service affiliation (Question #4-What is your federal service affiliation?). One of the two dentists indicated their service grade (Question #5-What is your service grade?) and based on their ID# was included in the Navy federal service group for further analysis. The other dentist, missing both federal service affiliation and service grade information was considered a civilian during analysis.

Respondents were considered trained in Dental Public Health if their training was in Dental Public Health, Public Health, Health Policy, Epidemiology, Geriatric Dentistry, Health Care Ethics, Preventive Dentistry, and Dentistry for the Developmentally Disabled, or Health Services Research. Operative Dentistry training also included training in Dental Materials. Of those with ADA recognized specialties other than Dental Public Health excluded from the analyses, 7 were Endodontists, 6 were Oral and Maxillofacial Surgeons, 6 were Orthodontists, 4 were Pediatric Dentists, 7 were Periodontists, and 7 were Prosthodontists. In addition, 3 respondents received training in Oral Medicine, 2 in Anesthesiology, 1 in Implantology, and 1 in TMJ/Oro-facial Pain and all these were excluded from analyses.

One hundred thirteen respondents did not complete questionnaires. Instead, they returned postcards stating that they did not wish to participate in the study. Thirteen of 113 postcards received had a written statement about the respondent's reason for non-participation. Four respondents indicated they were retired, four were no longer involved in clinical practice, and two respondents wrote they were "not a federal or non-federal dentist". One Pediatric Dentist chose not to participate, and one respondent stated their reason for choosing not to participate was that they were a faculty member in Dental Public Health. A postcard sent by someone other than the respondent stated, "He is not in U.S. currently due to military assignment."

Knowledge Concerning Minimal Intervention Dentistry

Table 13 presents the results for question #15. Question 15 assessed knowledge of MID and had two subquestions; 15a (How much do you know about Atraumatic Restorative Treatment (ART)?), and 15b (How much do you know about Minimal Intervention Dentistry (MID)?). The key question for knowledge was subquestion 15b. The greatest number of respondents selected "Some" for both 15a (36.6%), and 15b

37.2%). Respondents selected "None" more often for ART (13.0%) than for MID (10.2%).

Table 13. Knowledge Concerning Minimal Intervention Dentistry [n (%)]

#	Wording	Missing	Valid n	1-Very Much	2-Much	3-Some	4-Little	5-None
15 a.	How much do you know about Atraumatic Restorative Treatment?	3	462	66(14.3%)	89(19.3%)	169(36.6%)	78(16.9%)	60(13.0%)
15 b.	How much do you know about Minimal Interventon Dentistry?	2	463	75(16.2%)	117(25.3%)	172(37.2%)	52(11.2%)	47(10.2%)

Note: Test statistic-Frequency distributions

Table 14 shows the result for the composite variable summing the scores (1=Very Much to 5=None) for the 2 subquestions. The composite scores ranged from 2 to 10, with a mean of 5.7, a standard deviation of 2.1, and a median of 6.0. The majority of respondents had scores greater than 4. Forty-eight respondents had a composite score of '2' which indicated that they had 'very much' knowledge of Atraumatic Restorative Treatment and Minimal Intervention Dentistry. Twenty-five respondents had a composite score of '10', which indicated that they had no knowledge of ART and MID.

Table 14. Composite Knowledge* Using Subquestions of Question 15 [n (%)]

Score	n(%)
2	48(10.4%)
3	25(5.4%)
4	61(13.2%)
5	58(12.6%)
6	125(27.1%)
7	51(11.1%)
8	51(11.1%)
9	17(3.7%)
10	25(5.4%)

Note: Missing=4, Valid n = 461

*Sum of responses to questions 15a and 15b

Attitudes Concerning Minimal Intervention Dentistry

Two questions evaluated respondents' attitudes towards MID. Question #16 asked respondents to separately consider five hypothetical practice settings for use of MID. Respondents were asked to skip this question if they circled 5 (None) for question 15b (How much do you know about MID?). There were 47 respondents circling '5' to question 15b (No knowledge of MID). None of these 47 respondents completed question # 16.

Table 15 presents the results for each of the 5 subquestions of question #16. The number of missing responses to question #16 were 100 for subquestion 16a, 95 for subquestion 16b, 98 for subquestion 16c, 93 for subquestion 16d, and 80 missing responses for subquestion 16e. Table 16 is a composite variable summing the scores (from 1=Always or most of the time to 4=Never or rarely).

For each of the five settings, less than thirty-one percent (22.0% to 30.1%) of respondents thought MID should be used 'always or most of the time'. Seven percent or

less of respondents (4.7%-7.0%) for each practice setting selected 'never or rarely' for use of MID. A public health clinic was selected most often to "never or rarely" use MID (7.0%).

Composite scores ranged from 4 to 16, with a mean of 8.6, a standard deviation of 2.9, and a median of 8. Most respondents had scores of 12 or less (94.7%). The greatest number of respondents received scores of 4(16.5%), 8(22.4%), and 12(17.1%). Fifty-nine respondents achieved a score of '4' which indicated that they thought all the practice settings should use MID 'always or most of the time', while only 2 achieved the highest score of '16' which indicated the respondents' believed that none of the practice settings should use MID.

Table 15. Attitudes by Hypothetical Practice Settings [n(%)]

#	Wording	Missing	Valid n	1-Always or most of the time	2-Often	3-Sometimes	4-Never or rarely
16a.	Ship at sea	100	365	108(29.6%)	124(34.5%)	113(31.0%)	18(4.9%)
16b.	Fixed military site in a remote location	95	370	95(25.7%)	134(36.2%)	123(33.2%)	18(4.9%)
16c.	Indian Health Service facility.	98	367	83(22.6%)	128(34.9%)	135(36.8%)	21(5.7%)
16d.	Public Health Clinic	93	372	82(22.0%)	133(35.8%)	131(35.2%)	26(7.0%)
16e.	Private dental office	80	385	117(30.4%)	136(35.3%)	114(29.6%)	18(4.7%)

Note: Test statistic frequency distribution

Table 16. Composite Score Using Subquestions of Question 16 [n(%)]

Score	**n(%)**
4	59(16.5%)
5	12(3.4%)
6	13(3.6%)
7	21(5.9%)
8	80(22.4%)
9	27(7.5%)
10	35(9.8%)
11	31(8.7%)
12	61(17.0)
13	10(2.8%)
14	6(1.7%)
15	1(0.3%)
16	2(0.6%)

Note: Missing=107, valid n = 358

*Sum of responses to questions
16a, 16b, 16c, 16d, and 16e

Question #17 requested information on respondent attitudes concerning four separate aspects of MID (Table 17). Table 18 shows results of the composite variable summing the scores (from 1=Strongly agree to 4=Strongly disagree) for each of the 4 subquestions of Question #17. The key question for attitudes was subquestion 17a, "What is your attitude toward 'Fluoride is an effective remineralizing agent' for adult patients?" Most respondents agreed or strongly agreed that fluoride was an effective remineralizing agent (96.7%). Two respondents (0.4%) strongly disagreed.

Table 17. Attitudes Using Subquestions of Question 17 [n (%)]

#	Wording	Missing	Valid n	1-Strongly Agree	2-Agree	3-Disagree	4-Strongly Disagree
17 a.	Fluoride is an effective remineralizing agent.	4	461	298(64.4%)	146(31.7%)	15(3.3%)	2(0.4%)
17 b.	G.V. Black's "extension for prevention" is still relevant in certain clinical situations.	5	460	67(14.6%)	211(45.9%)	129(28.0%)	53(11.5%)
17 c.	The use of adhesive restorative materials reduces the size of restorations.	4	461	198(43.0%)	225(48.8%)	34(7.4%)	4(0.9%)
17 d.	There is adequate time to conduct a caries risk assessment for every patient.	7	458	82(17.9%)	209(45.6%)	146(31.9%)	21(4.6%)

The majority of respondents agreed individually with each of the other 3 subquestions, with total agreement (agree and strongly agree) of 60.4% for 17b (G.V. Black's extension for prevention is still relevant in certain clinical situations.), 91.8% for 17c (The use of adhesive restorative materials reduces the size of restorations.), and 63.5% for 17d (There is adequate time to conduct a caries risk assessment for every patient).

The composite scores ranged from 4 to 12, with a mean of 7.6, a standard deviation of 1.5, and a median of 8.0. Most respondents (82.4%) received scores in the range of 6 through 9. Eleven respondents achieved the lowest score of 4, indicating strong agreement with each statement, while only 3 respondents had the highest score of 16, indicating strong disagreement with each statement.

Table 18. Composite Measure of Attitudes Using Subquestions of Question 17 [n (%)]

Score	n(%)
4	11(2.4%)
5	21(4.6%)
6	71(15.6%)
7	111(24.4%)
8	111(24.4%)
9	81(17.8%)
10	32(7.1%)
11	13(2.9%)
12	3(0.7%)

Note: Missing=11, Valid n =454

* Sum of responses to questions
17a, 17b, 17c, and 17d

Behaviors concerning Minimal Intervention Dentistry

Question #18 had 4 subquestions concerning clinical treatment choices. Each subquestion result is presented separately in Tables 19 and 20. The composite variable summing the scores (from 1=Always or most of the time to 4=Never or rarely) is shown in Table 21. The key question 18d "How much do you monitor and not restore a proximal carious lesion in the middle third of enamel?" was one of two key questions used to evaluate dentists' restorative behaviors. The second key question for behaviors was subquestion 20d, "How often do you perform 'remineralize non-cavitated carious lesions' for your adult patients?"

As shown in Table 19, over half of respondents (56.4%) would 'always or most of the time' restore a grossly carious central incisor in a high caries risk patient with limited resources. Seventy percent of respondents would 'never or rarely' restore an asymptomatic lower molar with a white spot lesion and 67.1% would 'never or rarely' replace a non-carious stained facial composite restoration. More dentists (41.6%) would

'never or rarely' monitor an enamel proximal carious lesion in a high caries risk (HCR) patient than those in each of the groups who would monitor sometimes (27.8%), often (16.4%), or always or most of the time (14.2%).

Table 19. Clinical Decision-Making Behaviors* Original Question 18 [n (%)]

#	Wording How often would you make the following treatment choices?	Missing	Valid n	1-Always or most of the time	2-Often	3-Sometimes	4-Never or rarely
18a	Restore (and not extract) a central incisor in HCR patient with limited finances	16	449	253(56.4%)	119(26.5%)	57(12.7%)	20(4.4%)
18b	Restore (and not monitor) a vital lower molar with a white spot lesion in LCR patient	13	452	39(8.6%)	20(4.4%)	77(17.0%)	316(70.0%)
18c	Replace (and not monitor) an anterior facial composite in LCR patient for whom esthetics is not a concern	14	451	8(1.8%)	20(4.4%)	120(26.7%)	301(67.1%)
18d	Monitor (and not restore) a proximal carious lesion in a HCR patient with limited finances	14	451	64(14.2%)	74(16.4%)	125(27.8%)	187(41.6%)

* HCR=high caries risk, LCR=low caries risk

Because subquestions 18b and 18c were written in the opposite direction to 18a and 18d, 18b and 18c then were "reversed" so that the stem was changed and the score of

"1=Always or most of the time" became "4=Never or rarely", a score of "2=Often" became "3=Sometimes", a score of "3=Sometimes" became "2=Often", and a score of "4=Never or rarely" became "1=Always or most of the time." Therefore, 18b is effectively changed to "Monitor and not restore", and 18c is changed to "Monitor and not replace." Table 20 shows the results after this reversal, and these four components were used to create the composite variable described later and shown in Table 21.

Table 20. Clinical Decision-Making Behaviors*- Recoded Question 18 [n (%)]

#	Wording How often would you make the following treatment choices?	Missing	Valid n	1-Always or most of the time	2-Often	3-Sometimes	4-Never or rarely
18a	Restore and not extract a central incisor in HCR patient with limited finances	16	449	253(56.4%)	119(26.5%)	57(12.7%)	20(4.4%)
18b.*	Monitor and not restore a vital lower molar with a white spot lesion in LCR patient	13	452	316(70.0%)	77(17.0%)	20(4.4%)	39(8.6%)
18c.*	Monitor and not replace an anterior facial composite in LCR patient for whom esthetics is not a concern	14	451	302(67.1%)	120(26.7%)	20(4.4%)	8(1.8%)
18d	Monitor and not restore a proximal carious lesion in a HCR patient with limited finances	14	451	64(14.2%)	74(16.4%)	125(27.8%)	187(41.6%)

Note: HCR-high caries risk, LCR-low caries risk

*This wording and, therefore, the percent distribution of responses are reversed from the original found in Table 19.

With the reversal, over half of respondents (56.4%) would 'always or most of the time' restore a grossly carious central incisor in a high caries risk patient with limited resources. Seventy percent of respondents would monitor an asymptomatic lower molar with a white spot lesion and 67.1% would monitor a non-carious stained facial composite restoration. MID principles are to restore rather than extract and to monitor rather than restore. Thus, lower scores on all four subquestions (after recoding) are consistent with MID principles. Therefore, as recoded, a lower composite score is more consistent with MID principles (Table 21). Composite scores ranged from 4 to 14 with a mean of 7.6, a standard deviation of 2.0, and a median of 7.0. More respondents received a composite score of 7(23.6%) or 8(18.2%) than any other score. Less than 1% of respondents received the highest score of 14(0.4%).

Table 21. Clinical Decision Making Composite Score (Recoded) Question 18* [n(%)]

Composite Score*	n(%)
4	23(5.2%)
5	43(9.7%)
6	69(15.5%)
7	105(23.6%)
8	81(18.2%)
9	47(10.6%)
10	44(9.9%)
11	13(2.9%)
12	11(2.5%)
13	7(1.6%)
14	2(0.4%)

Note: Missing=20, Valid n = 445

*This uses the composite variable for subquestions 18a-d that is shown in Table 22. Subquestions b & c were reversed to be consistent with the direction of MID tendency.

The results for Question #20, with 15 subquestions about procedures related to MID performed on adult patients, are presented separately in Table 22. Subquestion m was missing 84 responses and subquestion o was missing 95 responses.

The subquestion with the greatest percentage of dentists selecting "always or most of the time" was the use of topical fluoride (41.9%). No one chose "always or most of the time" for microbial testing (0.0%). About a third of the respondents (33.7%) selected 'always or most of the time' for conducting a caries risk assessment. The most common response to question 20d- remineralize non-cavitated carious lesions was "sometimes" (32.2%). The subquestion with the most missing responses was question 20o-ART. Ninety-five dentists who returned a questionnaire (20.4%) did not answer this subquestion, and a few who did answer the question placed a question mark next to the term. The composite variable summing the scores, which is presented in Table 23, used scores ranging from 1=Strongly agree to 4=Strongly disagree for each of 13 subquestions. The subquestions 'm' and 'o' were excluded from the composite score because there were many missing responses.

The composite scores ranged from 18 to 52. The mean was 36.0, the standard deviation was 5.6, and the median was 36.0. The lowest score of 18 implied that the respondent selected "always or most of the time", which had a value of "1" the majority of the time for each subquestion. A score of 52 indicated that the respondent selected "never or rarely", which had a value of "4", for all thirteen subquestions. A score of 26 translated to an average of "2" for each subquestion, and a score of 39 translated to an average of "3" for each subquestion. Only one respondent had the lowest score of 18, while three respondents had the highest score of 52. The most common single scores were 35 (8.0%) and 37(8.0%).

Table 22. MID Procedures using Subquestions of Question 20 [n (%)]

#	Wording How often do you perform the following procedures?	Missing	Valid n	1-Always or most of the time	2-Often	3-Sometimes	4-Never or rarely
20a.	Caries risk assessment	35	430	145(33.7%)	109(25.4%)	103(24.0%)	73(17.0%)
20b.	Microbial testing	34	431	0(0.0%)	5(1.2%)	32(7.4%)	394(91.4%)
20c.	Remineralize with CPP/ACP	43	432	2(.05%)	15(3.6%)	55(13.0%)	350(82.9%)
20d.	Remineralize non-cavitated lesions	43	412	57(13.5%)	113(26.8%)	136(32.2%)	116(27.5%)
20e.	Topical fluoride application	33	432	181(41.9%)	164(38.0%)	76(17.6%)	11(2.6%)
20f.	Prescribe chlorhexidine	33	432	30(6.9%)	112(25.9%)	164(38.0%)	126(29.2%)
20g.	Prescribe 5,000 ppm fluoride dentifrice	32	433	87(20.1%)	197(45.5%)	116(26.8%)	33(7.6%)
20h.	Seal amalgams	34	431	58(13.5%)	109(25.3%)	134(31.1%)	130(30.2%)
20i.	Seal composites	32	423	83(19.2%)	143(33.0%)	139(32.1%0	68(15.7%)
20j.	Repair restorations	31	424	26(6.0%)	131(30.2%)	203(46.8%)	74(17.1%)
20k.	Slot and tunnel preps	34	422	36(8.4%)	107(37.8%)	163(37.8%)	125(29.0%)
20l.	Redo restorations	42	423	21(5.0%)	172(40.7%)	207(48.9%)	23(5.4%)
20m.	Sandwich technique	84	381	32(8.4%)	93(24.4%)	131(34.4%)	125(32.8%)
20n.	Restore with glass ionomer	41	424	17(4.0%)	99(23.4%)	175(41.3%)	133(31.4%)
20o.	Atraumatic Restorative Treatment	95	370	15(4.1%)	65(17.6%)	161(43.5%)	129(34.9%)

Table 23. Composite Score Using 13 Subquestions of Question #20 [n (%)]

Composite Score*	n(%)
18	1(0.3%)
22	1(0.3%)
23	2(0.5%)
24	4(1.0%)
25	4(1.0%)
26	8(2.1%)
27	9(2.3%)
28	14(3.6%)
29	10(2.6%)
30	12(3.1%)
31	16(4.1%)
32	19(4.9%)
33	25(6.5%)
34	19(4.9%)
35	31(8.0%)
36	25(6.5%)
37	31(8.0%)
38	28(7.2%)
39	23(5.9%)
40	17(4.4%)
41	26(6.7%)
42	13(3.4%)
43	17(4.4%)
44	17(4.4%)
45	3(0.8%)
46	4(1.0%)
47	4(1.0%)
48	1(0.3%)
52	3(0.8%)

*This composite variable uses 13 of 15 subquestions from Question 20, excluding subquestions m and o.

Bivariate Relationships Comparing Outcomes by Provider Status Groups

Knowledge, Attitudes, and Behaviors

Tables 24 shows differences between federal service and civilian dentists concerning knowledge of Minimal Intervention Dentistry. A significant difference was found between them in Table 24 (p=0.0043).

Table 24. Bivariate Analysis of Knowledge (15b) of MID by Provider Group [n(%)]

Knowledge – Question 15b	Federal	Civilian
Missing*	0 (0 %)	2 (0.6 %)
Very Much	33 (23.9 %)	42 (12.9 %)
Much	36 (26.1 %)	81 (24.9 %)
Some	47 (34.1 %)	125 (38.5 %)
Little	9 (6.5 %)	43 (13.2 %)
None	13 (9.4 %)	34 (10.5 %)
Total	138 (100 %)	325 (100 %)

Note: p=0.0043- Significance probability associated with test of the null hypothesis that the distribution of the outcome of interest was the same for federal and civilian dentists, using Ridit Analysis.

* Missing values not included in analysis.

No significant differences were found between federal service and civilian dentists for attitudes shown in Table 25. More than ninety-five percent of federal service (97.1%) and civilian dentists (96.0%) believed that fluoride was an effective remineralizing agent.

Tables 26 presents the results for clinical treatment decisions between federal service and civilian dentists. No significant differences were detected. Federal dentists (15.4%) and civilian dentists (13.7%) reported similar percentages in monitoring enamel

proximal caries 'always or most of the time'. An open-ended question requested that respondents record their reasons for their selection to this question. Of 465 dentists returning a questionnaire, 79.1% made a comment for this question.

Reasons for selecting the response to this question ranged from delaying restoration because of a desire to educate the patient to immediately restoring the tooth to prevent future caries. Other comments included financial considerations, and the motivation of the patient. Many stated the lesion would progress without operative intervention and chose to restore it before the lesion increased in size and might need endodontic treatment or extraction.

Table 25. Bivariate Analysis of Attitudes (17a) of MID by Provider Group [n(%)]

Attitudes – Question 17a	Federal	Civilian
Missing*	1 (0.7 %)	3 (0.9 %)
Strongly Agree	96 (70.1 %)	202 (62.3 %)
Agree	37 (27 %)	109 (33.6 %)
Disagree	4 (2.9 %)	11 (3.4 %)
Strongly Disagree	0 (0 %)	2 (0.6 %)
Total	137 (100 %)	324 (100 %)

Note: p=0.1108- Significance probability associated with test of the null hypothesis that the distribution of the outcome of interest was the same for federal and civilian dentists, using Ridit Analysis.

* Missing values not included in analysis.

Appendices C and D summarize the potential covariates for knowledge, attitudes, and behaviors concerning Minimal Intervention Dentistry for all respondents and federal service subgroups, respectively.

Table 26. Bivariate Analysis of Behavior (18d) of MID by Provider Group [n(%)]

Behavior – Question 18d	Federal	Civilian
Missing*	2 (1.5 %)	13 (4.1 %)
Always or Most of the Time	21 (15.4 %)	43 (13.7 %)
Often	24 (17.6 %)	50 (15.9 %)
Sometimes	41 (30.1 %)	84 (26.8 %)
Never	50 (36.8 %)	137 (43.6 %)
Total	136 (100 %)	314 (100 %)

Note: p=0.2248 Significance probability associated with test of the null hypothesis that the distribution of the outcome of interest was the same for federal and civilian dentists, using Ridit Analysis.

* Missing values included in analysis.

Table 27 shows that there was a significant difference between federal service and civilian dentists' behavior towards remineralizing non-cavitated carious lesions ($p<0.0001$). Federal dentists (24.6%) 'always' remineralized non-cavitated carious lesions more than did civilian dentists (8.6%). More civilian dentists (33.2%) 'never or rarely' remineralized non-cavitated carious lesions" than federal dentists (14.6%) did.

Table 27. Bivariate Analysis of Behavior (20d) of MID by Provider Group [n(%)]

Behaviors – Question 20d	Federal	Civilian
Missing	8 (6.2 %)	35 (12.0 %)
Always or Most of the Time	32 (24.6 %)	25 (8.6 %)
Often	48 (36.9 %)	65 (22.3 %)
Sometimes	31 (23.8 %)	105 (36.0 %)
Never or Rarely	19 (14.6 %)	97 (33.2 %)
Total	130 (100 %)	292 (100 %)

Note: p<0.0001 Significance probability associated with test of the null hypothesis that the distribution of the outcome of interest was the same for federal and civilian dentists, using Ridit Analysis.

Federal Service Groups

Tables 28 through 31 present the results for each of the key questions for knowledge-question 15b (How much do you know about MID?), attitudes-question 17a (Fluoride is an effective remineralizing agent.), and behaviors questions-18d (How often would you monitor and not restore an enamel proximal lesion?), and question 20d (How often do you remineralize non-cavitated carious lesions?), along with composite scores questions 18 and 20 by federal service group.

Table 28. Bivariate Analysis of Knowledge by Federal Service Subgroup [n(%)]

Knowledge	N	Air Force	Army	Navy	PHS
Very Much	33	11(28.2%)	9(21.4%)	7(28.0%)	6(18.8%)
Much	36	15(38.5%)	10(23.8%)	5(20.0%)	6(18.8%)
Some	47	10(25.6%)	19(45.2%)	7(28.0%)	11(34.4%)
Little	9	1(2.6%)	2(4.8%)	3(12.0%)	3(9.4%)
None	13	2(5.1%)	2(4.8%)	3(12.0%)	6(18.8%)

Note: p=0.1039 - Significance probability associated with test of the null hypothesis that the distribution of the outcome of interest was the same for federal service dentists using Ridit Analysis.

Table 29. Bivariate Analysis of Attitudes by Federal Service Subgroup [n(%)]

Attitudes	N	Air Force	Army	Navy	PHS
Strongly Agree	96	31(79.5%)	24(57.1%)	18(72.0%)	23(74.2%)
Agree	37	8(20.5%)	16(38.1%)	6(24.0%)	7(22.6%)
Disagree	4	0(0.0%)	2(4.8%)	1(4.0%)	1(3.2%)
Strongly Disagree	0	0(0.0%)	0(0.0%)	0(0.0%)	0(0.0%)

Note: p=0.1413 Significance probability associated with test of the null hypothesis that the distribution of the outcome of interest was the same for federal service dentists using Ridit Analysis.

Tables 28, 29, and 30 show that there were no significant differences among federal service subgroups for knowledge (p=0.1039), attitudes (p=0.1413), or behavior for question 18d (p=0.3120). A statistically significant difference occurred for question 20d. Table 31 indicates that 100% of Air Force respondents would remineralize non-cavitated carious lesions always/most of the time, often, or sometimes, compared to the Army (88.0%), Navy (88.0%), or Public Health Service (57.7%).

Table 30. Bivariate Analysis of Behavior (18d) by Federal Service Subgroup [n(%)]

Behavior 18	N	Air Force	Army	Navy	PHS
Always or Most of the Time	21	7(18.0%)	6(14.3%)	4(16.0%)	4(13.3%)
Often	24	9(23.1%)	9(21.4%)	5(20.0%)	1(3.3%)
Sometimes	41	12(31.8%)	11(26.2%)	7(28.0%)	11(36.7%)
Never or rarely	50	11(28.2%)	16(38.1%)	9(36.0%)	14(46.7%)

Note: p=0.3021 - Significance probability associated with test of the null hypothesis that the distribution of the outcome of interest was the same for federal service dentists using Ridit Analysis.

Table 31. Bivariate Analysis of Behavior (20d) by Federal Service Subgroup

Behavior 20	N	Air Force	Army	Navy	PHS
Always or Most of the Time	32	15(39.5%)	9(22.0%)	4(16.0%)	4(15.4%)
Often	48	17(44.7%)	15(36.6%)	10(40.0%)	6(23.1%)
Sometimes	31	6(15.8%)	12(29.3%)	8(32.0%)	5(19.2%)
Never or rarely	19	0(0.0%)	5(12.2%)	3(12.0%)	11(42.3%)

Note: p=0.0004 Significance probability associated with test of the null hypothesis that the distribution of the outcome of interest was the same for federal service dentists using Ridit Analysis.

Dichotomized outcomes are presented in Tables 32 and 33. Key outcome variables were dichotomized for use in future logistic regression analyses. Question 15b, the key question for knowledge, was dichotomized into Yes and No for knowledge about Minimal Intervention Dentistry. The subheadings 'very much', 'much', and 'some', were combined and recoded as 'Yes'. Subheadings 'little', and 'none', were combined and recoded as 'No'. Question 17a, the key question for attitudes, was dichotomized into Agree and Disagree. The subheadings 'strongly agree', and 'agree' were combined and recoded as 'Agree', and 'disagree' and 'strongly disagree' were combined and recoded as 'Disagree'. For questions 18d and 20d, the key questions for behaviors, the subheadings 'always or most of the time' and 'often' were combined and recoded as Select (18d) and Use (20d), respectively, while the subheadings 'sometimes' and 'never or rarely' were combined and recoded as 'Not Select' (18d) and 'Not Use' (20d), respectively.

Table 32. Dichotomized Outcomes Using Key Questions [n(%)] for all respondents by provider status

Variable	Overall	Federal	Civilian	p-value*
Knowledge (15b)				0.0628
Yes	364(78.6%)	116(84.1%)	248(76.3%)	
No	99(21.4%)	22(15.9%)	77(23.7%)	
Attitudes (17a)				0.7877**
Agree	444(96.3%)	133(97.1%)	311(96.0%)	
Disagree	17(3.7%)	4(2.9%)	13(4.0%)	
Behavior18 (18d)				0.1747
Select	263(58.4%)	86(63.25%)	177(56.4%)	
Not Select	187(36.8%)	50(36.8%)	137(43.6%)	
Behavior20 (20d)				<0.0001
Use	306(72.5%)	111(85.4%)	195(66.8%)	
Not use	116(27.5%)	19(14.6%)	97(33.2%)	

*Significance probability associated with the chi-square test of the null hypothesis of no association between outcome and provider status or analogous exact test. **Fisher's Exact Test

Table 33. Dichotomized Knowledge, Attitudes, and Behaviors using Key Questions for Federal Service Subgroups [n(%)]

Variable	Air Force	Army	Navy	Public Health Service	p-value*
Knowledge (15b)					0.0454
Yes	36(92.3%)	38(90.5%)	19(76.0%)	23(71.9%)	
No	3(7.7%)	4(9.5%)	6(24.0%)	9(28.1%)	
Attitudes (17a)					0.6173
Agree	39(100.0%)	40(29.2%)	24(96.0%)	30(96.8%)	
Disagree	0(0.0%)	2(4.8%)	1(4.0%)	1(0.7%)	
Behavior18 (18d)					0.4694
Select	28(71.8%)	26(61.9%)	16(64.0%)	16(53.3%)	
Not Select	11(28.2%)	16(38.1%)	9(36.0%)	14(46.7%)	
Behavior20 (20d)					<0.0001
Use	38(100.0%)	36(87.8%)	22(88.0%)	15(57.7%)	
Not use	0(0.0%)	5(12.2%)	3(12.0%)	11(42.3%)	

*Significance probability associated with the chi-square test of the null hypothesis of no association between outcome and federal service subgroup.

Composite Scores

There were significant differences between federal service and civilian dentists for the composite score for Question 18. Civilian dentists (7.76)had higher mean scores than federal service dentists(7.07) did (p=0.0007). As shown in Table 35, no significant differences were found for the composite variable for question 18 by federal service group (p=0.1215) and a suggestive significant difference was found for composite 20 variable by federal service group (p=0.0619). Tables 34 and 35 also show p-values of the composite outcomes for Questions 18 and 20.

Table 34. Descriptive Statistics for Composite Q18* by Provider Status

Group	N	Mean	STD	Min	Median	Max	P value§
All Respondents	445	7.55	2.02	4.00	7.00	14.00	
Civilian	312	7.76	2.00	4.0	7.0	14.0	0.0007
Federal	133	7.07	11.98	4.0	7.0	12.0	
Air Force	38	6.55	2.02	4.0	6.0	12.0	0.1215
Army	41	7.07	2.00	4.0	7.0	12.0	
Navy	24	7.21	1.67	4.0	7.0	10.0	
Public Health Service	30	7.60	2.06	4.0	7.50	12.0	

*This composite variable sums the scores from subquestions 18a-d. Subquestions b & c were reversed to be consistent with the direction of MID tendency.

§ Significance probability associated with test of the null hypothesis that the distribution of the outcome of interest was the same for subgroups of interest, test statistic Wilcoxon Rank Sum Test and Kruskal-Wallis Test.

Table 35. Descriptive Statistics for Composite Q20* by Provider Status

Group	N	Mean	STD	Min	Median	Max	P value
All Respondents	387	36.00	5.58	18.00	32.00	52.00	
Civilian	270	37.03	5.08	22.00	37.00	52.00	<0.0001
Federal	117	33.56	5.92	18.00	33.00	52.00	
Air Force	32	31.03	4.83	18.00	31.00	41.00	0.0619
Army	38	34.37	5.15	24.00	35.00	44.00	
Navy	23	34.48	5.79	23.00	35.00	44.00	
Public Health Service	24	34.75	7.64	25.00	34.50	52.00	

*This composite variable uses 13 of 15 subquestions from Question 20, excluding subquestions m and o.

Note: Significance probability associated with test of the null hypothesis that the distribution of the outcome of interest was the same for subgroups of interest, test statistic Wilcoxon Rank Sum Test and Kruskal-Wallis Test.

Summary

Federal service and civilian dentists reported similar responses in two key areas, and reported differences in two key outcome areas. For knowledge, federal service dentists reported more knowledge of MID than did civilian dentists. Both federal service and civilian dentists had similar attitudes towards fluoride as an effective remineralizing agent, and decisions regarding monitoring or restoring enamel caries in a high risk patient. The most significant difference between federal service and civilian dentists was reported remineralizing non-cavitated carious lesions. Federal service dentists selected this procedure more than civilian dentists did. Lower composite scores for questions 18 and 20 indicated more MID tendency. Federal service dentists had lower composite scores.

The four federal service groups (AF, AR, NA, and PHS) reported similar responses for three of the key outcome areas: knowledge, attitudes, and decisions regarding monitoring or restoring enamel caries in a high- risk patient. The most significant difference among the federal service groups was reported for remineralizing non-cavitated carious lesions. Air Force dentists reported this practice more often than the other services. Air Force respondents had the lowest composite scores and the Public Health Service had the highest composite scores. However, these results were only suggestive of statistical significance.

Bivariate Relationships Comparing Provider Groups: Covariate Relationships

Tables 36 through 38 show the differences between federal service and civilian dentists by selected categorical and ordinal variables. Significant differences were found for gender, postgraduate training, age category, and graduation date. The percentage of time involved in direct patient care and number of continuing education hours did not differ significantly between federal service and civilian dentists.

Table 36. Regional Differences of Dental School Graduation by Provider Group [n(%)]

Region of Dental School	Federal	Civilian
Missing *	2	5
North Central	38 (27.9 %)	104 (32.3 %)
Northeast	27 (19.9 %)	74 (23.0 %)
Northwest	7 (5.1 %)	18 (5.6 %)
Out of Country	0 (0 %)	2 (0.6 %)
South Central	15 (11.0 %)	27 (8.4 %)
Southeast	31 (22.8 %)	60 (18.6 %)
West	18 (13.2 %)	37 (11.5 %)
Total	136 (100 %)	322 (100 %)

Note: p=0.7181 - Significance probability associated with test of the null hypothesis that the distribution of the outcome of interest was the same for federal and civilian dentists, using chi-square test.
*Missing values not included in analysis.

Table 37. Graduation Date Differences by Provider Group [n(%)]

Graduation Date	Federal	Civilian
Missing*	4	6
1=1950-1959	1 (0.7 %)	3 (0.9 %)
2=1960-1969	1 (0.7 %)	33 (10.3 %)
3=1970-1979	10 (7.5 %)	93 (29 %)
4=1980-1989	28 (20.9 %)	99 (30.8 %)
5=1990-1999	16 (11.9 %)	62 (19.3 %)
6=2000-2005	78 (58.2 %)	31 (9.7 %)
Total	134 (100 %)	321 (100 %)

Note: p<0.0001 - Significance probability associated with test of the null hypothesis that the distribution of the outcome of interest was the same for federal and civilian dentists, using chi-square test.
*Missing values not included in analysis.

Table 38. Postgraduate Credential Differences by Provider Group [n(%)]

Postgraduate Credential	Federal	Civilian
Missing§	41	181
Certificate	80 (82.5 %)	98 (67.1 %)
Combination*	4 (4.1 %)	5 (3.4 %)
Masters	7 (7.2 %)	32 (21.9 %)
Other**	5 (5.2 %)	8 (5.5 %)
PhD	1 (1 %)	3 (2.1 %)
Total	97 (100 %)	146 (100 %)

Note: p=0.0375 - Significance probability associated with test of the null hypothesis that the distribution of the outcome of interest was the same for federal and civilian dentists, using chi-square test.

*Certificate and Master's degree

**PhD and Masters and/or certificate

§Missing values not included in analyses.

Tables 39 and 40 describe demographic and practice characteristics of respondents overall, by provider group, and by federal service subgroup. Comparisons between federal service and civilian dentists and among federal service groups were made using the Kruskal-Wallis test for quantitative variables, chi-square statistic for nominal variables, and Ridit Analysis for ordinal variables. The age distribution of the patient population of each provider was profiled using percentages provided by the respondent for each of 5 age groups. Although responses for each age group were analyzed separately, the profile across all 5 age groups was also analyzed using a multivariate approach. This study used MANOVA as the statistical approach for overall comparisons (for example, federal service and civilian dentists) referring to the patient population percentages for those 0-15, 16-18, 19-37, 38-59, and 60+ years of age. The Wilk's Lambda was the test statistic used to evaluate subgroup comparisons.

Table 39. Distribution of Quantitative Characteristics of Dentists Overall and for Federal and Civilian Dentists [μ(std)]

Variable	N	Missing	Overall	Federal	Civilian	p-value*
Age in years	457	8	45.6(11.7)	37.6(10.4)	49.1(10.5)	<0.0001
Years since graduation	458	7	19.2(12.3)	10.6(10.7)	22.8(11.1)	<0.0001
Years of practice	459	6	17.2(12.0)	8.8(9.3)	20.6(11.3)	<0.0001
Percentage Patient Populations**						
0-15 years	411	54	14.4(21.8)	5.5(13.3)	18.5(23.7)	<0.0001
16-18 years	411	54	9.4(7.7)	8.2(8.5)	10.0(7.2)	0.0202
19-37 years	411	54	34.5(24.0)	57.9(26.4)	23.6(12.2)	<0.0001
38-59 years	410	55	26.6(14.7)	20.0(13.3)	29.7(14.3)	<0.0001
60+ years	410	55	14.4(13.7)	5.8(11.6)	18.4(12.8)	<0.0001

*Significance probability associated with test of the null hypothesis that the distribution of the outcome of interest was the same for federal and civilian dentists, using the Wilcoxon Rank Sum Test.

** Significance probability associated with the test of the null hypothesis that the distribution of the outcome of interest was the same for federal and civilian dentists using multiple analysis of variance (MANOVA) Wilks Lambda Test (p<0.0001).

Age of Respondents

As shown in Table 39, the mean age of respondents overall was 45.6 years. Age ranged from 26 to 75 years of age. Federal service dentists were younger (p<0.0001).The mean age of federal dentists was 37.6 years, ranging from 26 to 72 years of age. Civilian dentists' ages ranged from 29 to 75, with mean of 49.1 years.

Significant differences were noted in the ages among the federal service subgroups (p<0.0001), as presented in Table 40. The PHS (49.1) and Navy (41.6) had an older mean age in years than did the Air Force (31.7) and Army (32.1).

Table 40. Descriptive Data by Federal Service Group [μ (std)]

Variable	AF	Army	Navy	PHS	p-value*
Age in years	31.7(6.2)	32.1(6.3)	41.6(11.0)	49.1(7.3)	<0.0001
Years since Graduation	4.7(5.4)	4.5(6.0)	14.2(11.2)	22.9(8.0)	<0.0001
Years of Practice	4.1(5.3)	3.8(6.0)	13.6(11.1)	16.9(7.1)	<0.0001
Percentage Patient Populations**					
%Patient pop 0-15 yrs	4.8(15.9)	1.9(3.4)	2.8(7.7)	15.0(18.0)	0.0004
16-18 yrs	6.7(6.2)	8.4(9.8)	8.5(10.0)	10.0(7.8)	0.4865
19-37 yrs	67.8(21.2)	68.5(17.4)	60.7(26.2)	23.8(14.9)	<0.0001
38-59 yrs	17.7(12.2)	18.2(10.3)	20.1(12.2)	26.0(18.2)	0.0638
60+ yrs	2.0(4.2)	3.1(7.9)	8.4(18.7)	13.3(11.8)	0.0002

*Significance probability associated with test of the null hypothesis that the distribution of the outcome of interest was the same for federal service subgroups, using Kruskal Wallis Test.

** Significance probability associated with the test of the null hypothesis that the distribution of the outcome of interest was the same for federal service subgroups using multiple analysis of variance (MANOVA) Wilks Lambda Test ($p<0.0001$).

Years since Graduation from Dental School

The overall mean years since graduation were 19.2 years. There were significant differences regarding years since graduation for federal service and civilian dentists ($p<0.0001$). Civilian dentists had a mean of 22.8 years since graduation and federal service dentists had 10.6 years. Table 42 shows that Army respondents (4.5) had the lowest mean number of years since graduation, followed by the Air Force (4.7) and Navy (14.2). Public Health Service dentists (22.9) had the greatest mean years since graduation from dental school.

Years of Clinical Dental Practice

The mean number of years in practice, shown in Table 39, for the entire sample was 17.2 years. Federal service dentists had 8.8 years, and 20.6 years for civilian dentists. This difference between federal service and civilian dentists was statistically significant ($p<0.0001$). Table 40 shows that Army dentists had the lowest mean years of practice at 3.8 years, followed by the Air Force at 4.1 years, and the Navy at 13.6 years and PHS respondents reported the greatest mean number of years of practice for the federal services at 16.9 years. The difference among the federal service subgroups was statistically significant ($p<0.0001$).

Table 41. Distribution of Categorical Characteristics of Dentists Overall and for Federal and Civilian Dentists [n (%)]

Variable	N	Missing	Overall	Federal	Civilian	p-value
Gender	459	6				0.0036*
Male			373(81.3%)	101(73.2%)	272(84.7%)	
Female			86(18.7%)	37(26.8%)	49(15.3%)	
PG Training	458	7				<0.0001*
Yes			266(58.1%)	103(75.2%)	163(50.7%)	
No			192(41.9%)	34(24.8%)	153(49.2%)	
CE hours	464	1				0.2407**
0-4			3(0.7%)	1(0.7%)	2(0.6%)	
5-9			9(1.9%)	5(3.6%)	4(1.2%)	
10-14			30(6.5%)	6(4.4%)	24(7.4%)	
15-19			70(15.1%)	17(12.3%)	53(16.3%)	
20+			352(75.9%)	109(79.0%)	243(74.5%)	
Patient Care (%)	458	7				0.6164**
0-25			62(13.5%)	18(13.1%)	44(9.6%)	
26-50			17(3.7%)	6(4.4%)	11(3.4%)	
51-75			82(17.9%)	29(12.2%)	53(16.5%)	
76-100			297(64.8%)	84(61.3%)	213(66.4%)	

Note:Significance probability associated with test of the null hypothesis that the distribution of the outcome of interest was the same for federal and civilian dentists, using chi-square test* and ridit analysis**.

Patient Population Percentages

Table 39 shows that the mean percentages of patients were 14.4% for 0-15 years, 9.4% for patients 16-18 years, 34.5% for patients 19-37 years of age, and 26.6% for patients aged 38-59. The mean percentage of patients with ages of 60 and above comprised an average of 14.4% of respondent's patient populations. The patient populations aged 19-37 years and 38-59 years, taken together, were the majority (61.1%) for respondents overall. The percentage of the patient population less than 18 years of age averaged 24.0%. Respondents had the same mean percentage of patients 0-15 years of age (14.4%) as age 60 and above (14.4%). The data provided strong evidence that the profile of the patient population as specified by these age groups differed significantly by provider status (federal vs. civilian).

Federal service dentists (Table 40) reported a mean percentage of 57.9% of their patient population was 19-37 years of age, while civilian dentists reported a mean percentage of 23.6% for the same age group. Significant differences were found between federal service and civilian dentists in percentages within all age groups of patients. Federal service dentists had substantially fewer patients 0-15 years of age ($p<0.0001$), and more patients 19-37 years of age ($p<0.0001$) compared to civilian dentists. Federal service dentists had the lowest mean percentage of patients 60 years and above (5.8%) and civilians had the greatest mean percentage of patients 0-15 years of age (18.5%).

Among the federal service groups, as shown in Table 40, significant differences were found for patient populations 0-15, 19-37, and 60+ years of age. Public Health Service dentists ($p<0.0001$) reported fewer patients aged 19-37 years of age than did dentists in the Air Force, Army, or Navy.

Gender of Respondents

As shown in Table 41 over eighty percent of respondents were male (81.3%); female responses accounted for 18.7%. Approximately eighty percent of respondents

were male for civilian dentists (84.7%), while federal service dentists were 73.2% male. This result was statistically significant (p=0.0036).

Table 42 shows that Army respondents reported the highest percentage of female respondents (33.3%), followed by the Public Health Service (31.2%), and the Air Force (28.2%) while the Navy reported the lowest percentage of female respondents (8.0%), but this result was not statistically significant (p=0.1229).

Table 42. Distribution of Categorical Characteristics of Dentists for Federal Service Subgroups [n (%)]

Variable	Air Force	Army	Navy	PHS	p-value
Gender					0.1229*
Male	28(71.8%)	28(66.7%)	23(92.0%)	22(71.0%)	
Female	11(28.2%)	14(33.3%)	2(8.0%)	10(31.2%)	
PG Training					0.2480*
Yes	32(82.1%)	27(71.1%)	21(84.0%)	22(71.0%)	
No	7(18.0%)	11(29.0%)	4(16.0%)	9(29.0%)	
CE hours					0.3147**
0-4	0(0.0%)	1(2.4%)	0(0.0%)	0(0.0%)	
5-9	4(10.3%)	0(0.0%)	0(0.0%)	1(3.1%)	
10-14	2(5.1%)	2(4.8%)	1(4.0%)	1(3.1%)	
15-19	1(2.6%)	4(9.5%)	3(12.0%)	9(28.1%)	
20+	32(82.1%)	35(83.3%)	21(84.0%)	21(65.6%)	
Patient Care (%)					<0.0001**
0-25	0(0.0%)	1(2.4%)	3(12.0%)	14(45.2%)	
26-50	2(5.1%)	3(7.1%)	0(0.0%)	1(3.2%)	
51-75	7(18.0%)	14(33.3%)	3(12.0%)	5(16.1%)	
76-100	30(76.9%)	12(57.1%)	19(76.0%)	11(35.5%)	

* Significance probability associated with test of the null hypothesis that the distribution of the outcome of interest was the same for federal service subgroups, using Fisher's Exact Test.

** Significance probability associated with test of the null hypothesis that the distribution of the outcome of interest was the same for federal service subgroups, using Ridit Analysis.

Completion of Postgraduate Training

More dentists responding to this survey had completed postgraduate training (58.1%) compared to those not completing training (41.9%), as reported in Table 41. Approximately 75% of federal dentists completed postgraduate training whereas only 51% of civilian dentists ($p<0.001$) completed training. No significant differences were noted among the federal service subgroups ($p=0.2480$).

Those respondents that completed postgraduate training compared to a PhD (1.7%) or a combination of degrees (certificate and Masters and/or PhD) (9.1%) received certificates (73.5%) and Masters Degrees (16.1%) more often. This result was significant between federal service and civilian dentists ($p=0.0375$). Federal service dentists (82.5%) received certificates more often than civilian dentists (67.1%) did. Civilian dentists received more Masters degrees (21.9%) compared to federal service dentists (7.2%). Certificates awarded to Army (89.3%), Navy (72.2%), and Public Health Service (57.1%) respondents were less than Air Force dentists (100%) received. This result was statistically significant ($p=0.0019$).

Continuing Education Hours

In the entire sample, 75.9% of the respondents reported earning twenty or more continuing education credits per year, shown in Tables 42 and 43. Less than 1% of respondents reported earning 0-4 credit hours of continuing education in the previous year. There were no significant differences found between percentages of federal service dentists (79.0%) and civilian dentists (74.5%) earning twenty or more continuing education credits per year ($p=0.2407$). Navy dentists (84.0%) earned 20+ continuing education hours most, followed by the Army (83.3%), Air Force (82.1%), and Public Health Service (65.6%), and this was not significant ($p=0.3147$).

Percentage of Direct Patient Care

Table 41 shows that almost 65% of respondents reported devoting 76-100% of their total work-time per week to direct patient care (64.8%). There were no significant differences detected between federal service and civilian dentists (p=0.6164). Public Health Service was involved in direct patient care less than the other services, reporting. A large percentage of PHS dentists (45.2%) reported 0-25% of their time per week devoted to direct patient care. The differences among federal service dentists, shown in Table 42, was statistically significant (p<0.0001).

Journals Read

Approximately 95% of respondents read the Journal of the American Dental Association (95.2%), with no differences detected between federal service and civilian dentists (p=0.8488), or federal service subgroups (p=0.7197). Almost 60% of dentists responding to this survey read General Dentistry (59.4%). There were no statistically significant differences detected between federal service and civilian dentists (p=0.4048). Among the federal service subgroups, Army dentists (72.7%) and Navy dentists (65.0%) read General Dentistry more than did Air Force dentists (48.5%) or Public Health Service dentists (33.3%), and this result was statistically significant (p=0.0229).

A quarter of the respondents read the Journal of Public Health Dentistry (25.0%), with no differences detected between federal service and civilian dentists (p=0.2612). Public Health Service dentists (69.6%) read the journal more than Air Force (0.0%), Army (4.4%), or Navy dentists (0.0%) did, and this result was statistically significant (p<0.0001).

Fewer respondents read Military Medicine (5.2%). Of those that read the journal, 85.7% were federal service dentists and 14.3% were civilian dentists, and this result was significant (p<0.0001). Among the federal service subgroups, another significant finding

occurred (p=0.0021); Navy (33.3%) and Public Health Service dentists (30.0%) read the journal more than Air Force (0.0%) or Army (4.4%) dentists did.

States of Dental School Graduation

The three most commonly reported states of dental school graduation overall were California (9.7%), Pennsylvania (6.8%), and Texas (6.4%). A difference suggestive of significance was found between federal service and civilian dentists (p=0.0566) regarding state of dental school graduation. Federal service dentists' three most commonly reported states of graduation were Pennsylvania (11.0%), Texas (10.1%), and California (9.6%), while civilian dentists reported graduation from dental schools more commonly in California (10.0%), New York (8.1%) and Texas (6.2%). Three respondents graduated from dental schools in Puerto Rico. Two respondents graduated from dental schools outside of the United States, one from India and the other from France. There were no significant differences among federal service groups for state of dental school graduation.

When states were categorized into regions; Northeast, North Central, Northwest, Southeast, South Central, Southwest, West, and Out of Country, no differences were found between federal service and civilian dentists (p=0.7181), but a suggestive difference was detected among federal service subgroups (p=0.0968).

Federal Service Affiliation and Grade

Table 43 lists the service affiliations and grade (rank) of federal service respondents. There were significant differences found among the federal service subgroups (p<0.0001).

Table 43 shows that Army dentists had the greatest number of Lieutenants (O-3), followed by the Air Force, Navy and the PHS. The Public Health Service had the greatest number of Captains (O-6). The Army had no respondents who reported the grade of Captain. There was one respondent, in the Army, among all of the federal service subgroups that indicated the grade of Admiral (O-7).

Table 43. Distribution of Service Grade among Federal Service Subgroups [n (%)]

Grade	Total	Air Force	Army	Navy	PHS	p-value*
O-3	80(58.8%)	34(25.0%)	37(27.2%)	9(6.6%)	0(0.0%)	<0.0001
O-4	13(9.6%)	2(1.5%)	2(1.5%)	7(5.2%)	2(1.5%)	
O-5	15(11.0%)	1(0.7%)	1(0.7%)	4(2.9%)	9(6.6%)	
O-6	27(19.8%)	2(1.5%)	0(0.0%)	5(3.7%)	20(14.7%)	
O-7	1(0.7%)	0(0.0%)	1(0.7%)	0(0.0%)	0(0.0%)	
Total	136(100.0%)	39(28.7%)	41(30.2%)	25(18.4%)	31(22.8%)	

*Significance probability associated with test of the null hypothesis that the distribution of the outcome of interest was the same for federal and civilian dentists, using Fisher's Exact Test.

Summary

This section highlighted the similarities and differences between federal service and civilian dentists in terms of knowledge, attitudes, and behaviors concerning MID, and personal and practice characteristics. There were also differences among the federal service subgroups. The majority of federal service and civilian dentists completed 20+ hours of continuing education and spent 75-100% of their time in direct patient care. Generally, federal service dentists were significantly younger, graduated from dental school later, and have fewer years of practice.

Bivariate Relationships Comparing Outcomes Versus Covariates

Tables 44 and 45 present p-values of dichotomous outcome variable and potential covariates for all respondents, and for federal service subgroups, respectively. The key variable for knowledge, Question 15b had the greatest number of respondents with 463 out of 465 for all respondents, and 138 out of 138 for the federal service groups.

Table 44. Bivariate Analyses of Dichotomous Key Variables Assessing Relationships with Potential Covariates for All Respondents (p-values)

Variable	*Knowledge(15b)*	*Attitudes(17a)*	*Behavior18d*	*Behavior20d*
N	463	461	450	422
Age in Years[1]	0.0036	0.0047	0.0157	0.0001
Years of Practice[1]	0.0016	0.0015	0.0190	<0.0001
Years since Graduation[1]	0.0092	0.0039	0.0309	<0.0001
Provider[2]	0.0644**	0.7877**	0.1779**	<0.0001**
Gender[2]	1.000**	1.000**	0.2661**	0.0044**
Post-graduate Training[2]	0.1662**	0.0126	0.7916	<0.0001
Region[2]	0.9703	0.9205	0.3276	0.3394
Continuing Education[3]	0.0006	0.8563	0.3847	0.0490
Direct Patient Care[3]	0.4915	0.3897	0.0153	0.8399
Patient Populations combined (Wilks-Lambda) [4]	0.0907	0.1749	0.1449	0.0001
% Patient Population 0-15 years[4]	0.1236	0.2135	0.2986	0.3033
% Patient Population 16-18 years[4]	0.5121	0.5591	0.8568	0.6105
% Patient Population 19-37 years[4]	0.0180	0.2103	0.1953	<0.0001
% Patient Population 38-59 years[4]	0.3236	0.1224	0.0082	<0.0001
% Population 60+ Years[4]	0.0622	0.0164	0.0754	<0.0001

1. Significance probability of the null hypothesis of no difference (age, years of practice, graduation, years since graduation)-Kruskal Wallis Test

2. Significance probability of the null hypothesis of no difference (gender, post-grad training, provider, region)-Chi-Square Test

3. Significance probability of the null hypothesis of no difference Test statistic (continuing education, direct patient care) - Ridit Analysis

4. Significance probability of the null hypothesis of no difference (patient populations overall, 0-15, 16-18, 19-37, 38-59)-MANOVA (Wilks-Lambda)

** Fisher's Exact Test

Table 45. Federal Service Group Bivariate Analyses of Dichotomous Key Variables Assessing Relationships with Potential Covariates for Federal Service Respondents (p-values)

Variable	*Knowledge(15b)*	*Attitudes(17a)*	*Behavior18d*	*Behavior20d*
N	138	133	136	120
Age in Years[1]	0.0155	0.0450	0.0523	0.0001
Years of Practice[1]	0.0074	0.0507	0.1581	0.0003
Years since Graduation[1]	0.0390	0.0391	0.1332	0.0002
Gender[2]	0.7950**	1.000**	0.8409**	1.000**
Post-graduate Training[2]	0.0280**	1.000**	0.1313**	0.0178**
Region[2]	0.9664	0.1408	0.3623	0.6368
Rank[2]	0.0829	<0.0001	0.2881	<0.0001
Federal Group[2]	0.0454	0.6173	0.4694	<0.0001
Continuing Education[3]	0.0141	0.2444	0.1408	0.1871
Direct Patient Care[3]	0.5466	0.5840	0.3688	0.2158
Patient Populations combined (Wilks-Lambda) [4]	0.0109	0.2538	0.0507	<0.0001
% Patient Population 0-15 years[4]	0.2111	0.6185	0.8178	0.7895
% Patient Population 16-18 years[4]	0.5407	0.3219	0.7612	0.1102
% Patient Population 19-37 years[4]	0.0160	0.2747	0.1593	0.0004
% Patient Population 38-59 years[4]	0.2266	0.0484	0.0010	0.0004
% Population 60+ years[4]	0.0002	0.0543	0.5459	0.0001

1. Significance probability of the null hypothesis of no difference (age, years of practice, years since graduation)-Kruskal Wallis Test

2. Significance probability of the null hypothesis of no difference (gender, post-grad training, rank, federal group, region)-Chi-Square Test

3. Significance probability of the null hypothesis of no difference (continuing education, direct patient care) - Ridit Analysis

4. Significance probability of the null hypothesis of no difference (patient populations overall, 0-15, 16-18, 19-37, 38-59)-MANOVA (Wilks-Lambda)

** Fisher's Exact Test

Table 46. Bivariate Analyses for Composite Variables and Potential Quantitative Covariates

p-values*		
Variable	Composite Q18**	Composite Q20***
Age	0.0007	<0.0001
Years of Practice	0.0001	<0.0001
Years Since Graduation	0.0019	<0.0001
Direct Patient Care	0.3009	0.7215
Continuing Education	0.2035	0.9588
Percentage of patient population in each age category		
0-15 years	0.3308	0.2304
16-18 years	0.1210	0.6969
19-37 years	0.0491	0.0003
38-59 years	<0.0001	<0.0001
60 years and older	0.0006	<0.0001

*Significance probability associated with test of the null hypothesis that the distribution of the outcome of interest was the same for potential covariates using Spearman Rank Correlation.

**Note: This uses the composite variable for subquestions 18a-d that is shown in Table 21. Subquestions b & c were reversed to be consistent with the direction of MID tendency.

***Note: This composite variable uses 13 of 15 subquestions for Question 20, excluding subquestions m and o as defined in Table 23 and associated text.

Tables 46 and 47 present the composite variables and potential quantitative and categorical covariates. The composite score for question 20 is highly significantly ($p<0.0001$) related to age, years of practice, years since graduation, and patient populations 38-59 and 60+ years and older. The composite variable for question 18 was also highly significantly ($p<0.0001$) related to the percentage of patients 38-59 years.

Table 47. Bivariate Analyses for Composite Variables and Potential Categorical Covariates

p-values*		
Variable	Composite Q18**	Composite Q20***
Region	0.4024	0.7134
Postgraduate Training	0.4743	0.0002
Gender	0.7494	0.1184
Knowledge (q15b)	0.0175	<0.0001
Attitudes (q17a)	0.0993	0.0019
Behavior18 (q18d)	0.0001	0.0051
Behavior20 (q20d)	0.0001	<0.0001

*Significance probability associated with test of the null hypothesis that the distribution of the outcome of interest was the same for potential covariates using Kruskal Wallis Test.

**Note: This uses the composite variable for subquestions 18a-d that is shown in Table 21. Subquestions b & c were reversed to be consistent with the direction of MID tendency.

***Note: This composite variable uses 13 of 15 subquestions for Question 20, excluding subquestions m and o as defined in Table 23 and associated text.

Summary

Key outcomes for knowledge (question 15b), attitudes (question 17a), and behaviors (questions 18d and 20d) between federal and civilian dentists in this study had several significant and many highly significant covariates. In the overall sample and within the federal service respondents, Question 20d had the greatest number of significant bivariate relationships. Responses to question 20d differed significantly between federal service and civilian respondents and among federal service groups. Age was an important factor for the key variables, knowledge-question 15b, attitudes-question 17a, behaviors – question 18d and question 20d. Years of practice and years since graduation were also significantly related to knowledge-question 15b, attitudes-question 17a, and behaviors-question 20d, as well as to composite variables for questions 18 and 20. Percentages of patient populations 0-15 years and 16-18 years of age were not

significant for any key outcome area, while percentages of older age categories were (19-37, 38-59, and 60 years and older) significant. Gender was not significant for any bivariate key outcome area, including the composite scores.

Multiple Linear Regression

Linear regression was used to identify predictor variables that were associated with the composite scores for Questions 18 and 20. Four multiple linear regression models are presented in this section. The composite scores for questions 18 and 20 (from Tables 46 and 47, respectively) were the outcome variables for the regression models. Two of the models were for all respondents, and two models were limited to the federal service subgroups.

Multicollinearity Testing

The results of the multicollinearity tests for age, years of practice, and years since graduation are presented in Table 48. Spearman Rank Correlations are also listed for age, years since graduation, and years of practice. The table lists the two variables used to evaluate collinearity, tolerance and Variable Inflation Factor (VIF). Based on these results, age and years of practice were used in modeling. Years since graduation was dropped from analyses due to its high correlation with both age and years of practice and collinearity test results on the basis of bivariate relationships with the composite outcomes. The tolerance for years since graduation was less than 0.1 and the VIF was greater than 10. Because years since graduation also had the highest correlation with age (0.9678) and years of practice (0.9133), it was not used. Instead, this study substituted age if both age and years since graduation were significant in bivariate analyses. In cases where all three variables were significant (age, years since graduation, and years of practice), only age and years of practice were used in the linear regression model.

Table 48. Collinearity Test Results for Age, Years Since Graduation, and Years of Practice

Variable	Tolerance*	Variance Inflation Factor (VIF)**	Spearman Rank Correlations
Age	0.04765	20.9857	With years since graduation r=0.9678 With years of practice r=0.8948
Years Since Graduation	0.03799	26.3214	With age r=0.9678 With years of practice r=0.9133
Years of Practice	0.11749	8.5117	With age r=0.8948 With years since graduation r=0.9133

*Tolerance >0.1 is desired.

**VIF <10.0 is desired.

Variable Selection

The covariates considered for modeling were gender, age, region, years of practice, years since graduation, percentages of patient population 0-15 16-18, 19-37, 38-59, and 60+ years, postgraduate training, direct patient care, continuing education, provider group, federal subgroups, and rank. The permissible number of variables to include in the models was based on the rule of n/10 as described by Harrell & others (1985). In this instance, n represents the sample size divided by 10. For all respondents, the number of variables eligible for entry into the model was 465/10, or approximately 47 variables, reducing the possibility of overfitting. Therefore, for the composite score models for the entire sample, all variables were able to be considered for entry into the initial model. However, for the composite score models for the federal service

respondents, with a smaller total sample size (138), variables were prescreened. Those variables that had p-values ≤ 0.15 in bivariate analyses were allowed to initially enter into the models. This prescreening of variables was only necessary for multiple regression analyses of the federal subset of 138 respondents, where only 14 variables could be entertained without incurring concerns about overfitting and model validity and reproducibility.

Composite Score Modeling

Multiple linear regression was performed on the composite score variables for questions 18 and 20. The Composite Q18 is the sum of the scores from subquestions 18a-d, which includes the recoded subquestions 18b and 18c. The Composite Q20 is the sum of the scores from subquestions 20a-m. Subquestions 20n and 20o were not included in the composite score because of the number of missing values. Lower composite scores were associated with more MID decision-making (Question 18) or MID practices (Question 20).

Modeling Composite 18

In modeling Composite Q18, lower composite scores were associated with more MID oriented decisions. Responses to subquestions 18a through 18d were combined to produce the composite score for question 18 for all respondents and federal service subgroups. The composite score for question 18 was limited because it drew on only four questions with a limited score range (4-14). All covariates were considered for possible inclusion in this model. As described earlier in the Material and Methods, for each model, three types of selection methods were performed: stepwise selection, forward selection, and backward elimination, as well as additional exploratory modeling guided by

hypothesized relationships and the need for assessment of interactions. All modeling approaches yielded the same general results and conclusions. Two-way interaction terms involving significant variables ($p<0.05$) were entered and conditional first order interactions were explored, particularly those with provider status. No significant two-way interactions were found in modeling Composite 18 for the overall sample.

Residual analyses for Composite 18 scores were not normally distributed (Shapiro-Wilk $p<0.0001$). Logarithmic transformations were applied but failed to achieve conformance with normality assumptions, so rank transformations were applied. All gave the same result in terms of the final models: the same variables were significant for untransformed, log transformed, and rank transformed outcomes. The significant variables were age and the percentage of the respondent's patient population 38-59 years of age. Increases in age or in the percentage of patients 38-59 years of age raised the composite score for Question 18, which meant less MID-oriented decisions. The results presented here were from a parametric approach because parameter estimates are more readily interpretable. Since a primary emphasis was to investigate differences between federal service and civilian dentists, and these differences did not emerge in initial linear regression analyses, provider group (or federal group) was forced into the final model. Forcing provider group into the model had no significant effect for Composite 18 ($p=0.4559$). The final linear regression model, in Table 49, shows that age ($p=0.0032$) and percentage of the patient population in the age range of 38-59 years ($p=0.0032$) were positively associated with the composite score for Question 18, and explained 5.1% of the variability in the model. None of the interactions evaluated were statistically significant ($p>0.05$).

Table 49. Final Linear Regression Models (p-Values) of Composite Scores for All Respondents (n=465)

Final Model	Estimate	Standard Error	p-Value**	R^2
All Respondents Dependent Variable= Composite 18§				0.0513
Age	0.0252	0.0065	0.0032	
Percentage of patients 38-59 years	0.0203	0.0068	0.0032	
Dependent Variable= Composite 20∞				0.1650
Provider Group (Fed vs. civilian)	2.5187	0.7909	0.0016	
Age	0.0864	1.1008	0.0009	
% of patients aged 38-59 years	0.0514	0.0239	0.0095	
Postgraduate Training	3.1880	0.0197	0.0040	
Provider Group*Postgraduate Training	-2.5961	1.2807	0.0434	

**Test statistic regression analyses, significance set at $p \leq 0.05$

§This uses the composite variable for subquestions 18a-d that is shown in Table 21. Subquestions b & c were reversed to be consistent with the direction of MID tendency.

∞ Note: This composite variable uses 13 of 15 subquestions for Question 20, excluding subquestions m and o as defined in Table 23 and associated text.

Figure 1 depicts the predicted composite scores for question 18, based upon modeling results using all respondents. Predicted values are graphed versus age for selected values of the percentage of patients 38-59 years of age: the minimum (0% of patients aged 38-59), 25th percentile (15%), median (30%), 75th percentile (35%), and maximum (90%).

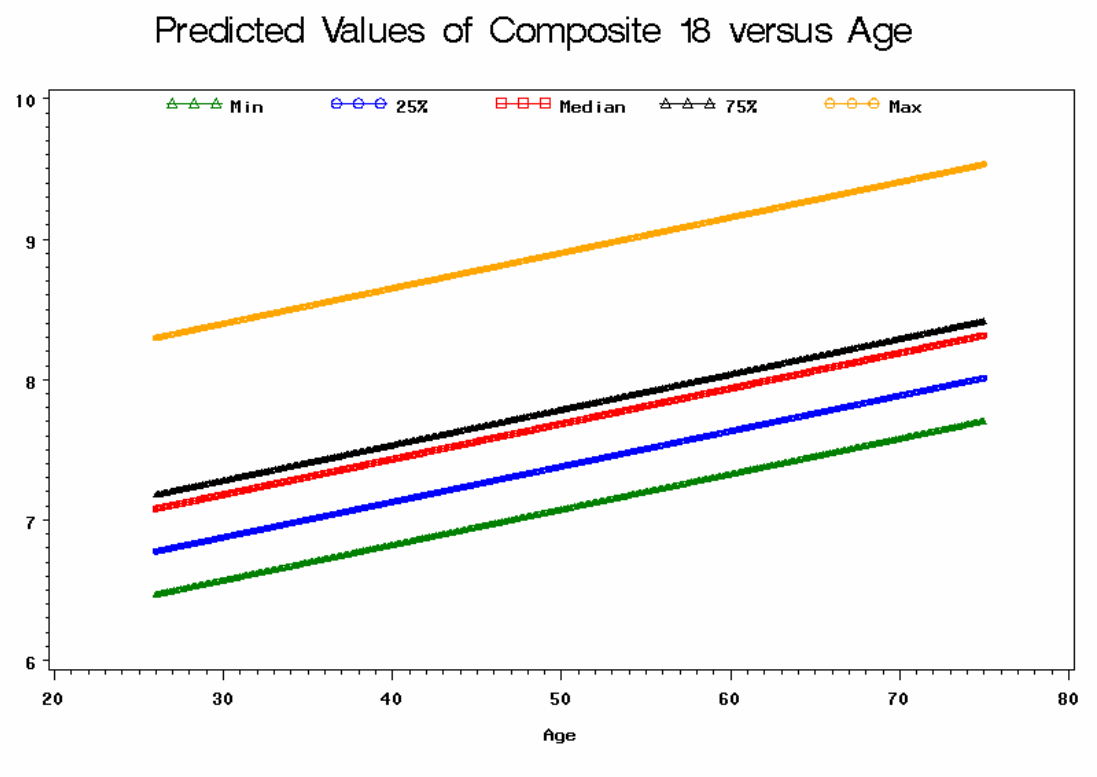

Figure 1. Predicted composite score for Question 18, based upon modeling results using all respondents. Predicted values are graphed versus age for selected values of the percentage of patients 38-59 years of age: the minimum (0% of patients aged 38-59), 25th percentile (15%), median (30%), 75th percentile (35%), and maximum (90%).

Using prescreened covariates, a similar procedure was used in modeling Composite Q18 for the smaller sample of federal service respondents. Lower composite scores were associated with more MID oriented decisions. The covariates selected included age, years of practice, rank, and percentages of patient populations 19-37 years, 38-59 years, and 60+ years old. All steps proceeded in the same manner; stepwise, forward, and backward selection methods, normality tests, data transformation, and use

of parametric procedures. The Shapiro-Wilk Test found the data were not normally distributed (p= 0.0226). The results are presented in Table 50. In this model, age and percentage of patients 38-59 years of age were significantly associated with the composite score. Increases in respondent age or percentage of the patient population aged 38-59 years meant higher composite scores and less MID-oriented decisions. The model explained relatively little of the variability, with an R^2 of 0.0897. Figure 2 shows the predicted values of the composite score for Question 18 for the federal service respondents for selected values of the percentage of patients 38-59 years of age.

Table 50. Linear Regression Models (p-Values) of Composite Scores for Federal Service Respondents (n=138)

Final Model	Estimate	Standard Error	p-Value**	R^2
Composite 18§				0.0897
Age	0.0390	0.0168	0.0222	
Percentage of Patients 38-59 years	0.0291	0.0131	0.0277	
Composite 20∞(n=113)				0.1376
Postgraduate Training	2.8091	1.1872	0.0197	
Percentage of Patients 60+ years	0.1123	0.0435	0.0112	

Note: No 2-way interaction terms were significant.

**Test statistic regression analyses, significance set at p≤0.05.

§This uses the composite variable for subquestions 18a-d that is shown in Table 21. Subquestions b & c were reversed to be consistent with the direction of MID tendency.

∞ Note: This composite variable uses 13 of 15 subquestions for Question 20, excluding subquestions m and o as defined in Table 23 and associated text.

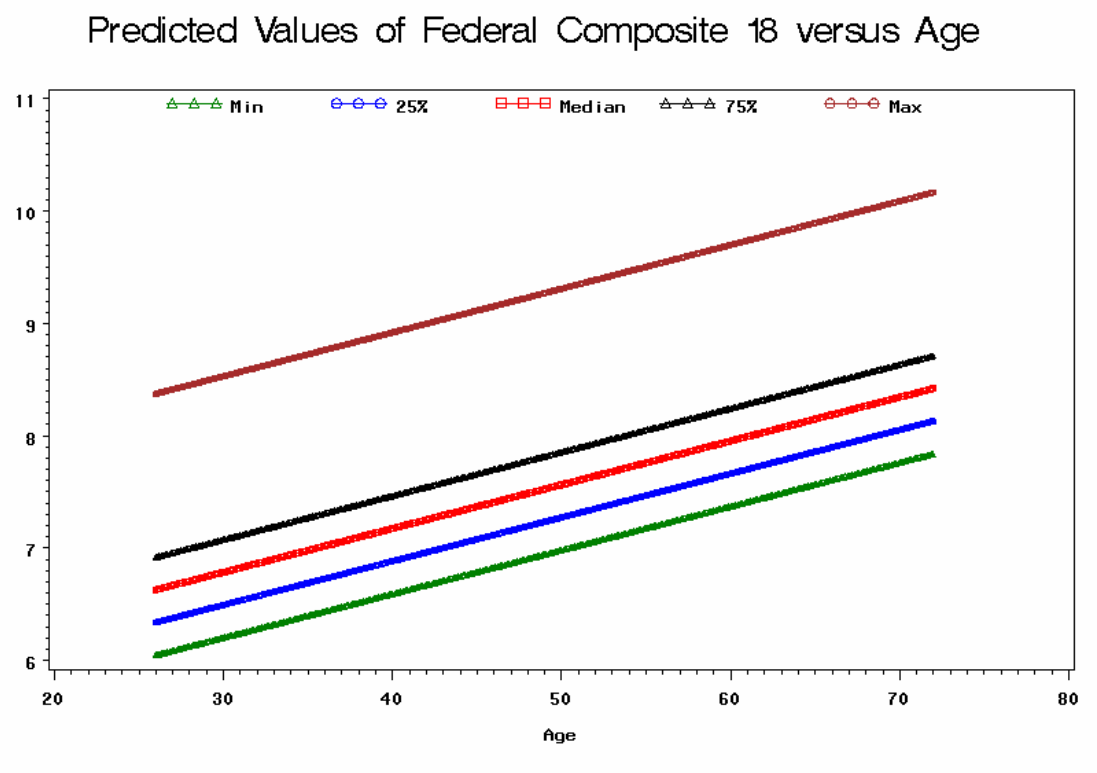

Figure 2. Predicted composite score for Question 18, based upon modeling results using all respondents. Predicted values are graphed versus age for selected values of the percentage of patients 38-59 years of age: the minimum (0% of patients aged 38-59), 25th percentile (10%), median (20%), 75th percentile (30%), and maximum (80%).

Modeling Composite 20

The covariates used to model Composite Q20 were gender, age, years of practice, percentage of patient populations 0-15, 16-18, 19-37, 38-59, and 60 years and older, postgraduate training, direct patient care percentage (0-25%, 26-50%, 51-75%, 76-100%), and continuing education (1-4 hours, 5-9 hours, 10-14 hours, 15-19 hours, 20+ hours). Lower composite scores were associated with more MID practices. The

composite score for Question 20 had a wider range, since it drew on thirteen questions and composite scores ranged from 18 to 52. Three selection methods were used, stepwise selection, forward selection, and backward elimination.

Residual analyses employing conformance with normality assumptions and Shapiro-Wilk tests indicated that all other examinations of residuals to evaluate validity of model assumptions were satisfactory. Table 49 shows that provider group (p=0.0016), age (p=0.0009), percentage of patients 38-59 years of age (p=0.0095), completion of postgraduate training (p=0.0040), and the interaction between provider group and postgraduate training (0.0434) were significant for Composite 20.

Lower composite scores (more MID practices) for Composite 20 were associated with being a member of a federal service group. The model explained a modest amount of the variation, with an R^2=0.1649. An increase in age, a greater percentage of patients 38-59 years of age, being a civilian, and not having completed postgraduate training were associated with higher composite scores for Question 20 for all respondents, indicating less MID practices.

A significant interaction occurred between provider group and postgraduate training (p=0.0434), indicating that the impact of these two factors was not additive. Means adjusted for age and percentage of patients aged 38-59 years were derived for four groups defined by provider group and postgraduate training status, and are given in Table 50 together with their standard errors. No other interactions were significant. for Composite 20. Table 51 shows results of the least square means (LSMEAN).

Table 51. LSMEAN [Mean (SE)] Results for Composite 20 Interaction

Group	Postgraduate Training	LSMEANS(Standard Error)
Federal Service	Yes	33.56 (0.60)*
Civilian	Yes	36.08 (0.48)
Federal Service	No	36.75 (0.97)
Civilian	No	36.67 (0.48)

Note: Federal Service (AF/AR/NA/PHS)

*p<0.0040 Federal service with postgraduate training was significantly different from the three other combinations.

As shown in Figure 3, being a member of a federal service group and completing postgraduate training (adjusted mean 33.56) was significantly different ($p<0.0040$) from any other combination of provider group and postgraduate status. Federal service dentists with postgraduate training had the lowest composite scores, which differed significantly from the other three groups after adjustment for multiple comparisons. The other three combinations, 1) federal group, no post-graduate training (adjusted mean 36.75), 2) civilian, postgraduate training (adjusted mean 36.08), and 3) civilian, no postgraduate training (adjusted mean 36.67), were associated with higher composite scores and could not be said to differ significantly from each other, with p-values of 0.37 or greater. The higher composite scores of these three groups indicated less tendency toward MID; it is noted that the composite scores of civilians with postgraduate training tended to be lower, but not significantly so.

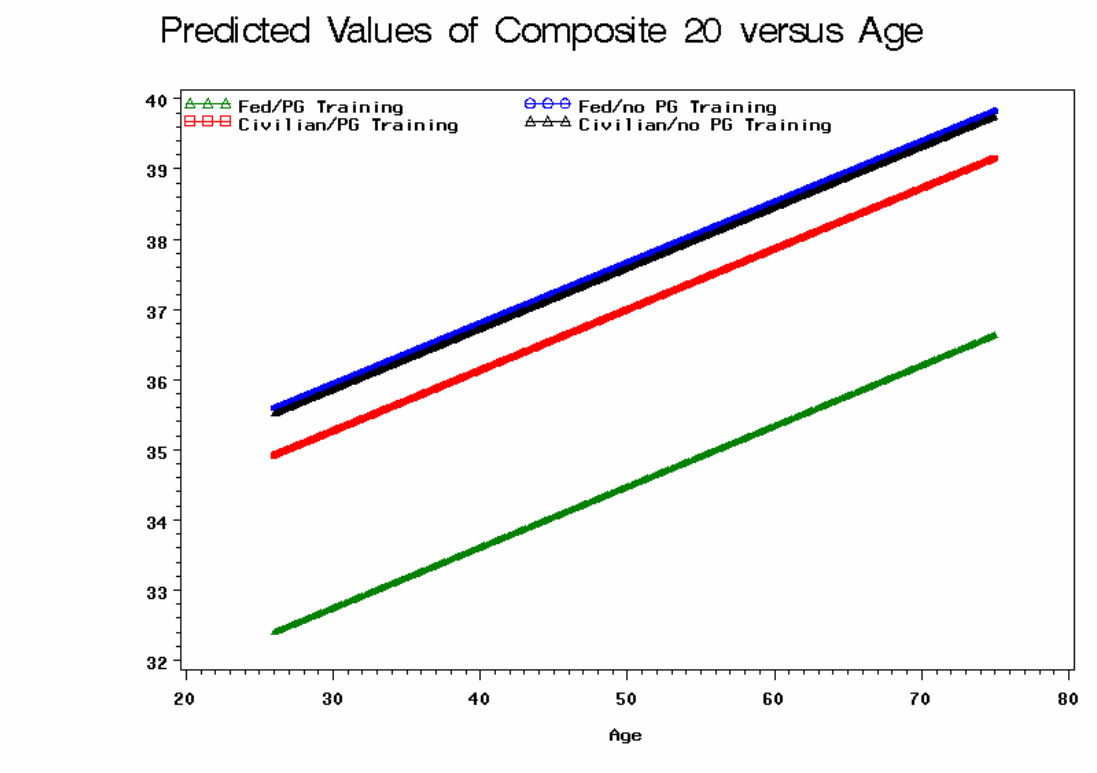

Figure 3. Predicted Values of Composite 20 Scores Versus Dentist Age in Years for All Respondents, adjusted to the median value of the percentage of patients 38-59 years of age, for four groups defined by provider group and postgraduate training status.

A similar procedure was used in modeling Composite Q20 for the federal service respondents. Lower composite scores were associated with more MID practices. The variables included after screening based on bivariate analyses were age, years of practice, continuing education, postgraduate training, and patient populations 60+ years of age.

Table 50 shows that the two significant predictor variables for the composite score of Question 20 for federal service respondents were postgraduate training ($p=0.0197$) and percentage of patients sixty years of age or older ($p=0.0112$).

Respondents without postgraduate training had higher composite scores, associated with fewer MID practices. Completion of postgraduate training was significantly associated with lower composite Question 20 scores and more tendency toward MID. A one-unit increase in the percentage of patients 60+ years increased the composite score by 0.11 points. When federal group was forced into the linear regression model for composite 20 for the federal service dataset, the p-value was not significant (p=0.2081). Figure 4 shows that the predicted value of the composite score for federal service respondents was higher for respondents without postgraduate training. No significant interactions were identified.

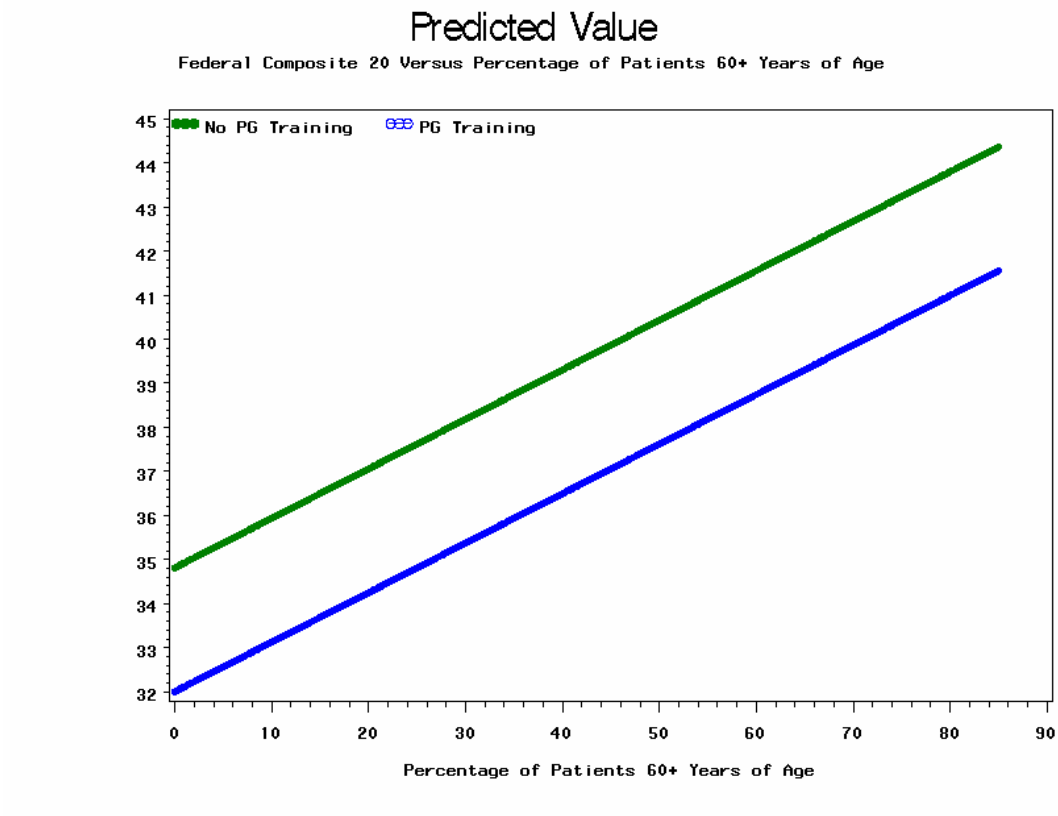

Figure 4. Predicted Value of Composite Score for Question 20 for Federal Respondents

Additional Exploratory Analyses

Although not part of the original thesis plan, at the thesis defense one committee member recommended entering knowledge into the final model to determine if it explained more of the variability. Increasing scores for knowledge categories (1=very much, 2=much, 3=some, 4=little, 5=none) meant less MID knowledge. Table 52 presents the results. Knowledge was significant in all models except the regression model of the composite variable for Question 18 for federal service respondents (p=0.1159). However, the p-value was suggestive of significance. Knowledge was highly significant for composite scores for Question 20, both overall and for federal service respondents.

Table 52. Knowledge (Question 15b*) Added to Final Composite Linear Regression Models for Questions 18 and 20

Model	**Original R^2	R^2 after adding Knowledge	p-value for Question 15b in model
Composite 18§-Overall	0.0513	0.0881	0.0037
Composite 18§-Federal Service Respondents	0.0897	0.1438	0.1159
Composite 20∞-Overall	0.1650	0.2286	<0.0001
Composite 20∞-Federal Service Respondents	0.1376	0.2864	<0.0001

*How much do you know about Minimal Intervention Dentistry?

**R^2 depicted in Tables 49 and 50.

§This uses the composite variable for subquestions 18a-d that is shown in Table 21. Subquestions b & c were reversed to be consistent with the direction of MID tendency.

∞This uses the composite variable for subquestions 20a-n that is shown in Table 23, excluding subquestions m and o.

Summary

Age, years since graduation and years of practice are highly correlated in this study. Therefore, collinearity diagnostic tests were performed. Years since graduation was removed from composite score modeling. Predictions of what factors were associated with composite scores revealed that age and the percentage of patients 38-59 years were significant factors for composite Q18 for all respondents (federal/civilian together) and among federal service subgroups only. Factors that influenced the composite score for Q20 were age, postgraduate training, and percentage of the patient population aged 38-59 years. Postgraduate training and percentage of patients 60 years and older were significantly related to the question 20 composite score for the federal service respondents. All of the linear regression models predicted relatively little of the variability of the model, as several R^2 values were less than 17%.

CHAPTER V

DISCUSSION

Overview

The primary objective of this study was to compare the knowledge, attitudes, behaviors, and associated characteristics of federal service and civilian dentists in the United States concerning the areas of Minimal Intervention Dentistry. Comparisons of the knowledge, attitudes and behaviors and their associated characteristics were also made among federal service respondents.

This study's results indicated that there were differences in 1) knowledge, 2) attitudes, and 3) behaviors concerning Minimal Intervention Dentistry, between federal service and civilian dentists, and among federal service subgroups. Results also demonstrated that there were significant differences in the characteristics associated with knowledge, attitudes, and behaviors between federal service and civilian dentists, and among federal service respondents.

Response rates

The effective response rate for this study, as the result of two mailings, was 31.0%. Although the effective response rate overall was low, the response rate for civilian dentists (54.5%) was much greater than that of federal service dentists (15.3%), and was comparable to response rates found in other studies (Warren & others (2000), Haj-Ali & others (2005)). Warren & others (2000) achieved a response rate of 22% in their study of factors related to decisions to extract or retain at-risk teeth. They attributed their low response rate to the result of a single mailing and the requirement of having the active participation of respondents in selecting cases and reporting their findings. Haj-Ali & others (2005) had an overall response rate of 26.3% in their survey concerning the materials that general dentists used for direct and indirect posterior restorations. Haj-Ali

& others (2005) believed that the validity of their study was satisfactory and that their results should not be undervalued. However, the authors recognized that non-response bias was an associated limitation of their study.

Initially, by design, United States federal service dentists selected to receive questionnaires totaled 60.0% of the sample population (900 out of 1500) in this study. A response rate of 15.3% for federal service dentists lowered the overall effective response rate. Other studies involving federal service dentists achieved higher response rates. A survey of similar sample size to this study, of 1100 Army dentists and dental health promotion and prevention practices by Chisick & others (1997) achieved a response rate of 55.1%. Two studies involved a smaller sample of federal service personnel; Dixon & others (2002), and Atchison & others (2002), had response rates of 92% and 75%, respectively.

Since there was no demographic information available about the non-responders other than their name and address, it was not possible to investigate nonresponse bias using this information (Parashos & others, 2005). Parashos & others (2005) recommended achieving a high response rate to avoid the complexities of nonresponse bias.

Several methods were used to try to improve the response rate for this study. These methods included pre-testing the questionnaire among University of Iowa College of Dentistry faculty in the Departments of Family Dentistry and Operative Dentistry; including a cover letter with a university letterhead inviting dentists to participate in the study; placing the questionnaire in booklet form to minimize page-turning; inserting a non-participation post-card for dentists who did not want to participate; a follow-up second mailing ten weeks after the first mailing with identical inserts; and a reply postage-paid return envelope.

Parashos & others (2005) found their response rate improved after each contact. In their study reporting on response rate and nonresponse bias of a questionnaire survey

of dentists, the response rate from the first mailing was 49%, increasing to 71% after the second mailing, 79% after the third mailing, and 87% after the fourth contact, which was by telephone (Parashos & others, 2005). Perhaps the reason civilian dentists responded in greater numbers than federal service dentists did was because civilian dentists had a greater interest in the topic of MID than did federal service dentists. It is also possible that federal service dentists were engaged in mission essential activities, or were reluctant to admit gaps in their knowledge, attitudes and behaviors concerning Minimal Intervention Dentistry.

Although this was a national survey of United States federal service and civilian dentists, some of the federal service respondent postmarks' were located in countries outside of the United States. Several envelopes had postmarks from Army and Air Force facilities in Europe and Asia. One questionnaire was received from Fallujah, Iraq. One comment on a returned non-participation postcard, likely written by someone other than the addressee, indicated that the federal dentist was on assignment out of the country. This suggests that active duty federal service dentists might not be available to respond due to several United States overseas and domestic engagements during the period of this survey.

The first mailing occurred just before the holiday period. Assuming the holiday period could have lowered the rate of return for the first mailing, the second mailing was released at the end of the holiday period, rather than earlier, as originally planned. The holiday period could have lowered the rate of return for the first mailing in several ways. It was sent a few weeks before Thanksgiving, a time when most spend time with family and community. For the federal service dentists, this time is often a period of leave from the normal workplace, and for those stationed overseas, a time to return to the United States. The response rate might improve if the first mailing occurred in September or October, months without big holiday periods.

Demographic differences

The main differences between United States federal service and civilian dentists were in the variables of age, years of practice, years since dental school graduation, completion of postgraduate training, and mean percentages of patients in the age groups 0-15 years, 16-18 years, 19-37 years, 38-59 years, and 60 years and above. Federal service dentists were younger, graduated from dental school later, had fewer years of practice, and were more likely to have completed postgraduate training compared to civilian dentists. Civilian dentists had greater patient percentages in the youngest (0-15 years) and oldest (60+ years) patient population age groups compared to the federal service, where the patient populations concentrated more in the 19-37 and 38-59 year old age groups.

No significant difference was detected in the percentage of time spent by respondents in direct patient care (0-25%, 26-50%, 51-75%, or 76-100%). The majority of federal service (61.3%) and civilian dentists (66.4%) spent most of their time (76-100%) involved in direct patient care. Over seventy percent of both federal service and civilian dentists earned more than twenty continuing education hours per year.

Overall, respondents were predominantly male (81.3%), with greater representation of female dentists reported for the federal services (26.8% compared to 15.3%). The active recruitment efforts of the federal services might explain why there were more female respondents from the federal service group. Female dentists were younger than male dentists. It could also be that civilian female dentists were too busy to respond or were not as interested in the topic compared to federal service female dentists.

Key Outcome Measures

Significantly more United States federal service dentists (23.9%) indicated that they knew a great deal about MID (selection of 'Very Much' for knowledge of MID), compared to 12.9% of civilian dentists. Federal service dentists were more recent dental

school graduates, and might have had more exposure to Minimal Intervention Dentistry concepts while in pre-doctoral dental training. This area requires further study. There were slight differences between federal service (9.4%) and civilian dentists (10.5%) pertaining to having no knowledge of MID. The result of no significant differences among federal service subgroups for knowledge of MID could be because more graduates had more consistent knowledge of MID. Secondly, federal service dentists are within organizations, which offer standardized practice procedures and protocols. The federal services are also much smaller than the civilian sector and might accept new paradigms more easily than civilian dentists would. Civilian dentists might not be interested in knowing more about MID since, at present, most third party payers do not reimburse dentists for MID procedures. In addition, the small sample sizes of the federal service subgroups could have resulted in a relative decrease in the power to detect significant differences.

Overwhelmingly, dentists in both federal service and civilian sectors believed that fluoride was an effective remineralizing agent. Information on fluoride's effectiveness in caries prevention has been readily available to dentists for decades. Over 95% of responding dentists indicated strong agreement or agreement with this statement. This left only 17 dentists (3.7%) who strongly disagreed or disagreed. Significant differences between federal service and civilian dentists were detected in caries prevention methods other than fluoride, such as the use of chlorhexidine, microbial testing, and ACP/CPP, which federal dentists used more often than civilian dentists did. Both United States federal service and civilian dentists were using procedures related to MID (Question 20), but a greater percentage of federal service dentists used them more than civilian dentists did.

For the four multiple linear regression models for Composite Q18 and Composite Q20 (one each for all respondents and just federal service respondents), age was used if age and years since graduation were both significant because of collinearity, which could

have compromised the validity of the statistical analyses. Age and the percentage of patients 38-59 years were significantly related in the regression models overall and among federal service respondents for the composite variable for Question 18. In fact, the final models were identical for the Composite Q18 for federal/civilian respondents, and federal service respondents. As age increased, the composite score also increased and was interpreted as less tendency toward MID. Respondents of older age might have more years in clinical practice and years since dental school graduation (collinearity tests indicated this). This study found that more recent graduates and younger dentists tended to use more MID practices. The percentage of patients 38-59 years was significantly related to MID practices in three of the linear regression models, composite 18 overall and among federal service groups, and composite 20 overall. The higher the percentages of patients in the age category of 38-59 years, the higher the composite score for Question 18 and 20, which implied less tendency toward MID. It is likely that practitioners who treat patients in this age category are older and do less MID. Perhaps patients in this age category have dental insurance that does not cover these procedures, or these patients require other more extensive treatment, such as replacement of existing restorations or replacement of missing teeth. In addition, it is possible that dentists treating patients in this age category fear a lawsuit if decay is not removed in the traditional manner. Patients might also be reluctant to participate in these procedures.

The percentage of patients 60 years and above was significantly associated with higher composite scores for Composite Q20 for the federal service respondents. Increases in this patient population meant higher composite scores and less MID tendency. Federal service dentists in the Air Force (4.2%), Army (7.9%), and PHS (11.8%) saw fewer patients in this age category than did the Navy dentists (18.7%). Inexperience in working with this age group might be part of the reason for less MID use. Among the military federal services, contact with patients in this age category (retirees) usually occurs on a space available basis. Therefore, a large part of treatment might be

emergency care, with little opportunity for follow-up care. Public Health Service dentists might reserve MID for pediatric populations, since they had greater patient populations 18 years or less of age (25.8%) than patients 60 years and above (11.8%) . It is also possible that patients 60 years and above present with extensive dental needs inappropriate for MID practices.

Postgraduate training was a significant factor in the regression model for the composite variable for Question 20 overall and among the federal service respondents. Those with postgraduate training had lower scores, implying more tendency toward MID, than those without postgraduate training. Perhaps the most interesting finding of this study was the interaction between postgraduate training and provider group, and the categorization of four groups based on these two variables.

Federal service dentists with postgraduate training achieved the lowest composite scores and stood out among the other three groups (civilian dentists with and without training, and federal dentists without PG training), as discussed in the previous chapters. Atchison & others (2002c) reported that military AEGD programs treated more healthy adults and had 58% more treatment planning, while military GPR programs had 63% more preventive dentistry. These practices could have prepared federal service dentists to embrace MID more readily than would civilian dentists. An investigation of the influence of these curriculum changes on clinical practice was not part of this study, but it would be helpful to investigate in future studies. While regression models did not distinguish a federal service subgroup with more MID tendency, bivariate analyses indicated that Air Force dentists used significantly more MID practices than did the other services. Analyses were not able to separate out different variables fully due to the small numbers of respondents among the federal services.

After completing all the main thesis analyses and thesis defense, knowledge (Question 15b) was added to the final regression models to evaluate what effect knowledge had on the outcome of the composite score variable for both Question 18 and

Question 20. Knowledge was significant in the overall model ($p=0.0318$, $R^2=0.09$) and the model for federal service respondents ($p=0.0001$, $R^2=0.29$) and explained more of the variability for composite 18, compared to the model that did not contain knowledge. Knowledge was highly significant for composite 20 overall ($p<0.0001$, $R^2=0.23$) and federal service respondents ($p<0.0001$, $R^2=0.29$), and again explained more of the variability but not substantially, compared to the model that did not contain knowledge. Each unit increase in the knowledge category (very much=1, much=2, some=3, little=4, none=5) was associated with higher composite scores and less MID. This investigation of adding knowledge to models was very preliminary and needs more focused analyses.

Study Strengths

This was the first study of its kind to survey United States federal service and civilian dentists about their knowledge, attitudes, and behaviors concerning Minimal Intervention Dentistry and this, therefore, is the study's greatest strength. Dentists selected to participate in this survey were randomly selected from the American Dental Association's database. A stratified random sampling method was used for the federal service subgroups. United States federal service dentists from four services, the Air Force, Army, Navy, and Public Health Service, and across ranks represented the commissioned federal services and were intended to provide a glimpse of active duty federal dental practice. However, due to the low federal service responses, a more comprehensive view of federal dentists, perhaps particularly those in active duty dental practice, did not occur. This study was also broad in scope, providing information about knowledge, attitudes, and treatment decisions and practices.

Study Limitations

The survey was intended for general dentists, those trained in Dental Public Health and Operative-trained dentists. Forty-four specialists, trained in areas other than

Dental Public Health or Operative Dentistry, returned questionnaires, and were deleted from analyses. The initial request to the ADA requested that all specialists other than than Dental Public Health or Operative Dentistry were excluded from the mailing list. Three possible reasons why specialists appeared in the mailing list received from the ADA are 1) dentist did not notify the ADA of their specialty designation, 2) recent qualification, as several respondents indicated they were presently enrolled in specialty training programs, or 3) clerical error.

Federal service dentists in this study did not include dentists within the Veterans Administration, civil service dentists, or dentists employed by United States local, county, or state governments. This study also did not specify that dentists had to be actively engaged in clinical practice. Several respondents, particularly administrators, commented that they were not in clinical practice and did not see patients and therefore, 1) did not wish to participate (so they returned non-participation postcards), or 2) partially completed the questionnaire, leaving some or all the clinical questions blank, or 3) completed the questionnaire noting that they did not treat patients. These dentists were included in all analyses, excluding those who returned non-participation postcards. Their responses were considered important since they could be responsible, in many cases, for directing or monitoring programs that might include components of MID. Retired federal service dentists and reserve dentists who indicated a federal service affiliation were considered federal service dentists during data analyses. Those not indicating an affiliation with the Air Force, Army, Navy, or Public Health Service were regarded as civilian dentists. In addition, there are many dentists employed by federal installations through private employment contractors, who were not considered in this study to be federal service dentists. Several respondents in this group mentioned that there was no category for them on the questionnaire.

A weakness of the study was the inability to investigate nonresponse bias. Projections for the response rate for this study were 60% and higher, based on other

questionnaire surveys to dentists in general, and among federal service dentists. Had there been a suspicion that response rates would be less than 60%, efforts would have been made to gather more demographic information in order to investigate nonresponse bias. It is recommended that future questionnaire surveys request this additional information. In addition, the low response rate led to low power and a higher chance of beta error than desirable. Therefore, caution is needed in concluding that factors are not significantly related. For this reason, post-hoc power calculations were done, and found that the study had 80% power to detect differences of 9.9% to 14.1%. Civilian dentists had a large percentage of their patient population who were 0-18 years of age (30.9%). This study did not investigate responses for children; it limited questions to the adult population. Additional research is needed to determine whether federal service and civilian dentists' responses would be similar for pediatric patient populations.

This study did not use weighting in the analysis because it compared groups to one another, not to the general population. Because this study surveyed predominantly United States trained dentists, these results might not be applicable to other parts of the world. There is need for comparative studies with other parts of the world.

Respondents were asked to skip question 16 if they had no knowledge of MID. For questions 15, 16, and 17, no composite score was created. Thus, composite scores were created only for questions 18 and 20. Question 15 had only two subquestions. Question 16 had four subquestions, but because it was skipped if q15b =5, and because sites were provider-specific, i.e., federal or civilian, a composite variable was not created. For Question 17, subquestions a and c had a different presentation of results than subquestions b and d, making it difficult to create a composite score with any meaningful interpretation. Subquestion 18b and 18c were recoded by reversing the values. This was done in order to create a composite variable for clinical decision-making behaviors, which was the most important area of interest. Subquestions m and o were removed from

the composite variable 20 because many (84 and 95) respondents did not answer these subquestions.

There was no separate category for 0% or 100% in questions 8a-e (percentage of patients in 5 age categories) and question 12 (percentage of time involved in direct patient care). This means that those without patients in these age categories or solely patients in a particular age category were grouped with those respondents who had some patients. This might confound the results since responses might be different for those on the extremes (0 or 100%) versus those reporting not all but low ones (>0) and not all, but high ones(<100%) Separate categories for 0% and 100% might help reduce any confusion.

Possible Changes to the Study if It Were Repeated

If this study were repeated, several changes would be incorporated. The proposed changes are discussed briefly. Question 18 would be reworded so that responses would be consistently in line with MID concepts and ensure that the outcome expected was favoring MID. In this question with four subquestions, two subquestions favored MID with lower scores and two subquestions favored MID with higher scores. Consequently, two subquestions were recoded so that all four favored MID with lower scores. Prior to this recode, this compromised the validity of the question.

Subquestion 18d asked about monitoring the lesion or restoring the lesion. Adding an option for non-operative treatment that included application of fluoride varnish, nutritional counseling and antimicrobial therapy would incorporate more MID concepts than just monitoring, which is difficult to define. When this question was worded, it was assumed that monitoring meant non-operative intervention, which might include application of topical agents. However, it was not actually in the question, so it would be best to have it as an explicit option in the future.

This study received IRB approval through the University of Iowa Institutional Review Board and used the official database of the American Dental Association for both federal service and civilian dentists. A future study might include a federal IRB and use of a federal database for mailing lists of federal service dentists. Quite often, federal service dentists are assigned to a major treatment facility which has several branches scattered within a region. An advantage of using a federal database is that the exact address would be available, as the service member is assigned to a new facility, without any input by the service-member. A federal service database would presumably be more accurate, and contact with the member could occur more quickly. A federal service database would also allow more comprehensive assessment of the sample in , for instance, behaviors, since all federal dentists would be represented, and nonresponse bias could be evaluated. An outside database, as used in this study, depended on the federal service member to update the address, which is often the home address. It also requires dues paying membership in the organization, so many federal dentists might not be available using their database. This study used a national database after weighing the advantages and disadvantages.

Another study might consider limiting the questions to knowledge and attitudes or behaviors, but not all three at the same time. There was too much information to interpret within the confines of a postgraduate master's degree training program timeline, which for this study totaled about nine months. Concentrating on one or two areas would have been more focused.

Other considerations to incorporate might be to include categories for dentists not participating in clinical practice (state and local public health administrators) and non-federal dentists employed on federal installations, as well as sending the questionnaires to dentists in the Veteran's Administration.

It might be revealing to include more demographic data in the questionnaire, such as ethnicity, race, marital status, and number of children, and employment location. The

employment location could reveal additional information since many of the DPH trained respondents were not involved in clinical practice and were employed in county, state, and local organizations versus federal facilities for the federal service respondents. This information would be important for others as well, since those employed in larger clinical practices may respond differently from those employed in smaller facilities. These variables could be included in regression models to determine what impact they have on outcomes.

The questionnaire asked clinical questions pertaining to adult populations. A separate section in the questionnaire or a questionnaire exclusively pertaining to pediatric populations might show whether dentists' practices concerning MID are similar for these two patient populations. It would be interesting to see whether dentists incorporated MID into their practice relatively more when treating children versus adults. It also would be worthwhile to consider a separate series of questions about behaviors for different ages of adults, since behaviors could vary by different patient populations.

A few respondents suggested that the questionnaire define Minimal Intervention Dentistry. The intent of the questionnaire was to determine how much respondents already knew about this treatment philosophy. Without a clear definition, it was left to respondents to interpret its meaning. It's possible that some respondents indicated they knew little about the term "MID" but they might be using procedures related to it in their offices. This area requires further study.

The response rate was low after two mailings. The use of a postcard indicating that dentists were going to receive a questionnaire, shortening the questionnaire, use of incentives, and an additional contact either mail or telephone, after mailing the questionnaire, might improve the response rate. In addition, formal endorsement by the ADA, Air Force, Army, Navy, and Public Health Service might help. Selection of a non-holiday period to send the questionnaire might make a positive impact on the response rate.

Clinical Relevance of the Study

The results of this study suggest that federal service dentists were using more MID procedures than civilian dentists were. The results also indicated that both federal service and civilian dentists completing postgraduate training and participating in more than twenty hours of continuing education hours per year were more likely to use MID. Among the federal service, dentists, the United States Air Force dentists used MID more than those in the other services, and the Public Health Service used it least.

Younger dentists might be more conservative in their clinical practice, although they have less clinical experience. Use of MID in clinical practice might improve oral health by strengthening tooth structure, reducing the number of restorations provided and educating the public about caries prevention. Dentists who incorporate MID into their practices are utilizing evidence-based procedures. Insurance carrier and third party payers need to alter their policies to encourage these conservative practices among practicing dentists.

Some preventive practices cost less than restorations. Kallestal & others' (2003) systematic review for economic evaluation of dental caries prevention measures found that, except for professionally applied fluoride gels, all preventive measures were cost-effective compared to fillings. Since MID emphasizes prevention, paying for MID procedures now might save money in the long term. Dentists might use more of these practices if insurers reimbursed them for it. Regional licensing examinations might consider revising their caries depth criteria for board examinations, since many respondents indicated they would monitor early carious lesions rather than restore.

Future Directions

Minimal Intervention Dentistry is an emerging area of dentistry. Interested parties can conduct clinical studies of actual practices related to MID, while others interested in the administration of these programs might evaluate costs associated with these procedures compared to costs from traditional procedures. This study provides a baseline for a plethora of future studies. Further exploration into the factors that contribute to knowledge, attitudes, and behaviors concerning Minimal Intervention Dentistry with multiple logistic regression might explain some of the reasons for the differences shown in bivariate analyses.

Other analyses to include are an evaluation of whether knowledge and/or attitudes explain some of the variability in the linear regression models for composite score variables for Questions 18 and 20. As mentioned in the Results, knowledge being added to the models did not explain large amounts of the variability, and most of the same variables were significant. This should be explored further in future analyses outside the thesis.

Future studies are needed to determine whether MID concepts are taught during pre-doctoral training, post-doctoral training, or continuing education courses, as curriculum changes in postgraduate training programs could influence clinical practices. Further research is also needed to determine whether dentists' responses would be similar for pediatric (0-18 years) and elder (60 years and older) patient populations, and provide more detail for adult age group comparisons.

This study was conducted at the College of Dentistry at The University of Iowa. Because of its preventive emphasis, Minimal Intervention Dentistry applies to several Healthy Iowans 2010 Oral Health objectives (Goal Statements 15-1, 15-2, 15-3, 15-6, 15-9) (Healthy Iowans 2010, 2006):

1. Goal Statement 15.1 Reduce cavities in primary and permanent teeth so the proportion of children who have had one or more cavities, filled or unfilled, is no more

than 10% among children aged 3 to 5, 25% among children aged 7 to 9, and 50% among adolescents aged 12 to 14.

2. Goal Statement 15.2 Reduce untreated cavities in the primary and permanent teeth so that the proportion of low-income children with decayed teeth not filled is no more than 2% for children aged 3 to 5, 10% for children aged 7 to 9, and 20% for adolescents 12 to 14.

3. Goal Statement 15.3 Reduce to no more than 20% the proportion of people aged 65 and older who have lost all of their teeth.

4. Goal Statement 15.6 Increase the proportion of children in the 3rd grade who have received protective sealants in permanent molar teeth.

5. Goal Statement 15.8 Increase to at least 93% the proportion of the population served by community water systems with optimally fluoridated water.

6. Goal Statement 15.9 Increase by 25% the use of topical fluorides, in addition to fluoridated toothpaste, by at-risk populations.

7. Goal Statement 15.10 Increase to 25% the proportion of 1-year-olds, especially those from low-income families who receive exams or screenings by a qualified health professional (dentist, dental hygienist, pediatrician, nurse, nurse practitioner). Exams or screenings will be for moderate to high-risk decay conditions (existing or recent decay, demineralization, visible plaque on anterior teeth). The professionals will also counsel patients on the need for additional sources of fluoride or decrease potentially excessive amounts of fluoride.

A similar study among Iowa dentists might provide insights into current practices regarding Minimal Intervention Dentistry, which might help reach some Healthy Iowan 2010 goals.

MID encourages prevention practices at the primary, secondary, and tertiary levels. It might be beneficial to explore 1) what public health administrators know about MID, and 2) to what level public health administrators incorporate MID principles into

caries prevention programs, and 3) to what level public health administrators advocate for MID procedures.

In this study, four subquestions were selected to represent knowledge, attitudes, and behaviors. Future studies might provide detailed exploration of other subquestions. This thesis project emerged due to a single question "How much do dentists know about ART?" which was Question 15a. This was not fully explored during this study. Many interesting findings were found which require further analyses.

Several categories of variables were not considered in multivariable analyses. This study did not consider journals read by respondents or postgraduate training content area, length, or credential. Since postgraduate training was important in several regression models (Composite 20 overall and federal service respondents), it might be useful to explore more detailed ways of describing postgraduate training, by specialty, training length, and postgraduate credential.

Because of time constraints, this thesis was not able to investigate much of the descriptive data, which included the open-ended responses. The open-ended responses indicate that some respondents had definite views about MID which would be worth exploring further. It might be beneficial to add state-specific exploratory data analyses, too. This information might assist state dental schools or state boards in aligning training and licensure requirements.

CHAPTER VI

CONCLUSIONS

This study used a questionnaire mailed to federal service and civilian dentists (total n=1500), selected by stratified random sampling among members of the American Dental Association, representing general dentists and dentists trained in Dental Public Health and Operative Dentistry. Other specialists were excluded. Response rates were much lower among the federal service dentists. The questionnaire asked about dentists' personal and practice background, including gender, age, year and state of dental school graduation, and completion of postgraduate training. In addition, the number of years in practice, and the percentages of patients in five age categories were also determined from the questionnaire (Heinikainen 2004).

The results revealed that federal service dentists generally knew more about Minimal Intervention Dentistry than did civilian dentists. At first glance, a dentist's gender or state of dental school graduation was not a significant factor for knowledge, attitudes or behaviors between federal service and civilian dentists. However, care must be taken in concluding there is no significant relationship due to limited power. Bivariate analyses showed that gender played a role in MID practices among federal service dentists. This did not emerge in multiple linear regression analyses. Postgraduate training completion influenced MID practices. Federal service dentists with postgraduate training were more likely to use MID in clinical decision-making and in practice compared to civilian dentists with or without training or federal service dentists without postgraduate training. Dentists with higher patient percentages 38-59 years of age were less likely to use MID. Air Force dentists were more likely to use MID practices compared to Army, Navy, or Public Health Service dentists.

Multivariable linear regression analyses revealed that age and the percentage of patients 38-59 years were associated with lower composite scores for behaviors involving Minimal Intervention Dentistry. Selecting an MID procedure, that of monitoring an

enamel carious lesion in a high caries risk patient rather than restoring the tooth, was related to fewer years of clinical practice and lower percentages of patients with ages 38-59. The MID practice of remineralizing non-cavitated carious lesions was related to younger age, fewer patients with ages of 38-59 years, being a federal service dentist, and completion of post-graduate training.

This study supported the hypotheses of no differences in attitudes (bivariate analyses) between federal/civilian dentists or among federal service subgroups regarding fluoride as an effective remineralizing agent. However, this study did not support the null hypotheses of no differences in knowledge (bivariate analyses), or behaviors (multivariable analyses). Similarly, this study did not support the null hypotheses of no differences in characteristics (bivariate and multivariable analyses) of federal/civilian and among federal service subgroups concerning Minimal Intervention Dentistry.

These differences highlight the need for future studies in this area. Further acceptance by practicing dentists, third party payers, and educational institutions will encourage use of these procedures in the future.

APPENDIX A QUESTIONNAIRE

KNOWLEDGE, ATTITUDES, AND BEHAVIORS OF FEDERAL SERVICE AND CIVILIAN GENERAL DENTISTS CONCERNING MINIMAL INTERVENTION DENTISTRY

INSTRUCTIONS FOR COMPLETING THE QUESTIONNAIRE

Thank you for your participation in this study.

- The questions in this questionnaire pertain to different aspects of Minimal Intervention Dentistry.
- DO NOT WRITE YOUR NAME OR SOCIAL SECURITY NUMBER ANYWHERE ON THE QUESTIONNAIRE.
- Please read all the printed answers before marking your choice.
- Answer each question and subquestion.
- Choose the best answer for each subquestion.
- You may skip any questions you do not wish to answer.
- Use a pencil or black pen.
- Draw a circle around the best answer or write the response that best applies to you.
- Write responses legibly.
- Erase cleanly. If you use a black pen and make a mistake, place a line through the incorrect answer.
- Please turn the page to begin.

1. Gender **Please circle the number of your gender.**	**Male**	**Female**
What is your gender?	1	2

2. Age **Please write in your age.**	**Years**
What is your age in years?	____ ____

3. Duty Status **Please circle the number of your response.**	**Yes**	**No**
Are you presently an active duty commissioned officer? **If yes, continue to question #4.** **If no, skip to question #6.**	1	2

4. Service **Please circle the number below your service.**	**Air Force**	**Army**	**Navy**	**Public Health Service**
What is your federal service affiliation?	1	2	3	4

5. Grade **Please circle the number below your service grade.**	**O-3**	**O-4**	**O-5**	**O-6**	**O-7 or above**
What is your service grade?	1	2	3	4	5

6. **Dental School Graduation** **Please write in the year of your dental school graduation.**	**Year**
What year did you graduate from dental school?	____ ____ ____ ____

7. **Dental School Location** **Please write in the state or country where you received your dental degree.**
In which state is the dental school from which you received your DDS/DMD located? _____
Note: If not from a U.S. dental school, then please list the country where your dental degree was received. _____

8. Patient population **Please write in percentages.**	**0-15 years**	**16-18 years**	**19-37 years**	**38-59 years**	**60+ years**
What percentage of your patient population is in each of these age groups? The total must equal 100%.					

9. Post-graduate training **Post-graduate training is a period of one year or longer.** **Please circle the number of your response.**	**Yes**	**No**
Have you ever completed postgraduate training? **If yes, continue to #10.** **If no, skip to #11.**	1	2

10. Formal Post-graduate Training Content Area	**Please circle the number of your training content area(s).**	**Training length in months**	**Post-graduate outcome(s)** **1=Certificate** **2=Masters degree** **3=PhD** **4=other, please specify**
a. Dental Public Health	1		
b. Endodontics	2		
c. Operative	3		
d. Oral and Maxillofacial Pathology	4		
e. Oral and Maxillofacial Radiology	5		
f. Oral and Maxillofacial Surgery	6		
g. Orthodontics	7		
h. Pediatric Dentistry	8		
i. Prosthodontics	9		
j. Periodontics	10		
k. General Practice Residency (GPR)	11		
l. Advanced Program in General Dentistry (AEGD/ACP, Comprehensive Dentistry)	12		
m. Other, please specify:	13		

11. Years of practice **Please write in your years of practice.**	**Years**
How many years of clinical practice do you have, including while in post-graduate training programs?	____ ____

12. Direct patient care **Please circle the number of your response.**	**0-25%**	**26-50%**	**51-75%**	**76-100%**
What percentage of your total work-time per week is devoted to direct patient care?	1	2	3	4

13. Professional journals **Which professional journals do you read regularly for clinical articles?** **Please circle the number of your response for each journal.**	**Yes**	**No**
a. Journal of the American Dental Association	1	2
b. General Dentistry	1	2
c. Military Medicine	1	2
d. Journal of Public Health Dentistry	1	2
e. Also, list others you read regularly: 1.		
2.		
3.		

14. Continuing Education **Please circle the number of your response.**	**0-4 hours**	**5-9 hours**	**10-14 hours**	**15-19 hours**	**20+ hours**
How many official CE hours have you earned in the past year?	1	2	3	4	5

15. Knowledge **For each subquestion, please circle the number of your response.**	**Very Much**	**Much**	**Some**	**Little**	**None**
a. How much do you know about Atraumatic Restorative Treatment?	1	2	3	4	5
b. How much do you know about Minimal Intervention Dentistry (MID), sometimes called Minimally Invasive Dentistry, Preservative Dentistry, or Conservative Dentistry?	1	2	3	4	5
If "None" for #15b, then skip to question #17.					

For question #16 below, please use the following scale:
1 = "Always or most of the time" - means 80-100% of the time.
2 = "Often" - means 40-79% of the time.
3 = "Sometimes" - means 10-39% of the time.
4 = "Never or rarely" - means 0-9% of the time.

16. How much do you think MID should be used in each of these settings? For each subquestion, please circle the number of your response.	**Always or most of the time**	**Often**	**Sometimes**	**Never or rarely**
a. Ship at sea	1	2	3	4
b. Fixed military site in a remote location	1	2	3	4
c. Indian Health Service facility	1	2	3	4
d. Public Health Clinic	1	2	3	4
e. Private dental office	1	2	3	4

17. What is your attitude toward the following statements for adult patients? For each subquestion, please circle the number of your response.	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**
a. Fluoride is an effective remineralizing agent.	1	2	3	4
b. G.V. Black's "extension for prevention" is still relevant in certain clinical situations.	1	2	3	4
c. The use of adhesive restorative materials reduces the size of restorations.	1	2	3	4
d. There is adequate time to conduct a caries risk assessment for every patient.	1	2	3	4

For questions #18 and #20, please use the following scale:
1 = "Always or most of the time" - means 80-100% of the time.
2 = "Often" - means 40-79% of the time.
3 = "Sometimes" - means 10-39% of the time.
4 = "Never or rarely" - means 0-9% of the time.

18. Behaviors **How often would you make the following treatment choices?** **For each subquestion, please circle the number of your response.**	**Always or most of the time**	**Often**	**Sometimes**	**Never or rarely**
a. Restore (and not extract) a vital, asymptomatic upper left central incisor with gross coronal caries, in a 32-year-old, high caries risk patient with limited financial resources?	1	2	3	4
b. Restore (and not monitor) a vital, asymptomatic, lower right first molar in a 22-year-old, low caries risk patient, who has a non-fluorosis, initial, white spot, non-cavitated carious lesion, on the facial surface?	1	2	3	4
c. Replace (and not monitor) an intact, anterior facial composite restoration with a stained, non-carious, cavosurface margin, placed one year ago, in a low caries risk, 38-year-old patient for whom esthetics is not a concern?	1	2	3	4
d. Monitor (and not restore) a proximal carious lesion in the middle third of enamel, found on routine radiographic assessment of an upper left premolar of a 23-year-old, high caries risk patient with poor oral hygiene, inadequate fluoride exposures, and limited financial resources?	1	2	3	4

19. Please describe briefly why you selected your response to question 18 (d).

_____

_____

20. Behaviors **How often do you perform the following procedures related to Minimal Intervention Dentistry for your adult patients?** **For each subquestion, please circle the number of your response.**	**Always or most of the time**	**Often**	**Sometimes**	**Never or rarely**
a. Caries risk assessment	1	2	3	4
b. Microbial testing	1	2	3	4
c. Remineralize with casein phosphopeptide/amorphous calcium phosphate (CPP/ACP)	1	2	3	4
d. Remineralize non-cavitated carious lesions	1	2	3	4
e. Topical fluoride application	1	2	3	4
f. Prescribe chlorhexidine for caries control	1	2	3	4
g. Prescribe a high concentration fluoride dentifrice (5000 ppm)	1	2	3	4
h. Seal adjacent pits and fissures of amalgam restorations with a sealant	1	2	3	4
i. Seal adjacent pits and fissures of composite restorations with a sealant	1	2	3	4
j. Repair defective restorations instead of replacement	1	2	3	4
k. Slot and tunnel preparations	1	2	3	4
l. Redo existing restorations	1	2	3	4
m. Sandwich technique	1	2	3	4
n. Restore with glass ionomer cement	1	2	3	4
o. Atraumatic Restorative Treatment (ART)	1	2	3	4

21. Do you have any other comments about or experiences with MID that you want to share?

_____

_____

This ends the questionnaire. Thank you for your participation. Please return the survey in the enclosed, self-addressed, stamped return envelope.

ID#:____ ____ ____ ____

APPENDIX B INDEPENDENT AND DEPENDENT VARIABLES

Table B-1. Independent and Dependent Variables

Independent variables	Question	Relevant Question	Operational Definition	Type of Variable
Gender	1.	What is your gender?	Selection of male or female	Dichotomous
Age	2.	What is your age in years?	The age of the dentist	Interval (will categorize)
Duty Status	3.	Are you presently an active duty commissioned officer? If yes, continue to question #4. If no, skip to question #6.	A dentist in the Air Force, Army, Navy, or Public Health Service	Dichotomous
Service	4.	What is your federal service affiliation?	A dentist in the Air Force, Army, Navy, or Public Health Service	Nominal
Grade	5.	What is your service grade?	The federal service dentist's level of authority, 0-3, 0-4, 0-5, 0-6 or above	Ordinal
Yr. of dental school graduation	6.	What year did you graduate from dental school?	The year the dentist completed dental school.	Interval
Dental school location	7.	In which state is the dental school from which you received your DDS/DMD located? Note: If not from a U.S. dental school, then please list the country where your dental degree was received.	A dental school that is located in a state, territory, possession of the US or another country.	Nominal
Patient population	8.	What percent of your patient population is in each of these age groups The total must equal 100%. 0-15%, 16-18, 19-37,38-59, 60+	Patient population in five age groups	Discrete
Post-graduate training	9.	Have you completed postgraduate training, yes or no? If yes continue to question #10, otherwise skip to question #13.	Additional dental training after DMD/ DDS, ≥1 year	Dichotomous
Content area of post-graduate training	10.	Training content area: Dental Public Health, Endodontics, Oral and Maxillofacial (Pathology, Radiology, and Surgery), Orthodontics, Pediatric Dentistry, Prosthodontics, Periodontics, General Practice Residency (GPR), Advanced Program in General Dentistry, or other, please specify. Please circle the number of your training content area(s).	Post-graduate training course content area(s).	Nominal
Length of post-graduate training	10.	What was the program length in months?	The number of months spent in post-graduate training.	Interval

Table B-1. Continued

Dependent Variable	Question Number	Relevant Question	Operational Definition	Type of Variable
Outcome of post-graduate training	10.	Post-graduate outcome: 1=Certificate of completion, 2=Master's degree, 3=PhD, 4=other, please specify.	The credential awarded at the end of post-graduate training.	Nominal
Years of practice	11.	How many years of clinical practice do you have, including post-graduate training programs?	The number of years involved in the clinical practice of dentistry.	Interval (will categorize)
Direct patient care	12.	What percent of your total work-time per week is devoted to direct patient care? 0-25%, 26-50%, 51-75%, 76-100%	The percent of time in direct patient care.	Ordinal
Professional journals	13.	Which professional journals do you read monthly for clinical articles: Journal of the American Dental Association, General Dentistry, Military Medicine, Journal of Public Health Dentistry, also list others you read monthly (up to 3 more)? Please circle the number (1=yes, 2=no) below your response for each journal.	Journals read monthly that contain clinical articles.	Dichotomous Nominal
Continuing Education	14.	How many official CE hours have you earned in the past year? Please circle the number below your response. 0-4,5-9,10-14,15-19, 20+ hours.	CE hours awarded in the past year.	Ordinal
Knowledge	15a. 15b.	How much do you know about Atraumatic Restorative Treatment? How much do you know about Minimal Intervention Dentistry?	A 5-point Likert scale Scoring: very much-1, much-2, some-3, little-4, none-5	Ordinal
Overall Knowledge	15	How much do you know about Atraumatic Restorative Treatment and Minimally Invasive Dentistry?	A composite score of questions a and b: from (2 x 1) to (2 x 4), very much 7-8, much 5-6, some 3-4, little 1-2, none- 0	Ordinal

Table B-1. Continued

Dependent Variable	Question Number	Relevant Question	Operational Definition	Type of Variable
Attitudes about locations for use of Minimal Intervention Dentistry	16a. 16b. 16c. 16d.	How much do you think MID should be used in the following locations Indian Health Service? How much do you think MID should be used on a ship at sea? How much do you think MID should be used in a fixed military site in a remote location? How much do you think MID should be used in a private dental office?	Midpoint of a 4-point Likert scale Scoring: Always or most of he time-(90%)-1 Often(60%)-2 Sometimes(25%)-3 Never or rarely(5%)-4 Report summary by percentage and frequency	Ordinal
Overall attitude about locations for use of Minimal Intervention Dentistry	16.	How much do you think MID should be used in each of these settings? Please answer each subquestion. Indian Health Service facility, ship at sea, fixed military site in a remote location, private dental office	A composite score of questions a-d: from (4 x 1) to (4 x4) or (4 x 90%) to (4 x 5%): Report summary by percentage and frequency	Ordinal
General attitudes	17a. 17b. 17c. 17d.	Fluoride is an effective remineralizing agent: The principles of G.V. Black are still relevant in certain clinical situations. The use of adhesive restorative materials reduces the size of restorations. There is adequate time to conduct a caries risk assessment for every patient.	A 4-point Likert scale Scoring: strongly agree-1, agree-2, disagree-3, strongly disagree-4	Ordinal
Overall general attitudes	17.	Please answer each subquestion. a. Fluoride is an effective remineralizing agent b. The principles of G.V. Black are still relevant in certain clinical situation. c. The use of adhesive restorative materials reduces the size of restorations. d. There is adequate time to conduct a caries risk assessment for every patient.	A composite score of questions a-d: from (4 x 1) to (4 x 4) or (4 x 90%) to (4 x 5%) very much 10-12 much 7-9 some 4-6 little 1-3 none 0	Ordinal

Table B-1. Continued

Dependent Variable	Question Number	Relevant Question	Operational Definition	Type of Variable
Behaviors	18a.	Restore (and not extract) a vital, asymptomatic upper left central incisor with gross coronal caries, in a 32-year-old, high caries risk patient with limited financial resources?	Midpoint of a 4-point Likert scale Scoring: Very likely (90%)-1 Likely(60%)-2 Maybe(25%)-3 Unlikely(5%)-4 Report summary by percentage and frequency	Ordinal
	18b.	Restore (and not monitor) a vital, asymptomatic, lower right first molar in a 22-year-old, low caries risk patient, who has a non-fluorosis, initial, white spot, non-cavitated carious lesion, on the facial surface?		
	18c.	Replace (and not monitor) an anterior facial composite restoration with a stained, non-carious cavosurface margin, placed one year ago, in a low caries risk patient for whom esthetics is not a concern?		
	18d.	Monitor (and not restore) a proximal carious lesion in the middle third of enamel, found on routine radiographic assessment of an upper left premolar of a 23-year-old, high caries risk patient with poor oral hygiene, inadequate fluoride exposures, and limited financial resources?		
Behaviors overall	18.	How likely would you be to...four clinical scenarios a-d presented?	A composite score of questions a-d: from (4 x 1) to (4 x 4) or (4 x 90%) to (4 x5%) Report summary by percentage and frequency	Ordinal
Behaviors	19.	Please describe briefly why you selected your response to 18 (d).	Descriptive, categorize after review	Nominal

Table B-1. Continued

Dependent Variable	Question Number	Relevant Question	Operational Definition	Type of Variable
Behaviors	20a. 20b. 20c. 20d. 20e. 20f. 20g. 20h. 20i. 20j. 20k.	Caries risk assessment Microbial testing Remineralize with casein phosphopeptide/amorphous calcium phosphate (CPP/ACP) Remineralize non-cavitated carious lesions Topical fluoride application Prescribe chlorhexidine for caries control Prescribe a high concentration fluoride dentifrice (5000 ppm) Seal adjacent pits and fissures of amalgam restorations with a sealant Seal adjacent pits and fissures of composite restorations with a sealant Repair defective restorations instead of replacement Slot and tunnel preparations	Midpoint of a 4-point Likert scale Scoring: Always or most of he time-(90%)-1 Often(60%)-2 Sometimes(25%)-3 Never or rarely(5%)-4 Report summary by percentage and frequency	Ordinal
Behaviors	20l.. 20m. 20n. 20o.	Redo existing restorations Sandwich technique Restore with glass ionomer cement Atraumatic Restorative Treatment	Midpoint of a 4-point Likert scale Scoring: Always or most of he time-(90%)-1 Often(60%)-2 Sometimes(25%)-3 Never or rarely(5%)-4 Report summary by percentage and frequency	Ordinal
Behaviors	20.	How often do you perform the following procedures related to Minimal Intervention Dentistry (a-o)?	Composite Score: from (15 x 1) to (15 x 4) or (15 x 90%) to (15 x 5%): Report summary by percentage and frequency	Ordinal
Open-ended question	21.	Do you have any other comments or experiences about MID that, you want to share?	Descriptive, categorize after review	Nominal

APPENDIX C BIVARIATE ANALYSES FOR OVERALL

Table C-1. Bivariate Analyses Assessing Relationships of Potential Categorical Covariates to Knowledge, Attitudes, and Behaviors (KAB) (p-values)

Question-KAB	*Federal/Civilian*	*AF/AR/ NV/PHS*	*Rank*	*Region*	*Postgrad Training*	*Gender*
15a	0.0082	0.0245	0.1897	0.5204	0.0011	0.6337
15b*	0.0043	0.1039	0.2264	0.9960	0.0007	0.7410
16a	0.2087	0.6238	0.2728	0.1413	0.3623	0.9843
16b	0.1502	0.2495	0.1206	0.5792	0.6314	0.9232
16c	0.0100	0.5032	0.0567	0.5062	0.2250	0.8454
16d	0.0087	0.6400	0.0127	0.3669	0.2515	0.9684
16e	0.0072	0.9523	0.2883	0.4050	0.0378	0.3995
17a*	0.1108	0.1413	0.2156	0.0040	0.0083	0.9365
17b	0.0109	0.2705	0.4371	0.4367	0.1113	0.7404
17c	0.5127	0.9518	0.8878	0.7435	0.4166	0.0694
17d	0.5156	0.0962	0.9007	0.9393	0.2761	0.2905
18a	0.0194	0.2058	0.0439	0.5454	0.8521	0.6963
18b	0.0017	0.5674	0.1475	0.1462	0.3514	0.1645
18c	0.0717	0.1620	0.1783	0.3915	0.9644	0.1408
18d*	0.2248	0.3021	0.2272	0.1153	0.9950	0.3007
20a	<0.0001	0.0033	0.0665	0.5158	0.2160	0.0253
20b	0.0036	0.5405	0.3413	0.5734	0.0111	0.2371
20c	0.5306	0.1157	0.1155	0.3849	0.4208	0.6404
20d*	<0.0001	0.0004	0.0102	0.4945	<0.0001	0.0057
20e	0.1014	0.0020	0.6045	0.1965	0.4969	0.8490
20f	0.0072	0.0455	0.0562	0.0741	0.0455	0.2232
20g	0.3957	0.0051	0.0064	0.3737	0.2825	0.2529
20h	<0.0001	0.4359	0.7888	0.3562	<0.0001	0.0251
20i	0.0001	0.6253	0.7179	0.9760	0.0011	0.0186
20j	0.1773	0.1613	0.1014	0.1004	0.0420	0.6815
20k	0.0078	0.0044	0.0333	0.9174	0.0075	0.2586
20l	0.0360	0.3964	0.5304	0.5896	0.2082	0.0578
20m	0.0990	0.3290	0.5258	0.6384	0.9320	0.6000
20n	<0.0001	0.4786	0.4103	0.3900	0.0007	0.0040
20o	0.0537	0.1837	0.8758	0.1744	0.7932	0.6180

Note: Tests were performed using Ridit Analysis/ * Key question

Table C-2. Bivariate Analysis of Potential Quantitative Covariates with Correlation Coefficients for Questions 15-18 Test statistic-Spearman Rank Correlation

Question-KAB	*Age*	*Years of Practice*	*Years Since Graduation*
15a	0.4072	0.1090	0.5260
Correlation	0.0390	0.0752	0.0298
15b	0.0023	0.0006	0.0040
Correlation	0.1424	0.1600	0.1346
16a	0.5086	0.8825	0.3215
Correlation	-0.0351	-0.0078	-0.0525
16b	0.9418	0.5205	0.9231
Correlation	0.0039	0.0337	-0.0051
16c	0.2401	0.0538	0.2272
Correlation	0.0621	0.1010	0.0637
16d	0.0875	0.0102	0.0838
Correlation	0.1731	0.1335	0.0905
16e	0.0007	<0.0001	0.0008
Correlation	0.1100	0.2017	0.1713
17a	0.0191	0.0002	0.0174
Correlation	0.0082	0.1728	0.1116
17b	0.8624	0.0617	0.9352
Correlation	0.0982	-0.0878	-0.0038
17c	0.0367	0.0707	0.0365
Correlation	0.0502	0.0848	0.0982
17d	0.2878	0.0731	0.3535
Correlation	0.0497	0.0844	0.0438
18a	0.2974	0.2060	0.3535
Correlation	0.1358	0.0601	0.0471
18b*	0.0041	0.0060	0.0158
Correlation	0.1358	0.1297	0.1143
18c*	0.0193	0.0231	0.0363
Correlation	0.1113	0.1077	0.0995
18d	0.0351	0.0143	0.0338
Correlation	0.0997	0.1160	0.1009

Table C-3. Bivariate Analysis of Potential Quantitative Covariates with Correlation Coefficients for Question 20, Test statistic-Spearman Rank Correlation

Question-KAB	*Age*	*Years of Practice*	*Years Since Graduation*
20a	<0.0001	0.0004	<0.0001
Correlation	0.1941	0.1709	0.1949
20b	0.9247	0.3816	0.6183
Correlation	-0.0046	0.0424	0.0243
20c	0.7609	0.6684	0.8508
Correlation	-0.0150	0.0210	0.0093
20d	<0.0001	<0.0001	<0.0001
Correlation	0.3202	0.3290	0.3447
20e	0.6809	0.7050	0.5871
Correlation	0.0200	0.0184	0.0264
20f	0.0169	0.0103	0.0052
Correlation	0.1158	0.1282	0.1355
20g	<0.0001	<0.0001	<0.0001
Correlation	0.2304	0.1891	0.2266
20h	<0.0001	<0.0001	<0.0001
Correlation	0.2128	0.2221	0.2245
20i	<0.0001	<0.0001	<0.0001
Correlation	0.2140	0.1930	0.2161
20j	0.9173	0.8308	0.8469
Correlation	0.0050	0.0103	0.0094
20k	0.0100	0.0053	0.0031
Correlation	0.1249	0.1348	0.1435
20l	0.1075	0.7369	0.1658
Correlation	0.0790	0.0165	0.0681
20m	0.9771	0.8704	0.7174
Correlation	0.0015	0.0084	0.0188
20n	0.0080	0.0011	0.0057
Correlation	0.1297	0.1590	0.1353
20o	0.6500	0.6772	0.7581
Correlation	0.0239	0.0218	0.0162

Table C-4. Bivariate Analyses Assessing Relationships of Potential Ordinal Covariates to Knowledge, Attitudes, and Behaviors (KAB) for Questions 15-18 Kendall's Tau B Test Statistic

Question KAB*	*Direct Patient Care*	*CE*
15a	0.0419	0.1809
Correlation	0.0822	-0.0546
15b	0.9179	0.0080
Correlation	-0.0042	-0.1088
16a	0.4687	0.9697
Correlation	-0.0340	0.0018
16b	0.9880	0.7841
Correlation	-0.0007	-0.0129
16c	0.8738	0.7279
Correlation	-0.0074	0.0164
16d	0.8225	0.8789
Correlation	-0.0104	0.0071
16e	0.3176	0.6771
Correlation	-0.0457	-0.0192
17a	0.4236	0.2705
Correlation	-0.0353	0.0490
17b	0.0886	0.8576
Correlation	-0.0710	-0.0076
17c	0.3601	0.3822
Correlation	-0.0397	0.0383
17d	0.0442	0.3015
Correlation	0.0849	0.0440
18a	0.2272	0.5842
Correlation	-0.0520	0.0238
18b*	0.8282	0.1388
Correlation	-0.0094	0.0649
18c*	0.1547	0.8072
Correlation	-0.0629	-0.0109
18d	0.0017	0.3386
Correlation	0.1317	0.0405

*Subquestions b & c were reversed to be consistent with the direction of MID tendency.

Table C-5. Bivariate Analyses Assessing Relationships of Potential Ordinal Covariates to Knowledge, Attitudes, and Behaviors (KAB) for Question 20 Kendall's Tau B Test Statistic

Question KAB*	*Direct Patient Care*	*CE*
20a	0.6880	0.5669
Correlation	0.0171	-0.0246
20b	0.0001	0.1568
Correlation	0.1774	-0.0659
20c	0.8716	0.9516
Correlation	0.0074	0.0028
20d*	0.5173	0.5906
Correlation	0.0279	-0.0234
20e	0.5683	0.1707
Correlation	0.0249	0.0604
20f	0.3298	0.1363
Correlation	0.0419	-0.0646
20g	0.0159	0.8714
Correlation	-0.1038	-0.0070
20h	0.6779	0.7891
Correlation	0.0177	-0.0115
20i	0.7305	0.5105
Correlation	0.0146	-0.0282
20j	0.3748	0.6390
Correlation	0.0384	-0.0205
20k	0.5197	0.7005
Correlation	-0.0276	-0.0167
20l	0.1236	0.3723
Correlation	-0.0691	-0.0401
20m	0.8727	0.1706
Correlation	-0/0073	-0.0633
20n	0.0105	0.5220
Correlation	0.1118	0.0282
20o	0.6635	0.6996
Correlation	-0.0204	-0.0184

Table C-6. Bivariate Analyses for Composite Variables (p-values)

Variable	Composite A*	Composite B**
Provider (Fed/Civ)	0.0006	<0.0001
Federal (AF/AR/NA/PHS)	0.1215	0.0619
Region	0.4024	0.7134
Postgraduate Training	0.4743	0.0002
Gender	0.7494	0.1184
Knowledge (q15b)	0.0175	<0.0001
Attitudes (q17a)	0.0993	0.0019
Behavior18 (q18d)	.0001	0.0051
Behavior20 (q20d)	0.0001	<0.0001
Age	0.0007	<0.0001
Years of Practice	0.0001	<0.0001
Years Since Graduation	0.0019	<0.0001
Direct Patient Care	0.3009	0.7215
Continuing Education	0.2035	0.9588
% patient populations		
0-15 years	0.3308	0.2304
16-18 years	0.1210	0.6969
19-37 years	0.0491	0.0003
38-59 years	<0.0001	<0.0001
60 years and older	0.0006	<0.0001

Note: AF-Air Force, AR-Army, NA-Navy, PHS-Public Health Service

Note: Test statistic-Kruskal-Wallis (provider, federal, region, postgraduate training, and gender, knowledge, attitudes, behavior 18, behavior 20)

Note: Test statistic-Spearman's Rank Correlation (age, years since graduation, years of practice, direct patient care, continuing education, patient population groups 0-15, 16-18, 19-37, 38-59, 60 and above)

* This uses the composite variable for subquestions 18a-d that is shown in Table 21. Subquestions b & c were reversed to be consistent with the direction of MID tendency.

** This composite variable uses 13 of 15 subquestions for Question 20, excluding subquestions m and o as defined in Table 23 and associated text.

Table C-7. Bivariate Analyses of Dichotomous Key Variables Assessing Relationships with Potential Covariates (p-values)

Variable	*Knowledge(15b)*	*Attitudes(17a)*	*Behavior18d*	*Behavior20d*
Age in years	0.0036	0.0047	0.0157	0.0001
Patient populations combined (Wilks-Lambda)	0.0907	0.1749	0.1449	<0.0001
% patient population 0-15 years	0.1236	0.2135	0.2986	0.3033
% patient population 16-18 years	0.5121	0.5591	0.8568	0.6105
% patient population 19-37 years	0.0180	0.2103	0.1953	<0.0001
% patient population 38-59 years	0.3236	0.1224	0.0082	<0.0001
% population 60+ years	0.0622	0.0164	0.0754	<0.0001
Graduation	0.0035	0.0519	0.1130	<0.0001
Years of practice	0.0016	0.0015	0.0190	<0.0001
Years since Graduation	0.0092	0.0039	0.0309	<0.0001
Gender	1.000**	1.000**	0.2661**	0.0044**
Post-graduate Training	0.1662**	0.0126	0.7916	<0.0001
Region	0.9703	0.9205	0.3276	0.3394
Continuing Education	0.0006	0.8563	0.3847	0.0490
Direct Patient Care	0.4915	0.3897	0.0153	0.8399
Provider	0.0644**	0.7877**	0.1779**	<0.0001**
Federal Group	0.0454	0.6173	0.4694	<0.0001

** Fisher's Exact Test

Note: Test statistic (age, years of practice)-Kruskal Wallis Test

Note: Test statistic (gender, post-grad training, provider, federal group, region)-Chi-Square Test

Note: Test statistic (continuing education, direct patient care) - Ridit Analysis

Note: Test statistic (patient populations overall, 0-15, 16-18, 19-37, 38-59)-MANOVA (Wilks-Lambda)

APPENDIX D BIVARIATE ANALYSES FOR FEDERAL SERVICE SUBGROUPS

Table D-1. Bivariate Analyses Assessing Relationships of Potential Categorical Covariates to Knowledge, Attitudes, and Behaviors (KAB) (p-values)

Question-KAB	*AF/AR/NV/PHS*	*Rank*	*Region*	*Postgrad Training*	*Gender*
15a	0.0245	0.1631	0.6756	0.6185	0.2197
15b*	0.1039	0.1923	0.5666	0.0149	0.3812
16a	0.6238	0.3124	0.3539	0.5365	0.9414
16b	0.2495	0.1553	0.6540	0.8576	0.7204
16c	0.5032	0.0663	0.7613	0.1812	0.7147
16d	0.6400	0.0144	0.8598	0.6141	0.4936
16e	0.9523	0.2966	0.2080	0.0880	0.3318
17a*	0.1413	0.2297	0.8762	0.6966	0.2408
17b	0.2705	0.4923	0.1085	0.0337	0.7581
17c	0.9518	0.8793	0.9769	0.9690	0.0159
17d	0.0962	0.8972	0.2659	0.7261	0.5901
18a	0.2058	0.0350	0.2557	0.7558	0.8138
18b	0.5674	0.1746	0.8733	0.7025	0.5795
18c	0.1620	0.1422	0.3599	0.6723	0.6795
18d*	0.3021	0.2890	0.0832	0.1732	0.5721
20a	0.0032	0.0822	0.9501	0.4692	0.1972
20b	0.5405	0.3382	0.9310	0.2800	0.2573
20c	0.1157	0.0935	0.7556	0.2579	0.7395
20d*	0.0004	0.0114	0.8395	0.0991	0.8138
20e	0.0010	0.7711	0.4932	0.7799	0.7146
20f	0.0455	0.0745	0.7827	0.4582	0.8536
20g	0.0051	0.0063	0.9399	0.5341	0.7047
20h	0.4359	0.7973	0.6249	0.1629	0.3091
20i	0.6253	0.7728	0.2995	0.7125	0.1639
20j	0.1613	0.1343	0.6482	0.0358	0.5465
20k	0.0044	0.0490	0.9352	0.0697	0.2585
20l	0.3964	0.5434	0.6324	0.8193	0.3352
20m	0.3290	0.5547	0.3788	0.0339	0.9846
20n	0.4786	0.4391	0.5941	0.0991	0.2471
20o	0.1837	0.8788	0.5147	0.7538	0.5070

Note: Tests were performed using Ridit Analysis/* Key question

Table D- 2. Bivariate Analysis of Potential Quantitative Covariates (p-Values) with Correlations for Questions 15-18 Test statistic-Spearman Rank Correlation

Question-KAB	*Age*	*Years of Practice*	*Years Since Graduation*
15a	0.5831	0.2477	0.2047
Correlation	-0.0473	-0.1009	-0.1094
15b	0.2962	0.1075	0.2511
Correlation	0.0896	0.1397	0.0987
16a	0.2255	0.3737	0.2101
Correlation	-0.1149	-0.0849	-0.1194
16b	0.3439	0.9693	0.7955
Correlation	-0.0883	0.0036	-0.0243
16c	0.8096	0.3187	0.5828
Correlation	-0.02313	0.0960	0.0529
16d	0.7769	0.4130	0.7115
Correlation	-0.0268	0.0778	0.0352
16e	0.9768	0.4300	0.7138
Correlation	-0.0027	0.0737	0.0341
17a	0.6864	0.7003	0.7748
Correlation	0.0348	0.0337	0.0248
17b	0.5444	0.7606	0.8704
Correlation	0.0520	-0.0266	0.0141
17c	0.4407	0.2564	0.3407
Correlation	0.0662	0.0987	0.0820
17d	0.8095	0.6658	0.8322
Correlation	-0.0308	0.0378	0.0183
18a	0.0748	0.0023	0.0012
Correlation	0.1544	0.2653	0.2784
18b	0.0413	0.0601	0.0771
Correlation	0.1752	0.1641	0.1527
18c	0.1053	0.0842	0.0847
Correlation	0.1400	0.1514	0.1495
18d	0.1626	0.1979	0.1038
Correlation	0.1204	0.1128	0.1406

Table D-3. Bivariate Analysis of Potential Quantitative Covariates (p-Values) with Spearman Rank Correlations for Question 20

Question KAB*	*Age*	*Years of Practice*	*Years since Graduation*
20a	0.0009	0.0021	0.0029
Correlation	0.2893	0.2730	0.2615
20b	0.1110	0.5181	0.4123
Correlation	-0.1404	-0.0581	-0.0728
20c	0.0009	0.0317	0.0261
Correlation	-0.2914	-0.1946	-0.1990
20d	0.0325	0.0018	0.0018
Correlation	0.1877	0.2752	0.2721
20e	0.5528	0.6619	0.5030
Correlation	0.0525	0.0393	0.0595
20f	0.1908	0.0961	0.1079
Correlation	0.1155	0.1489	0.1422
20g	0.0056	0.0171	0.0293
Correlation	0.2409	0.2113	0.1913
20h	0.8449	0.8980	0.9305
Correlation	-0.0172	0.0115	-0.0077
20i	0.5129	0.3376	0.2303
Correlation	0.0577	0.0858	0.1059
20j	0.3202	0.1607	0.2837
Correlation	-0.0875	-0.1252	-0.0947
20k	0.0018	0.0070	0.0063
Correlation	0.2719	0.2391	0.2394
20l	0.2125	0.6303	0.2916
Correlation	0.1109	0.0437	0.0943
20m	0.9313	0.6399	0.6778
Correlation	0-.0080	0.0439	0.0385
20n	0.5266	0.3312	0.2509
Correlation	-0.0560	-0.0873	-0.1018
20o	0.7946	0.6843	0.7349
Correlation	0.0239	-0.0380	-0.0312

Table D-4. Bivariate Analyses Assessing Relationships (p-values) of Potential Ordinal Covariates to Knowledge, Attitudes, and Behaviors (KAB) for Questions 15-18 Kendall's Tau B test statistic

Question KAB*	*Direct Patient Care*	*CE*
15a	0.8177	0.5353
Correlation	0.0170	-0.0464
15b	0.9575	0.0091
Correlation	0.0040	-0.1968
16a	0.4468	0.4355
Correlation	0.0632	-0.0672
16b	0.2103	0.2320
Correlation	0.1031	-0.1017
16c	0.6821	0.8528
Correlation	0.0345	-0.0162
16d	0.8343	0.8728
Correlation	0.0174	0.0138
16e	0.9513	0.2810
Correlation	0.0050	-0.0910
17a	0.5094	0.2956
Correlation	-0.0534	-0.0859
17b	0.0638	0.4379
Correlation	-0.1409	0.0601
17c	0.9201	0.7810
Correlation	0.0079	0.0.0223
17d	0.0517	0.7193
Correlation	0.1492	-0.0280
18a	0.5179	0.7036
Correlation	-0.0515	0.0308
18b	0.7607	0.4215
Correlation	-0.0243	0.0651
18c	0.0405	0.6223
Correlation	-0.1654	-0.0404
18d	0.1837	0.2249
Correlation	0.1005	-0.0933

Table D-5. Bivariate Analyses Assessing Relationships (p-values) of Potential Ordinal Covariates to Knowledge, Attitudes, and Behaviors (KAB) for Question 20-Kendall's Tau B test statistic

Question KAB*	*Direct Patient Care*	*CE*
20a	0.9338	0.6049
Correlation	-0.0066	-0.0415
20b	0.0171	0.2574
Correlation	0.1991	-0.0962
20c	0.1324	0.6064
Correlation	0.1262	-0.0440
20d	0.0980	0.0076
Correlation	-0.1279	-0.2098
20e	0.7812	0.9925
Correlation	0.0222	0.0008
20f	0.8295	0.1385
Correlation	0.0169	-0.1181
20g	0.0196	0.0234
Correlation	-0.1819	-0.1797
20h	0.4447	0.4370
Correlation	-0.0589	-0.0609
20i	0.9843	0.5084
Correlation	0.0015	-0.0523
20j	0.3952	0.2513
Correlation	0.0662	-0.0908
20k	0.2239	0.4930
Correlation	-0.0939	-0.0538
20l	0.9574	0.4678
Correlation	-0.0043	0.0600
20m	0.7390	0.5676
Correlation	0.0271	-0.0474
20n	0.4274	0.3136
Correlation	0.0622	-0.0803
20o	0.7361	1.000
Correlation	-0.0276	0.0000

Table D-6. Bivariate Relationships (p-Values) for Composite Scores and Independent Variables

Variable	Composite A*	Composite B**
Grade	0.0306	0.2783
Region	0.1496	0.9558
Postgraduate Training	0.2838	0.0260
Gender	0.9360	0.7543
Knowledge (q15b)	0.7263	0.0004
Attitudes (q17a)	0.0621	0.1321
Behavior18 (q18d)	<0.0001	0.0001
Behavior20 (q20d)	<0.0001	0.0953
Age	0.0133	0.1370
Years of Practice	0.0015	0.1016
Years Since Graduation	0.0006	0.1501
Direct Patient Care	0.9285	0.6378
Continuing Education	0.6040	0.1212
% patient populations 0-15 years	0.8449	0.6832
16-18 years	0.6201	0.7107
19-37 years	0.0647	0.1943
38-59 years	0.0102	0.3110
60 years and older	0.0455	0.0623

Note: Test statistic-Kruskal-Wallis (provider, federal, region, postgraduate training, and gender, knowledge, attitudes, behavior 18, behavior 20)

Note: Test statistic-Spearman's Rank Correlation (age, years since graduation, years of practice, direct patient care, continuing education, patient population groups 0-15, 16-18, 19-37, 38-59, 60 and above)

*This uses the composite variable for subquestions 18a-d that is shown in Table 21. Subquestions b & c were reversed to be consistent with the direction of MID tendency.

**This composite variable uses 13 of 15 subquestions for Question 20, excluding subquestions m and o as defined in Table 23 and associated text.

Table D-7. Bivariate Analyses of Dichotomous Key Variables for Federal Service Group Assessing Relationships with Potential Covariates

Variable	*Knowledge(15b)*	*Attitudes(17a)*	*Behavior(18d)*	*Behavior(20d)*
Age in years	0.0155	0.0450	0.0523	0.0001
Patient populations combined (Wilks-Lambda)	0.0109	0.2538	0.0507	<0.0001
% patient population 0-15 years	0.2111	0.6185	0.8178	0.7895
% patient population 16-18 years	0.5407	0.3219	0.7612	0.1102
% patient population 19-37 years	0.0160	0.2747	0.1593	0.0004
% patient population 38-59 years	0.2266	0.0484	0.0010	0.0004
% population 60+ years	0.0002	0.0543	0.5459	0.0001
Years of practice	0.0074	0.0507	0.1581	0.0003
Years since Graduation	0.0390	0.0391	0.1332	0.0002
Gender	0.7950**	1.000**	0.8409**	1.000**
Post-graduate Training	0.0280**	1.000**	0.1313**	0.0178**
Region	0.9664	0.1408	0.3623	0.6368
Continuing Education	0.0141	0.2444	0.1408	0.1871
Direct Patient Care	0.5466	0.5840	0.3688	0.2158
Rank	0.0829	<0.0001	0.2881	<0.0001
Federal Group	0.0454	0.6173	0.4694	<0.0001

** Fisher's Exact Test

Note: Test statistic (age, years of practice)-Kruskal Wallis Test

Note: Test statistic (gender, post-grad training, provider, federal group, region)-Chi-Square Test

Note: Test statistic (continuing education, direct patient care) - Ridit Analysis

Note: Test statistic (patient populations overall, 0-15, 16-18, 19-37, 38-59)-MANOVA (Wilks-Lambda)

REFERENCES

Abrams S, Scarlett MI, Trost L (2005). Focus on dental caries management. Woman Dentist Journal (March): 49-55.

Agresti A. Analysis of Ordinal Categorical Data. New York: Wiley, 1984.

Ahovuo-Saloranta A, Hiiri A, Nordblad A, Worthington H, Makela M (2004). Pit and fissure sealants for preventing dental decay in the permanent teeth of children and adolescents. The Cochcrane Database of Systematic Reviews Art No; CD001830.pub2.(3): 1-24.

Allison P, Bedos S (2003). Canadian dentists' view of the utility and accessibility of dental research. Journal of Dental Education 67(5): 533-541.

Amaechi B, Higham SM (2002). Quantitative light-induced fluorescence: A potential tool for general dental assessment. Journal of Biomedical Optics **7**(1): 7-13.

American Dental Association (2005). ADA policy on evidence-based dentistry. Retrieved online from www.ada.org on 6/22/05.

Anderson M (2003). Chlorhexidine and xylitol gum in caries prevention. Spec Care Dentist 23(5): 173-176.

Anusavice KJ (2001). Caries risk assessment. Operative Dentistry 6 (Supplement): 19-26.

Anusavice KJ (2005). Present and future approaches for the control of caries. Journal of Dental Education 69(5): 538-554.

Atchison K, Mito RS, Rosenberg DJ, Lefever KH, Lin S, Engelhardt R (2002a). PGD training and its impact on general dentist practice patterns. Journal of Dental Education 66(12): 1348-1357.

Atchison K, Bibb CA, Lefever KH, Mito RS, Lin A, Engelhardt R (2002b). Gender differences in career and practice patterns of PGD-trained dentists. Journal of Dental Education 66(12): 1358-1367.

Atchison A, Bachand W, Buchanan R, Lefever KH, Lin S, Engelhardt R (2002c). Military and VA general dentistry training: a national resource. Journal of Dental Education 66(6): 739-746.

Axelsson S, Soder B, Nordenram G, Petersson LG, Dahlgren H, Norlund A, Kallestal C, Mejare I, Lingstrom P, Lagerlof F, Holm AK, Twetman S (2004). Effect of combined caries-preventive methods: a systematic review of controlled clinical trials Acta Odontol Scand 62(3):163-9.

Bader J, Shugars DA, Bonito AJ (2001). A systematic review of selected caries prevention and management methods. Community Dent Oral Epidemiol 29: 399-411.

Bader J, Shugars Da, Kennedy JE, Hayden WJ, Baker S (2003). A pilot study of risk-based prevention in private practice. Journal of American Dental Association 134(September): 1195-1201.

Bader J, Perrin NA, Maupome G, Rindal B, Rush WA (2005). Validation of a simple approach to caries risk assessment. Journal of Public Health Dentistry 65(2): 76-81.

Barber LR, Wilkins EM (2002). Evidence-based prevention, management, and treatment of dental caries. J Dent Hyg. 76(4):270-5.

Beato C, Carmona RH (2005). Mission statement for the USPHS commissioned corps, U.S. Public Health Service.

Beazoglou T, Heffley D, Brown LJ, Bailit H (2002). The importance of productivity in estimating need for dentists. Journal of American Dental Association 133(October): 1399-1404.

Benn DK (2002). Applying evidence-based dentistry to caries management in dental practice A computerized approach. Journal of American Dental Association 133: 1543-1548.

Bhuridej P, Damiano PC, Kuthy RA, Flach SC, Kanellis MJ, Heller KE, Dawson DV (2005). Natural history of treatment outcomes of permanent first molars A study of sealant effectiveness. JADA 136(September): 1265-1272.

Blum I, Schriever A, Heidemann D, Mjor IA, Wilson NHF (2003). The repair of direct composite restorations: an international survey of the teaching of operative techniques and materials. Eur J Dent Educ 7: 41-48.

Blum I, Newton JT, Wilson NHF (2005). A cohort investigation of the changes in vocational dental practitioners' views on repairing defective direct composite restorations. British Dental Journal supplement: 27-30.

Brennan D, Spencer AJ (2002). Factors influencing choice of dental treatment by private general practitioners. International journal of Behavioral Medicine 9(2): 94-110.

Bross IDJ (1958). How to use ridit analysis. Biometrics; 14:18-38.

Brown L, Lazar V (1998). Solo general practitioners and specialists. Journal of American Dental Association 129(August).

Brown L, Lazar V (1999). Trends in the dental health work force. Journal of American Dental Association 130(December): 1743-1749.

Brown L, Wall TP, Lazar V (2002). Trends in caries among adults 18 to 45 years old. Journal of American Dental Association 133(July): 827-834.

Brown L, Wagner KS, Mikkelsen MC, Munson B (2005). A look at allied dental education in the United States. Journal of the American Dental Association 136:797-804.

Bray RM, Hourani LL, Rae KL, Dover JA, Brown JM, Vincus AA, Pemberton MR< Marsden ME, Faulkner DL, Vandermaaas-Peeler R (2002). Highlights 2002 survey of health related behaviors among military personnel. RTI International, Triangle Park, North Carolina. Retrieved Dec 2005 from www.tricare.osd.mil.

Bullock A, Belfield CR, Butterfield S, Ribbins PM, Frame JW (1999). Continuing education courses in dentistry: assessing impact on practice. Medical Education 33: 484-488.

Bureau of Medicine and Surgery (1991). U.S. Navy Medical Department Officer Career Guide. Washington, D. C, U. S. Navy.

Bureau of Naval Personnel (2005). Designator group & category by sex and race/ethnic group. www.npc.navy.mil.

Burke F, Wilson NHF, Cheung SW, Mjor IA (2001). Influence of patient factors on age of restorations at failure and reasons for their placement and replacement. Journal of Dentistry 29: 317-324.

Burke F, McHugh S, Shaw L, Hosey M-T, Macpherson L, Delargy S, Dopheide B (2005). UK dentists' attitudes and behaviour towards atraumatic restorative treatment for primary teeth. British Dental Journal 199(6).

Burt A, Eklund SA (2005). Dentistry, Dental Practice, and the Community. St. Louis, Missouri, Elsevier Saunders.

Byck G, Cooksey JA, Russinof H (2005). Safety-net dental clinics A viable model for access to dental care. Journal of American Dental Association 136(July): 1013-1021.

Callison GM (2005). Is a dental health risk assessment predictive of dental health? Military Medicine 170(1): 26-30.

Center for Disease Control and Prevention (1999). Achievements in public health, 1900-1999 impact of vaccines universally recommended for children- United States, 1990-1998. Morbidity and Mortality Weekly Report 48(120): 243-348.

Centers for Disease Control and Prevention (2001). Recommendations for using fluoride to prevent and control dental caries in the United States. Morbidity and Mortality Weekly Report 50(RR-14): 1-42.

Chalmers J, Pearson A (2005). Oral hygiene care for residents with dementia: a literature review. Journal of Advanced Nursing 52(4): 410-419.

Chisick M, Richter P, Piotrowski MJ (2000). Dental health promotion and preventive dentistry practices of U.S. Army dentists. Military Medicine 165(8): 604-606.

Clinical Affairs Committee (2004). Clinical guideline on periodicity of examination, preventive dental services, anticipatory guidance, and oral treatment for children. Pediatric Dentistry: 81-83.

Conover W, Iman R (1976). On some alternative procedures using ranks for the analysis of experimental designs. Commun Stat Theor Methods A5, 1349-1368.

Conover and Iman 1981 Conover W, Iman RL (1981). Rank transformations as a bridge between parametric and nonparametric statistics. Am Stat 35, 124-129.

Damiano PC (2001). The question of cost: reimbursement and remuneration. Journal of Dental Education 65(4): 364-367.

del Aguila M, Leggott PJ, Robertson PB, Porterfield DL, Felber GD (2005). Practice patterns among male and female general dentists in a Washington state population. Journal of American Dental Association 136(June): 790-796.

Dionysopoulos P, Gerasimou P, Tolidis K (2003). The effect of home-use fluoride gels on glass-ionomer, compomer and composite resin restorations. Journal of Oral Rehabilitation 30: 683-689.

Dixon S, Dunn WJ, Fancher JP (2002). Perceived initial clinical competencies of dentists at the start and completion of U.S. Air Force advanced education in general dentistry residency programs. Military Medicine 167: 470-473.

Donly K, Segura A, Kanellis M, Erickson RL (1999). Clinical performance and caries inhibition of resin modified glass ionomer cement and amalgam restorations. Journal of American Dental Association 130: 1459-1466.

Edwards P, Roberts I, Clarke M, DiGuiseppi C, Pratap S, Wentz R, Kwan I (2002). Increasing response rates to postal questionnaires: systematic review. British Dental Journal 324: 9 pages?

Ericson D, Kidd E, McComb D, Mjor I, Noack MJ (2003). Minimally invasive dentistry-concepts and techniques in cariology. Oral Health & Preventive Dentistry 1: 59-72.

FDI World (2005). United States of America Dental Workforce. R. f. fdiworlddental.org/resources/assets/facts_and_figures/2000/united%20states.pdf.

Featherstone J, Adair SM, Anderson MH, Berkowitz RJ, Bird WF, Crall JJ, Den Besten PK, Donly KJ, Glassman P, Milgrom P, Roth JR, Snow R, Stewart RE (2003). Caries management by risk assessment: consensus statement, April 2002. Journal of the California Dental Association March (Retrieved from www.cdafoundation.org/journal on 12/3/04).

Fejerskov O, Kidd EAM (2003). Dental Caries The disease and its clinical management. Denmark, Blackwell Munksgaard.

Fiset L, Grembowski D (1997). Adoption of innovative caries-control services in dental practice: a survey of Washington state dentists. Journal of American Dental Association 128(March): 337-345.

Fiset L, Grembowski D, Del Aguila M (2000). Third-party reimbursement and use of fluoride varnish in adults among general dentists in Washington state. Journal of American Dental Association 131(July): 961-968.

Folke B, Walton JL, Feigal RJ (2004). Occlusal sealant success over ten years in a private practice: comparing longevity of sealants placed by dentists, hygienists, and assistants. Pediatric Dentistry 26(5): 426-432.

Forss H, Widstrom E (2001). From amalgam to composite: selection of restorative materials and restoration longevity in Finland. Acta Odontol Scand 59: 57-62.

Forss H, Widstrom E (2004). Reasons for restorative therapy and the longevity of restorations in adults. Acta Odontol Scand 62(82-86).

Frame P, Sawai R, Bowen WH, Meyerowitz C (2000). Preventive dentistry: practitioners' recommendations for low-risk patients compared with scientific evidence and practice guidelines. Am J Prev Med 18(28159-162).

Frencken J, Van t Hof MA, et al. (2004). Effectiveness of single-surface ART restorations in the permanent dentition: a meta-analysis. J Dent Res 83(2): 120-123.

Glasspoole E, Erickson RL, Davidson CL (2002). Effect of surface treatments on bond strength to enamel. Dental Materials 18: 454-462.

Gonzalez-Cabezas C, Fontana M, et al. (2003). Early detection of secondary caries using quantitative light-induced fluorescence. Operative Dentistry 28(4): 415-422.

Gordan V, Mjor IA, Blum IR, Wilson N (2003). Teaching students the repair of resin-based composite restorations A survey of North American dental schools. Journal of American Dental Association 134(March): 317-323.

Gordon S, Dionne RA (2005). The integration of clinical research into dental therapeutics Making treatment decisions. Journal of American Dental Association 136(December): 1701-1708.

Government Accountability Office (2002). Military Personnel. Active duty benefits reflect changing demographics, but opportunities exist to improve. GAO-02-935.

Government Accountability Office (2005). Military Personnel Reporting additional servicemember demographics could enhance congressional oversight. G. A. Office.

Guzman-Armstrong S (2005). Rampant caries. The Journal of School Nursing 21(5): 272-278.

Haj-Ali R, Walker MP, Williams K (2005). Survey of general dentists regarding posterior restorations, selection criteria, and associated clinical problems. General Dentistry; 53(5): 369-375.

Hamilton J, Dennison JB, Stoffers KW, Gregory WA, Welch KB (2002). Early treatment of incipient carious lesions A two year clinical evaluation. Journal of American Dental Association 133: 1643-1652.

Hassall D, Mellor AC (2001). The sealant restoration: indications, success and clinical technique. British Dental Journal 191(7): 358-362.

Hataab F, Amin WM (2001). Fluoride release from glass ionomer restorative materials and the effect of surface coating. Biomaterials 22: 1449-1458.

Hawthorne WS, Smales RJ(1997). Factors influencing long-term restoration survival in three private dental practices in Adelaide. Aust Dent J. 1997 Feb;42(1):59-63.

Health Workforce Personnel Factbook (2006). Table 301- Professionally active and private practice dentists and dentist-to-population ratios, selected years: 1975-2000, retrieved from http://bhpr.hrsa.gov/healthworkforce/reports/factbook02/FB301.htm December 2005.

Healthy Iowans 2010 Mid Course Revision (2006). Retrieved from www.idph.state.ia.us May 20, 2006.

Heinikainen M (2004). Theoretical knowledge for treatment decisions among Finnish dentists. Department of Oral Public Health. Helsinki, University of Helsinki, Finland: 76.

Heller K, Reed SG, Bruner FW, Eklund SA, Burt BA (1995). Longitudinal evaluation of sealing molars with and without incipient dental caries in a public health program. Journal of Public Health Dentistry 55(3): 148-153.

Hewlett E, Mount GJ (2003). Glass ionomers in contemporary restorative dentistry-A clinical update. Journal of the California Dental Association.

Hick J, Garcia-Godoy F, Donly K, Flaitz C Fluoride releasing restorative materials and secondary caries. Journal of the California Dental Association.

Honkala S, Honkala E (2002). Atraumatic dental treatment among Finnish elderly persons. Journal of Oral Rehabilitation 29: 435-440.

Honkala E, Behbehani J, Ibricevic H, Kerosuo E, Al-Jame G (2003). The atraumatic restorative treatment (ART) approach to restoring primary teeth in a standard dental clinic. International Journal of Paediatric Dentistry 13: 172-179.

Hose S, Cecchine G (2001). Options for organizing the military health system. Reorganizing the Military Health system? Should there be a joint command? N. D. R. I. N. R. Corporation, Rand corporation. Retrieved from www.rand.org/pubs/monograph_reports/MR 1350/index.html 11/27/05.

HRSA (2005). Professionally active and private practice dentists and dentist-to-population ratios, selected years: 1975-2000. R. f. b. h. g. o. 11/6/05.

Inge R (2005). The ins and outs of dental insurance. Journal of American Dental Association 136(February): 204-209.

Iqbal A, Glenny AM (2002). General dental practitioners' knowledge of and attitudes towards evidence-based practice. British Dental Journal 193(10): 587-591.

Ismail A, Bader JD (2004). Evidence-based dentistry in clinical practice. Journal of American Dental Association 135(January): 78-83.

Ismail AI (2004). Visual and visuo-tactile detection of dental caries. J Dent Res 83(Spec Iss C).

Itota T, Carrick TE, Yoshiyama M, McCabe JF (2004). Fluoride release and recharge in giomer, compomer and resin composite. Dental Materials 20: 789-795.

Kallestal C, Norlund A, Soder B, Nordenram G, Dahlgren H, Peterson LG, Lagerlof F, Axelsson S, Lingstrom P, Mejare I, Holm AK, Twetman S (2003). Economic evaluation of dental caries prevention: a systematic review. Acta Odontol Scand;61:341-346.

Kay E, Nuttall NM, Knill-Jones R (1992). Restorative treatment thresholds and agreement in treatment decision-making. Community Dent Oral Epidemiol 20: 265-268.

Kidd EAM (2004). How 'clean' must a cavity be before restoration? Caries Research 38: 305-318.

Klausner L, Brandau HE, Charbeneau GT (1989). Glass ionomer cements in dental practice: A national survey. 14(170-175).

Kleinman D, Hickey DJ, Lipton JA (2003). Promoting the public's oral health: the department of health and human services, U.S. public health service, and the U.S. public health service commissioned corps. Journal of the American College of Dentists 70(2): 16-21.

Kleverlaan C, van Duinen RNB, Feilzer AJ (2004). Mechanical properties of glass ionomer cements affected by curing methods. Dental Materials 20: 45-50.

Koch GG, Beck JD. Statistical methodologies useful for the analysis of data from risk-assessment studies. Journal of Public Health Dentistry 1992;52(3):146-167

Kovari H, Pienihakkinen K, Alanen P (2003). Use of xylitol chewing gum in daycare centers: a follow-up study in Savonlinna, Finland. Acta Odontol Scand 61: 367-370.

Krause D, Frate DA, May WL (2005). Demographics and distribution of dentists in Mississippi. Journal of American Dental Association 136(May): 668-677.

Levato CM (2005). Caries management: a new paradigm. Compendium 26(6A): 448-454.

Levy SM (2003). An update on fluorides and fluorosis. J Can Dent Assoc 69(5): 286-291.

Lewis DW, K. E, Main PA, Pharoah MG, Csima A (1996). Dentists' stated restorative treatment thresholds and their restorative and caries depth decisions. Journal of Public Health Dentistry 56(4): 176-181.

Macek M, Wagner ML, Goodman HS, Manz MC, Marrazzo ID (2005). Dental visits and access to dental care among Maryland schoolchildren. Journal of American Dental Association 136(April): 524-533.

Manski R, Moeller JF (2002). Use of dental services. Journal of American Dental Association 133(February): 167-175.

Marinelli C, Donly KJ, et al. (1997). An in vitro comparison of three fluoride regimens on enamel remineralization. Caries Research 31: 418-422.

Markiewicz MR (2004). Enrollment, cost, and academic admission criteria of U.S. dental schools by geographic region and institution type. Journal of Dental Education 68(11): 1133-1138.

Maxfield BD (2004). Army Profile, Department of the Army, G-1.

McComb D (2001). Systematic review of conservative operative caries management strategies. Journal of Dental Education 65(10): 1154-1161.

Mehta CR, Patel NR (1983). A network algorithm for performing Fisher's exact test in rxc contingency tables. J Am Statistical Assoc 78:427-434.

Mertz E, O'Neil E (2002). The growing challenge of providing oral health care services to all americans. Health Affairs 21(5): 65-77.

Mertz-Fairhurst E, Curtis JW, Ergle JW, Rueggeberg FA, Adair SM (1998). Ultraconservative and cariostatic sealed restorations: Results at year 10. JADA 129(January): 55-66.

Mito R, Atchison KA, Lefever KH, Lin S, Engelhardt R (2002). Characteristics of civilian postdoctoral general dentistry programs. Journal of Dental Education 66(6): 757-765.

Mjor I, Gordan VV (1999). A review of atraumatic restorative treatment (ART). International Dental Journal 49(3): 127-131.

Moss D, York A, Martin G (2004). Changes in dental classification during the first 4 years of military service. Military Medicine 169: 38-40?

Mount G, Hume R (1997). A revised classification of carious lesions by site and size. Quintessence International 28(5): 301-303.

Mount G, Ngo H (2000a). Minimal intervention: a new concept for operative dentistry. Quintessence International 31: 527-533.

Mount G, Ngo H (2000b). Minimal intervention: early lesions. Quintessence International 31: 535-546.

Mount, G, Ngo H (2003). Minimal intervention dentistry: rationale of cavity design. Operative Dentistry 28: 92-99.

Murdoch-Kinch C, McLean ME (2003). Minimally invasive dentistry. Journal of American Dental Association 134(January): 87-95.

Murray G, Hancock AF, Fancher J, Chamberlain TM (2003). The Air Force Dental Service-cross into the blue. Journal of the American College of Dentists 70(2): 4-7.

Neumann LM (2004). Trends in dental and allied dental education. Journal of American Dental Association 135(September): 1253-1259.

Office of the PHS Historian (1994). Celebrating 75 years of the dental corps: origins and early years of service. Public Health Reports 100(5): 710-712.

Office of the Undersecretary of Defense, P. a. R. (2003). Executive summary of the 2003 population representation in the military services. R. f. www.defenselink.mil/prhome/poprep2003/download/ExecSummary2003.pdf.

Office of the Undersecretary of Defense, P. a. R. (2003). Population representation in the military services fiscal year 2003. r. f. www.defenselink.mil/prhome/poprep2003/download/AppendixB.pdf.

Okada K, Tosaki S, Hirota K, Hume WR (2001). Surface hardness change of restorative filling materials stored in saliva. Dental Materials 17: 34-39.

Palma-Dibb R, Gregorio de Castro C, Pereira Ramos R, Thomazatti Chimello D, Chinelatti MA (2003). Bond strength of glass-ionomer cements to caries-affected dentin. J Adhes Dent 5(1): 57-62.

Parashos P, Morgan MV, Messer HH (2005). Response rate and nonresponse bias in a questionnaire survey of dentists. Community Dent Oral Epidemiol 33: 9-16.

Petersen P, Lennon MA (2004). Effective use of fluorides for the prevention of dental caries in the 21st century: the WHO approach. Community Dentistry and Oral Epidemiology 32: 319-321.

Petrie A, Bulman JS, Osborn JF (2003). Further statistics in dentistry Part 8: systematic reviews and meta-analyses. British Dental Journal 194(2).

Pitts NB (2004). Are we ready to move from operative to non-operative/preventive treatment of dental caries in clinical practice? Caries Research 38: 294-304.

Program Support Center (2005). Comparison of benefits between commissioned corps & civil service. Retrieved from www.usphs.gov/html/comp_chart.html 11/27/05.

Ranney R, Haden NK, Weaver RW, Valachovic RW (2003). A survey of deans and ADEA activities on dental licensure issues. Journal of Dental Education 67(10): 1149-1160.

Randall R, Vrijhoef MA, Wilson NHF (2003). Dentists' perceptions of trends in restorative dentistry in the UK. Primary Dental Care 10(2): 49-52.

Reinhardt J, Swift EJ, Bolden AJ (1993). A national survey on the use of glass-ionomer cements. Operative Dentistry 18: 56-60.

Reynolds E. (1998). Anticariogenic complexes of amorphous calcium phosphate stabilized by casein phosphopeptides: a review. Special Care in Dentistry 18(1): 8-16.

Reynolds EC, Cai F, Shen P, Walker GD (2003)Retention in plaque and remineralization of enamel lesions by various forms of calcium in a mouthrinse or sugar-free chewing gum. J Dent Res 82(3):206-11.

Rigmont Barber L, Wilkins EM (2002). Evidence-based prevention, management, and monitoring of dental caries. The Journal of Dental Hygiene 76(IV): 270-275.

Roberson T, Heymann HO, Swift EJ (2002). Sturdevant's Art & Science of Operative Dentistry. St Louis, Missouri, Mosby.

Robinson B. (2000). Postgraduate educational opportunities in the military services. Journal of the American College of Dentists 67(1): 19-20.

Rozier RG (2001). Effectiveness of methods used by dental professionals for the primary prevention of dental caries. Journal of Dental Education 65(10): 1063-1072.

Sachdeo A, Gray GB, Sulieman MAM, Jagger DC (2004). Comparison of wear and clinical performance between amalgam, composite and open sandwich restorations: 2-year results. Eur J Prosthodont Rest. Dent 12(1).

SAS 9.1 Copyright 2002-2003. SAS for Windows. Help and documentation. SAS Institute Inc., Cary, NC, USA.

Saw S, Ng TP (2001). The design and assessment of questionnaires in clinical research. Singapore Med J 42(3): 131-135.

Schenkein H, Best AM (2001). Factors considered by new faculty in their decision to choose careers in academic dentistry. Journal of Dental Education 65(9): 832-840.

Schleyer T, Dodell D (2005). Continuing dental education requirements for relicensure in the United States. Journal of American Dental Association 136(October): 1450-1456.

Schulein TM (2004). A chronology of dental education in the United States. Journal of the History of Dentistry 52(3): 97-108.

Schwarz E, Lo EC, Wong MC (1998). Prevention of early childhood caries-results of a fluoride toothpaste demonstration trial on chinese preschool children after three years, J Public Health Dent. 58(1):12-18

Seldin L, for the Oversight Committee (2001). The future of dentistry An overview of a new report. Journal of American Dental Association 132(December): 1667-1677.

Shepherd DH (2004). 2003 Iowa Behavioral risk factor surveillance system-Oral Health. Retrieved online 11/05

Shwartz M, Grondahl HG, Pliskin JS, Boffa J (1984). A longitudinal analysis from bite-wing radiographs of the rate of progression of approximal carious lesions through human dental enamel. Arch Oral Biol. 29(7): 529-536.

Sidhu S, Schmalz G . The biocompatibility of glass-ionomer cement materials. A status report for the American Journal of Dentistry. Am J Dent 14: 387-396.

Simecek J, Diefenderfer KE, Ahlf RL, Ragain JC (2005). Dental sealant longevity in a cohort of young U.S. naval personnel. JADA 136(February): 171-178.

Simonsen RJ (2002). Pit and fissure sealant: review of the literature. Pediatric Dentistry 24(5): 393-414.

Strother J, Kohn DH, et al. (1998). Fluoride release and re-uptake in direct tooth colored restorative materials. Dental Materials 14: 129-136.

Summitt J, Robbins JW, Schwartz RS (2001). Fundamentals of Operative Dentistry A Contemporary Approach. Carol Stream, Illinois, Quintessence Publishing Co,Inc.

Summitt JB (2002). Conservative cavity preparations. Dent Clin N AM 46: 171-184.

Sundberg H, Mejare I, Espelid I, Tveit AB (2000). Swedish dentist' decisions on preparation techniques and restorative materials. Acta Odontol Scand 58: 135-141.

Sutherland SE (2001). Evidence-based Dentistry: part IV. Research design and levels of evidence. Journal of the Canadian Dental Association 67(7): 375-378.

Sweet M, Damiano P, Rivera E, Kuthy R, Heller K (2005). A comparison of dental services received by Medicaid and privately insured adult populations. Journal of American Dental Association 136(January): 93-100.

Swift E, Schulein TM, Reinhardt JW (1990). Use of glass ionomer cements by Iowa dentists. General Dentistry: 450-453.

Taifour D, Frencken JE, Beiruti N, van't Hof MA, Truin GJ, van Palenstein Helderman WH. (2003). Comparison between restorations in the permanent dentition produced by hand and rotary instrumentation-survival after 3 years. Community Dentistry & Oral Epidemiology 31(2) 122-8. 31(2): 122-128.

Thibodeau E, O'Sullivan DM (1999). Salivary mutans streptococci and caries development in the primary and mixed dentitions of children. Community Dent Oral Epidemiol 27: 406-12.

Thylstrup A, Fejerskov O (1999). Textbook of clinical cariology. Tests for assessment of caries risk, Munksgaard.

Tomar SL (2004). Assessment of the dental public health infrastructure in the United States. retrieved from www.nidcr.nih.gov assessed 5.17.06.

Traebert J, Marcenes W, Kreutz JV, Oliveira R, Piazza CH, Peres MA (2005). Brazilian dentists' restorative treatment decisions. Oral Health & Preventive Dentistry 3(1): 53-60.

Tubert-Jeannin S, Domejean-Orliaguet S, Riordan PJ, Espelid I, Tveit AB (2004). Restorative treatment strategies reported by French university teachers. Journal of Dental Education 68(10): 1096-1103.

Tyas M, Anusavice KJ , Frencken JE , Mount G (2000). Minimal intervention dentistry-a review* FDI Commission Project 1-97. International Dental Journal 50(1).

United States Navy Medical Department Officer Career Guide (1991).

United States Public Health Service Commissioned Corps (2005). Dentists. www.usphs.gov accessed 9/15/05.

United States Public Health Service Commissioned Corps (2006). Grades, titles, and billets. www.usphs.gov accessed 5.17.06.

van der Sanden W, Mettes DG, Plasschaert AJM, van't Hof MA, Grol RPTM, Verdonschot EH (2003). Clinical practice guidelines in dentistry: opinions of dental practitioners on their contribution to the quality of dental care. Qual Saf Health Care 12: 107-111.

Vehkalhti M, Widstrom E (2004). Teaching received in caries prevention and perceived need for best practice guidelines among recent graduates in Finland. Eur J Dent Educ 8: 7-11.

Walton S, Byck GR, Cooksey JA, Kaste LM (2004). Assessing differences in hours worked between male and female dentists An analysis of cross-sectional national survey data from 1979-1999. Journal of American Dental Association 135(May): 637-645.

Warren J, Hand JS, Levy SM, Kirchner L (2000). Factors related to decisions to extract or retain at-risk teeth. Journal of Public Health Dentistry 60(1): 39-42.

Warren J, Levy SM, Wefel JS (2003). Explorer probing of root caries lesions: an in vitro stud. Spec Care Dentist 23(1): 18-21.

Weaver R, Ramanna S, Haden K, Valachovic RW (2005). U.S. dental school applicants and enrollees: 2003 and 2004. Journal of Dental Education 69(9): 1064-1072.

Weaver R, Chmar JE, Haden NK, Valachovic RW (2005). Annual ADEA survey of dental school seniors: 2004 graduating class. Journal of Dental Education 69(5): 595-619.

Webb J, von Gonten AS, Luciano WJ (2003). Providing care for America's Army. Journal of the American College of Dentists 70(2): 8-11.

Weintraub JA (2001). Pit and fissure sealants in high-caries-risk individuals. Journal of Dental Education 65(10): 1084-1090.

White J, Eakle S (2000). Rationale and treatment approach in minimally invasive dentistry. Journal of American Dental Association 131(June): 13S-19S.

Williams L, McGinley J (2001). Oral health is within REACH. Navy Medicine(March-April).

Williams A, Bower EJ, Newton JT (2004). Research in primary dental care Part 4: measures. British Dental Journal 196(12): 739-746.

Wilson A, Kent BE (1972). A new translucent cement for dentistry. The glass ionomer cement. British Dental Journal 132: 133-135.

Winston A, Bhaskar SN (1998). Caries prevention in the 21st century. Journal of the American Dental Association 129: 1579-1587.

Woofter D, Peters A, Kvaska G, Turner CI, Peters RJ, Shaffer RG, Sobocinski AB (2003). Navy Dental Corps: ninety years... and forward. Journal of the American College of Dentists 70(2):12-15.

York A, Mongeau SW, Moss DL (2004). Dental treatment needs of active duty military personnel 1994 and 2003. Tri-Service Center for Oral Health Studies.

Zanata R, Navarro MFL, Barbosa SH, Lauris JRP, Franco EB (2003). Clinical evaluation of three restorative materials applied in a minimal intervention caries treatment approach. Journal of Public Health Dentistry 63(4): 221-226.