Editorial

Who Will Teach the Next Generation of Dental Hygienists?

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One of my greatest professional mentors is retiring in September. Mary George, RDH, MEd has been in dental hygiene academia since the late 1960s. She developed the current graduate program in dental hygiene for which I am the director. What an impact she made on my life and continues to do so today.

When I graduated from high school, I was educated as a dental assistant and then worked at the University of North Carolina (UNC) School of Dentistry for one year. During that year, I spoke with Mary George who was the current director of the Dental Auxiliary Teacher Education (D.A.T.E.) program. I told her of my interest in teaching but that I was torn between teaching dental assisting or dental hygiene. I thought that I might want to pursue dental hygiene and then teach. She was patient, reassuring and encouraging. She had just the qualities I wanted to have one day. During dental hygiene school, Mary visited our school because one of her students was a teaching intern and Mary was there to observe. Again, I told her that I, too, wanted to be a teacher one day. Her students were fantastic, and I wanted to be like them! Several years later and several degrees later, I had the opportunity to return to UNC for a full time teaching position. My position was divided into thirds and one third of my time was with Mary, teaching in the D.A.T.E. program. I loved teaching with her and the other faculty in the program. We had a faculty of 5 and we were a

real team! Academia was fun and stimulating and I looked forward to going to work! I remember one time when the faculty met at my house and we developed an entire curriculum in one afternoon. We were innovative, energetic and free to speak our minds, and extremely supportive of each other!

Mary was able to promote that kind of creativity in others. She has mentored numerous dental hygiene faculty and leaders throughout her time at UNC. She will be greatly missed, not only at UNC, but throughout dental hygiene education. But I am grateful to have had her for my mentor. I will carry those memories and, hopefully, her philosophy throughout my career!

All of this has led me to wonder who will teach the next generation of dental hygienists? I certainly have educated many wonderful dental hygienists who are contributing to academia and have successful careers. But will we be able to guide a sufficient number of dental hygienists into academia who will love their jobs and stay in the field? Certainly the growth for the dental hygiene profession is huge. The growth rate is predicted to be about 36% until 2018.[1] A 2009 ADEA publication stated that 131 new dental hygiene programs have received accreditation since 1990![2] However, many dental hygiene programs have difficulty attracting qualified faculty to their institutions. A 2004 publication reported that 36% of dental hygiene programs had vacancies for full time faculty.[3] I can only imagine what the numbers are now since so many new programs have opened. We also lack diversity in dental hygiene education. We desperately need more African American/Black educators, Hispanic educators and other underrepresented minorities. And, as of 2009, only 28.2% of full time dental hygiene faculty have a master's degree and only 2.7 % a doctoral degree. Twenty two percent have a DDS/DMD degree.[4] That means that the vast majority of full time dental hygiene educators do not have an advanced degree. What does this mean for the future? I wish I had the answers.

What I do know is that we need to strongly encourage qualified, enthusiastic dental hygienists to pursue advanced degrees to enter academia. With the future changes projected in the dental hygiene profession, we need academicians who can be creative, dedicated and excellent teachers. We need dental hygiene leaders who have vision

and who can facilitate growth in others. We need dental hygiene academicians who lead by example and promote the highest quality of skill, professionalism and ethical standards. We need more faculty like Mary!

Sincerely,
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Legislative Initiatives of the Developing Advanced Dental Hygiene Practitioner

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Abstract

Purpose: Today there is a heightened awareness to address access issues and unmet oral needs. The current private practice system of delivering oral health care is failing many Americans. Healthcare advocates and policy makers are taking a greater interest in addressing access problems and have begun to explore new approaches to eliminate oral health care disparities. One solution is the introduction of a new member of the dental team, which is creating a power paradigm shift within the dental profession. As the Advanced Dental Hygiene Practitioner (ADHP) becomes a reality it will be necessary to advocate for change in state dental practice acts to allow this new provider access to populations that are currently unserved or underserved. The National Call to Action to Promote Oral Health report that was published in 2003 called for flexibility in licensure laws that would permit alternative models of delivery of oral healthcare services to vulnerable populations. The American Dental Hygienists' Association responded to the Call to Action by proposing a mid–level provider, the ADHP. Six years later extensive work has led to curricula and one program that accepted applicants for the fall of 2009. This short report will outline steps necessary for changing the practice act along with an example of one state's experience at planning and implementing creative solutions to increase access and eliminate disparities in oral healthcare in a socially responsible and cost–effective approach.

Keywords: Advocacy, Advanced Dental Hygiene Practitioner, Dental Practice Acts, Healthcare Policy, Statutory Law

This study supports the NDHRA priority area, Health Services Research: Evaluate strategies that position and gain recognition of dental hygienists as a primary care providers in the health care delivery system; Identify how public policies impact the delivery, utilization, and access to oral health care services.

Introduction

The National Call to Action to Promote Oral Health was published in 2003 by the U.S Department of Health and Human Services. The National Call identified the need for an enhanced oral health workforce, and in response the American Dental Hygienists' Association (ADHA) proposed the Advanced Dental Hygiene Practitioner (ADHP).[1,2] An extensive process involving many stakeholders worked on the development and validation of competencies for the ADHP. The resulting document, which includes the background and justification for the ADHP mid–level provider, can be found on the ADHA website (http://www.adha.org/adhp/index.html). With the competencies and curriculum developed, it was time to focus energy on implementing legislative initiatives that would allow the ADHP entry into the oral health workforce.

Under Action 4 of the National Call to Action's report, (Increase Oral Health Workforce Diversity, Capacity and Flexibility), there is a call for more flexibility in the licensure laws for dental professionals. The report makes the case for increased flexibility in state practice acts that would permit alternative models of delivery to increase access to care and promote oral health in underserved and unserved populations. This paper will describe the fundamentals of the legislative process as it relates to licensure of oral health care providers. An example of how one state has progressed toward making their state practice act more flexible will be provided. Recommendations for how to proceed in other states can be found at the end of this paper.

Legislative Process

State practice acts and licensure are regulated within the legislative branch of law (the 3 branches being executive, legislative and judicial). The overarching purpose of licensure is the protection of the public. Dental hygiene practice acts are statutory law, passed by the respective state legislatures. These statutory laws outline such areas as the allowable scope of practice, requirements necessary to obtain a dental hygiene license and dental supervision requirements. Statutory law can only be changed by

the state legislature.

The state legislative process generally includes 2 legislative bodies, the Senate and the House of Representatives. In order to make any statutory changes, it is necessary for a concept (bill) to become a law. Both houses (Senate and House of Representatives) must pass a bill after it has spent time in specific committees, which may amend or make changes to each respective bill. It is not unusual for a bill to "die" in committee only to have the most vital ideas added to a totally different bill. This process functions as a political compromise between legislators. If both houses fail to pass a bill, the bill will not become a law. If both houses pass the bill, it is necessary for the governor to sign it into law, or if the governor vetoes the bill, both houses have the ability override the veto by a two–thirds majority vote.

When state lawmakers enact legislation, the details of implementation are often left to state agencies. A mechanism commonly used to implement legislation is rulemaking. A rule is a statement of general applicability that implements and interprets law or defines the practice and procedure requirements of an agency of a state government. In other words, rulemaking is lawmaking in areas which the legislature has decided are too specific or too detailed to be handled by legislation, such as dentistry and dental hygiene. The legislature therefore delegates its lawmaking power to an agency (such as state dental boards) by passing a law granting rulemaking authority to the agency to adopt rules pursuant to the approved legislation. In dentistry and dental hygiene, these state agencies are generally appointed by the governor. State dental boards (executive branch) are responsible to the legislature to regulate the practice of dentistry and dental hygiene in their respective states. Some of the functions carried out by state dental boards generally include:

- Determination of the qualifications of applicants for licensure to practice
- Issue of licenses to those persons who meet the standards of professional competences set forth in the statues
- Maintaining high standards of professional competence and ethical conduct among members of the profession through the requirement of continuing education for licensure

The rule–making process is ongoing, and state dental boards may promulgate rules at any time, provided they follow the provision of the law or statute. A rule can be changed by the board or by a person petitioning the board to promulgate, amend or repeal a rule. Clearly, it is in the best interest of dental hygiene to work toward legislative changes in the practice act passed by state legislators that result in statutory law, rather than a rule or regulation that has the potential to be changed by a dental board which may or may not be representative of the profession of dental hygiene.[3]

While efforts to legislate an increased scope of practice for dental hygienists as ADHPs sounds relatively simple in theory, in practice it is quite complex. In the United States, individual states have differing requirements for licensure to practice, and not all states offer reciprocity of licensure (which means if a dental hygienist is licensed in one state another state will recognize that license and grant the dental hygienist licensure in their state). This system of licensure is possible because the U.S. Constitution reserves many rights to the states, and regulation of occupational licenses is deemed to be a state's right. This constitution law was observed as early as 1898 when a U.S. Supreme Court decision authorized states to set their own requirements for licensure of physicians.[4] This decision still serves today as the basis for supporting state over federal regulations in health care licensure, including dental hygiene. The prospect of 50 different licensing bodies (in 50 U.S states) agreeing to mutual licensure recognition is highly unlikely. This is why it is important as a licensed dental hygiene practitioner to understand how the legislative process works in your individual states when advocating and lobbying for a workforce change, such as the ADHP. A recent effort by one state to address Action 4 of the National Call to Action Report (Increase Oral Health Workforce Diversity, Capacity and Flexibility) is instructive for dental hygienists across the country.

Case Report: The Minnesota Story

The political culture in Minnesota has historically valued the concept that government exists to achieve goals that are in the public's best interest.[5] The government is given a broad role in permitting legislators to initiate new programs as long as they can be justified as being beneficial to all Minnesotans.

In 1969, Minnesota became the first state to establish and implement a continuing education requirement for relicensure of dentists and dental hygienists.[6] In 2001, the Minnesota Legislature brought forth statutory language and passed the "Limited Authorization for Dental Hygienists." This legislation, commonly referred to as the "collaborative agreement" language, authorizes dental hygienists to serve as "gateways" to oral health promotion and primary preventive oral health services in a health care facility, program or nonprofit organization utilizing a collaborative agreement with a Minnesota licensed dentist. In 2007, the Minnesota legislature embarked on addressing oral health workforce issues through the creation of a new mid–level practitioner.

A partnership was formed in late 2005 between Metropolitan State University and Normandale Community College allowing these institutions to take a pivotal leadership role in advancing the concept of a new practitioner model in dental care. For the majority of 2006, these partners collaborated in the completion of a lengthy Minnesota State Colleges and Universities new program application, which received final approval in November 2007. The new programs were a baccalaureate

degree completion program, a post–baccalaureate certificate program and an oral health care practitioner master's of science (to be credentialed as an ADHP). During the application process, letters of support had to be solicited indicating the need for the development of these new programs. Advocacy efforts during 2006 paved the way for building valuable, sustaining relationships with influential community leaders and organizations. The one common theme voiced by the community partners was that the current workforce simply cannot meet the oral health needs of Minnesotans, especially the young and old. The ADHP was seen as one solution to increase access to oral health care to address unserved and underserved vulnerable populations.

During the 2007 legislative session, it was determined that one strategic initiative was needed to educate not only legislators and the public at large but dental hygienists and dentists on how a new approach was needed to provide additional, affordable, sustained access to the oral health care system. Before any legislative and public policy changes could be planned, dental health care professionals needed to become engaged and learn about the problems unserved and underserved vulnerable populations face on a daily basis.

Informal legislative visits with House and Senate members resulted in potential authors for future legislation as well as advice and direction. However, the consistent message was the need for the Minnesota Dental Hygienists' Association (MnDHA) to continue discussion with the Minnesota Dental Association to avoid a controversial turf battle.

At the conclusion of the 2007 legislative session, a legislative commission on health care access reform was formed to make recommendations to the 2008 legislature on steps needed to achieve the goal of universal oral health care coverage for all of Minnesota. Over the next 6 months, different subcommittees held open forums and hearings to address health care access. Two different subcommittees addressed workforce issues, and the MnDHA was able to provide testimony regarding the ADHP. The final report was submitted to the legislature on January 15, 2008, and included a recommendation to explore a new dental mid–level practitioner during the 2008 legislative session.

A most critical advocacy relationship transpired about this time between the MnDHA and the Minnesota Health Care Safety Net Coalition (SNC) under the leadership of Halleland Consulting, a law firm with health care as one of their identified practice areas. The SNC policy activities included developing a legislative agenda and strategy, building relationships with policymakers, collecting data and preparing reports, preparing legislative handouts and lobbying and activating SNC member involvement. One of the SNC recommendations was to support the creation of an ADHP to partially address the shortage of dentists willing to serve low–income and disadvantaged patients. In late 2007, an invitation was extended to the MnDHA to have a member serve on the SNC Oral Health Committee.

The formation of a strong strategic alliance between the Minnesota Health Care SNC, the MnDHA and the Minnesota State Colleges and Universities resulted in legislation moving forward without challenges from the opposition. Midway through the legislative session, as pressure on legislators to address dental care access mounted, a shift occurred when the University of Minnesota School of Dentistry, announced that the university would create a new member of the dental team. This member would practice within the traditional dental team and would not build upon the competencies of a licensed dental hygienist in the collaborative practice model. As a result there was a name change from Advanced Dental Hygiene Practitioner to an Oral Health Practitioner (OHP) to encompass both the School of Dentistry and the Minnesota State Colleges and Universities proposed models.

Amid controversy, the 2008 Minnesota Legislature passed legislation establishing a new oral health practitioner discipline, which would be licensed by the Board of Dentistry, and practice under a collaborative management agreement with a dentist.[7] The legislation also created a work group to advise the Commissioner of Health on recommendations and legislation to specify the training and practice details for an OHP. The Minnesota Department of Health's Office of Rural Health & Primary Care convened and hosted the 13 member work group which met 8 times and completed its work by December 15, 2008. The work group process did not result in consensus on all issues and a minority report was filed. The Commissioner of Health and the Board of Dentistry submitted the work group's recommendations and proposed legislation to the Legislature on January 15, 2009. The final report and proposed legislation for 2009 can be found at the Minnesota Department of Health website (http://www.health.state.mn.us/healthreform/oralhealth/index.html).

As the 2009 legislative session began, the proponents of the OHP final report once again began in earnest its lobbying and advocacy efforts. They determined resistance to specific elements of the work group's recommendations that most significantly extend access to oral health care to Minnesotans who are uninsured and underserved (i.e., general supervision and some scope of practice duties). In spite of opposition by certain entities, the Metropolitan State University's program prepared to admit its first cohort of dental hygiene students in the fall of 2009, when the legislative outcome was still pending. MnDHA held numerous strategic planning meetings to work on legislative handouts, mobilize dental hygienists, schedule listening sessions, and finalize an agenda for Day at the Capitol and other lobbying and advocacy efforts. A final compromise once again resulted in a name change from an Oral Health Practitioner to a Dental Therapist, both at a basic and advanced level. On May 13, 2009,

Minnesota Governor Tim Pawlenty signed into law Senate Bill 2083 establishing the Dental Therapist and the Advanced Dental Therapist.

Discussion

The political development of the MnDHA has strengthened the organization's ability of its members to influence public policy. As we are learning in Minnesota, a strong professional organization can be a powerful force with the Legislature, but we can not succeed without the support of other stakeholders. Due to the commitment and support MnDHA has received from joining forces with the SNC and Minnesota State Colleges and Universities, this collaborative network will continue to advocate as a unified voice on behalf of the uninsured and underinsured individuals to ensure access to oral health care through the OHP legislation and other health care policy changes initiated during the 2009 legislative session. To move new oral workforce models forward, the proponents pledge to stand firm to their convictions, maintain integrity and remain flexible, open and ready for the unknown.

Table I: Recommendation for states to create flexible practice acts

Recommendations
• Know your state practice acts and stay involved with state legislators • Stay informed about oral health care needs in your state • Work with individuals and organizations that can advocate for change in oral health care workforce models, e.g., ADHP • Remain focused on access and the underserved, not the providers • Stay grounded in facts, research, and proven experience

Conclusion

This review of the legislative process, along with a "real life" example, should provide direction for dental hygienists across the country to advocate for increased access to oral health care through more flexible licensure laws. Advocacy is a calling and it takes active involvement on behalf of people. Health care policy is the nexus for change and feeling empowered to act is critical for advocacy success. The end point of advocacy is the health and welfare of the public.[8]

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Literature Review

The Dental Water Jet: A Historical Review of the Literature

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Abstract

Purpose: The objective of this paper is to provide a broad overview of the predominant findings from research published on pulsating dental water jets over the last 45 years.

Method: The author performed a computerized MEDLINE search covering the years from 1962 to 2009, with 1962 chosen since it was the year the first dental water jet was introduced. Key words included "oral irrigator" and "oral irrigation." All past and current studies were reviewed and those that reflected original research were included. The article is not intended to provide an exhaustive detailed article review, but rather a broad review of predominant findings on currently available traditional pulsating dental water jets with no novelty features. The author makes no attempt to statistically analyze any of the data. Information reported in the article comes from the original investigator analysis and interpretation.

Results: The dental water jet is supported by a well–established body of evidence demonstrating the ability to remove plaque, reduce periodontal pathogens, gingivitis, bleeding and inflammatory mediators.

Conclusion: The dental water jet is a viable tool for reducing bleeding and gingivitis in a wide variety of patients. Due to the extensive body of knowledge on this product, a meta–analysis or systematic review is warranted. Additional research is recommended to confirm plaque biofilm removal, its effectiveness in comparison to flossing and efficacy on patients with special oral or systemic health needs.

Key Words: bacteremia, dental water jet, depth of delivery, inflammatory mediators, pulsation, pressure, oral irrigation

This study supports the NDHRA priority area, Clinical Dental Hygiene Care: Investigate how dental hygienists use emerging science to reduce risk in susceptible patients (risk reduction strategies).

Introduction

Since its debut in the 1960s, the dental water jet has been studied in numerous clinical trials. Consistent positive outcomes focus on the reduction of bleeding and gingivitis.[1–23] Patients with varying needs, from those in periodontal maintenance[9,11–14,17,19] or orthodontic appliances,[6,16,23,24] to people with diabetes,[20] implants,[18] crowns and bridges[1] and non–compliance with floss have been shown to benefit.[22,23] This is different from a toothbrush or dental floss where efficacy is generally measured by supragingival plaque removal.[25]

Mechanism of Action

Pulsation and Pressure

The physical action of the dental water jet centers on 2 critical components – pulsation and pressure. This combination provides for phases of compression and decompression of the tissue to help expel subgingival bacteria and other debris, as well as stimulate gingival tissue.[26–28] Studies have shown that a pulsating device was 3 times more effective than a continuous stream device.[26,27]

Pulsation allows for the regulation of pressure. Bhaskar et al showed that attached gingiva can withstand high amounts of pressure – up to 160 psi for up to 30 seconds without producing irreversible damage.[26] Moveable tissue is more vulnerable. From this, the researchers concluded that up to 90 psi was acceptable on undamaged oral tissue while 50 to 70 psi was recommended for inflamed or ulcerated tissue.[26] Selting et al found that efficacy was similar between medium and high pressure settings, but at lower settings it was 50% less efficient.[27]

Depth of Delivery

Water (or other solutions) delivered by a dental water jet create the process of subgingival irrigation. Water contacting with the embrasure area creates 2 zones of hydrokinetic activity. One is the impact zone, where the solution makes initial contact in the mouth. The second is the flushing zone, where the water widens out in concentric circles penetrating subgingivally.[29]

The most common tip used on a dental water jet is the standard jet tip (Figure 1). Studies have found that using the jet tip results in penetration of approximately 50% of the pocket depth. Depth of penetration may differ depending upon pocket depth and tip placement (Table 1).[30,31] There are a variety of subgingival tips available, but only one soft, conical, latex–free tip (Pik Pocket™ Subgingival Irrigation Tip, Water Pik, Inc, Fort Collins,

Table 1: Depth of Penetration with a Standard Jet[30]

Tip Placement	90 degree application		45 degree application	
Pocket Depth	Mean Percent Pocket Penetration	Incidence of 75% Pocket Penetration	Mean Percent Pocket Penetration	Incidence of 75% Pocket Penetration
0– 3 mm	71%	42.9%	54%	30.8%
4–7 mm	44%	25%	46%	29.9%
>7 mm	68%	60%	58%	34.4%

Colo.) has been scientifically evaluated (Figure 2). In pockets up to 6 mm in depth, penetration was 90% of pocket depth. In pockets 7 mm or greater, penetration was 64%. In comparison, rinsing penetrated 21% of the pocket depth.[32]

Solutions

Practitioners often view the dental water jet as a delivery device for antimicrobial solutions. Because the bulk of the research supports efficacy with plain water, it is more likely that efficacy is related to the mechanism of action versus the type of agent used. Adding an antimicrobial agent does have the potential to increase efficacy.[8–12,14,15,17,21] Flemmig et al compared manual tooth brushing plus either a dental water jet with 0.06% chlorhexidine or a dental water jet with water or 0.12% chlorhexidine rinsing (all used once daily) to tooth brushing alone. The results showed that the dental water jet with chlorhexidine provided the best results for reducing plaque, bleeding and gingivitis. However, the dental water jet with water was better than chlorhexidine rinsing at reducing marginal bleeding (39.6% versus 26.4%) and bleeding on probing (24% versus 15%).[10]

Clinical Measures

One of the earliest studies on the dental water jet, conducted in 1969, found it had the ability to significantly reduce calculus and gingivitis (50% and 52%, respectively) without causing injury in uninstructed users.[3] Over the years, numerous studies confirmed that the dental water jet provided significant benefits in the reduction of bleeding and gingivitis[1,2,4–23] (Table 2).

Figure 1: Subgingival penetration with a standard jet tip

Figure 2: Subgingival delivery with a soft, site specific subgingival tip

Early work looked at plaque removal and focused on the dental water jet as a monotherapy rather than an adjunct to tooth brushing. These studies found a limited effect on supragingival plaque.[33,34] In contrast, numerous studies that have utilized methodologies with the dental water jet as an adjunct to tooth brushing sometimes found significant reductions in plaque.[1,6,19,20,22] At minimum, the data often showed plaque reductions from baseline, though not necessarily better than tooth brushing alone.[3,4,10,13]

A 2009 study conducted by Gorur et al demonstrated that a dental water jet removes plaque biofilm. A total of 8 extracted teeth from a subject with advanced aggressive periodontitis were sliced and treated with ex–vivo salivary biofilm or served as untreated controls. Of those, 4 slices were treated for 3 seconds with the standard jet tip and 4 with the orthodontic tip. The unit was on a medium pressure setting (70 psi). When examined under the scanning electron microscope, it was shown that both the jet tip and orthodontic tip removed extensive biofilm, 99.9% and 99.8%, respectively, compared to untreated specimens. Biofilm removal was observed at both the crown surface and below the cemento–enamel junction.[35]

Infection

The primary physical action from a dental water jet has been shown to occur subgingivally.[8,9,11,14,15,30–33,36–38] Cobb et al compared test specimens from irrigated and non–irrigated extracted teeth that received no dental instrumentation for a minimum of 6 months. Upon examination with a scanning electron microscope, irrigated areas exhibited fewer microorganisms than the test groups in zones up to 6 mm. Additionally, non–irrigated areas contained plaque meshed in a fibrin–like material, whereas in irrigated specimens there was none or only a light fibrin–like network present.[26] Other researchers have also found bacterial reductions,[8,11,14,15,27,28] with Drisko et al showing the dental water jet disrupted spirochetes up to 6 mm.[27] Chaves et al found that the dental water jet with either water

or 0.04% chlorhexidine reduced subgingival pathogens, while 0.12% chlorhexidine rinsing or tooth brushing alone could not.[15]

Inflammation

Multiple studies have observed that adding a dental water jet to tooth brushing increases the reduction of bleeding and gingivitis over tooth brushing alone.[1–23] Because these improvements were not always accompanied by enhanced plaque reduction, researchers began to speculate that other mechanisms related to inflammation were involved.[11,13,15] In 2000, Cutler et al compared tooth brushing plus a dental water jet (with water only) to tooth brushing alone and found statistically significant improvements in traditional clinical measures as well as evidence of a "host modulation" effect. Samples of gingival crevicular fluid were taken 8 hours post–irrigation and analyzed for the presence of both pro– and anti–inflammatory mediators commonly associated with alveolar bone and attachment loss. The analysis revealed that in as little as 2 weeks, the dental water jet reduced the production of the destructive or pro–inflammatory mediators (IL–1β) while increasing 1 anti–inflammatory agent (IL–10) and stabilizing another known for its bactericidal capabilities (IFN–γ). Further scrutiny revealed that the reduction of bleeding on probing correlated to the reduction of one of the pro–inflammatory mediators, IL–1β, and not plaque reduction. The investigators concluded that the data supports the contention that oral irrigation is of clinical benefit due to a selective modulation of inflammatory mediators.[19] Two years later, a 3 month study on individuals with diabetes found similar host modulation outcomes as measured via blood serum.[20]

Patient–based Outcomes

It is well established that some patients are more susceptible to gingivitis and periodontal disease or have more difficult plaque–removal challenges. The dental water jet has been tested on numerous patient groups. These include those in periodontal maintenance[9,11–14,17,19] or who have orthodontic appliances,[6,16,23,24] implants,[18] crown and bridge,[1] diabetes[20] and non–compliance with flossing[22,23] (Table 3).

Diabetes

In a study of 52 subjects with either type 1 or type 2 diabetes, patients received scaling, root planing and self–care instructions for either routine oral hygiene (brushing and flossing, only if it was already a habit) or routine oral hygiene plus use of a dental water jet with the subgingival tip 2 times a day. At 3 months, the group using the dental water jet had better improvements in both oral and systemic health as measured by traditional clinical indices and serum pro–inflammatory mediator level. This included a 44% better reduction in bleeding, 41% better reduction in gingivitis and significant reductions in IL–1β and PGE2. Both groups had improvements in glycated hemoglobin (HbA1C), although there were no significant differences from

Table 2: Synopsis of Statistically Significant Re

Year	Primary Investigator	Subjects	Length	Agent(s)	Calcul
1969	Lobene[3]	184	12 wks	Water	Yes
1970	Hurst[24]	60	63 days	Water	NE
1971	Hoover[4]	48	3 mos	Water	Yes
1972	Lainson[5]	115	One year post 3 mos study	Water	No
1983	Phelps–Sandall[6]	21	6 wks	Water	NE
1989	Ciancio[8]	66	6 wks	Essential Oil Water	NE
1990	Newman[28]	222	6 mos	0.06% CHX+Water	NE
1990	Jolkovsky[9]	60	3 mos	0.04% CHX Water	NE
1990	Flemmig[10]	222	6 mos	0.06% CHX+Water	No No
1990	Brownstein[11]	44	60 days	0.06% CHX Water	NE
1992	Walsh[12]	16	56 days	0.02% CHX Water	NE
1994	Newman[13]	155	6 mos	Zinc sulphate Water	NE
1994	Fine[14]	50	6 wks	Essential Oil Water	NE
1994	Chaves[15]	125	6 mos	0.04% CHX Water	NE
1994	Burch[16]	47	2 mos	Water	NE
1995	Flemmig[17]	60	6 mos	Buffered 0.3% ASA++Water	NE
1997	Felo[18]	24	3 mos	0.12% CHX	Yes
2000	Cutler[19]	52	28 days	Water	NE
2002	Al–Mubarak[20]	52	3 mos	Water	NE
2003	Pistorius[21]	89	12 wks	Herbal§ CPC±	NE
2005	Barnes[22]	105	28 days	Water	NE
2007	Sharma[23]	105	28 days	Water	NE

*NE = Not evaluated in the study

+Chlorhexidine

++Acetylsalicylic acid

§ Herbal rinse contained: salvia officinalis, metha piperita, menthol, matrica

Echinacea purpurea diluted: 2.5 parts to 100 parts water

± Contains sodium benzoate, poloxamer 338, cetylpyridium chloride, and sodiu

ductions in Clinical Outcomes: 1969–2007

us	Plaque (Biofilm)	Gingivitis	Bleeding	Probing Depth	Bacteria	Inflammatory Mediators
	No	Yes	NE*	NE	NE	NE
	NE	NE	NE	NE	Yes	NE
	Yes	Yes	NE	NE	NE	NE
	NE	Yes	NE	No	NE	NE
	Yes	Yes	NE	NE	NE	NE
	Yes No	Yes Yes	Yes No	No No	Yes No	NE
	NE	NE	NE	NE	Yes No	NE
	Yes Yes	Yes Yes	NE	Yes Yes	Yes No	NE
	Yes No	Yes Yes	Yes Yes	Yes No	NE	NE
	Yes No	Yes No	Yes No	NE	Yes No	NE
	Yes No	NE	Yes No	Yes Yes	NE	NE
	No No	No Yes	Yes Yes	No Yes	NE	NE
	Yes No	Yes No	Yes No	No No	Yes Yes	NE
	Yes No	No No	Yes Yes	NE	Yes Yes	NE
	Yes	Yes	Yes	No	NE	NE
	No No	Yes Yes	No Yes	Yes Yes	NE	NE
	Yes	Yes	Yes	NE	NE	NE
	Yes	Yes	Yes	Yes	NE	Yes
	Yes	Yes	Yes	NE	NE	Yes
	No No	Yes Yes	Yes No	No No	NE	NE
	Yes	Yes	Yes	NE	NE	NE
	Yes	NE	Yes	NE	NE	NE

ia chamolilla, commiphora myrrha, carvum carvi, Eugenia caryophyllus, and

n fluoride diluted 2.5 parts to 100 parts water

baseline or between the groups.[20]

Implant/Crown and Bridge

The dental water jet with a subgingival tip used at low pressure has been tested on patients with implants and found safe and effective. Twenty–four subjects used either a dental water jet with half strength chlorhexidine (0.06%) or a full strength (0.12%) chlorhexidine rinse once daily. The group using the dental water jet had statistically greater reductions than the rinsing group for plaque, gingivitis and stain. The authors concluded a dental water jet is safe and effective for use on implants. They also speculated that irrigation was more effective than rinsing because irrigation allowed the chlorhexidine to penetrate deeper into the pocket, creating substantivity with the epithelium.[18]

In an early study that used a split mouth design, subjects undergoing periodontal therapy added a dental water jet to tooth brushing on the left side of the mouth only. When the sides were compared, the findings showed that using the dental water jet increased plaque removal and reduced gingivitis. The investigators also found that the subjects who had the best results had either fixed bridgework or crowns.[1]

Orthodontic Appliances

Multiple studies have evaluated the impact of a dental water jet on orthodontic appliances.[6,16,23,24] An early study by Hurst and Macedonia found that the addition of a dental water jet to tooth brushing was 80% more effective than tooth brushing and rinsing in reducing the total aerobic flora and 60% more effective in reducing the lactobacillus count in orthodontic patients.[24] A 2 month study by Burch et al found that adult orthodontic patients who added the dental water jet to either manual or a powered toothbrush had greater reductions in plaque, bleeding and gingivitis versus brushing alone.[16] A recent study of 105 adolescents ranging in age from 11 to 17 years compared a dental water jet with a tip designed specifically for orthodontic appliances plus manual tooth brushing to both manual tooth brushing plus floss via a floss threader and manual tooth brushing alone (Figure 3). The addition of the dental water jet and orthodontic tip (with water) was significantly more effective at plaque removal than brushing plus flossing with a floss threader or brushing alone, 3.76 and 5.83, respectively. The dental water jet also provided a significantly better reduction in bleeding – 84.5% from baseline. This was 26% better than the results achieved with dental floss.[23] Phelps–Sandall and Oxford evaluated the use of a dental water jet and sulcus brush on patients in maxillary fixation and found that using a dental water jet resulted in more plaque removal, less inflammation and less trauma.[6]

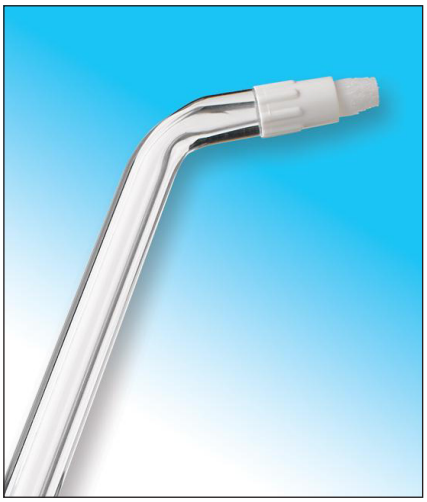
Periodontal maintenance

Newman et al conducted a 6 month, multi–center study with 155 subjects who had been treated for periodontal disease. All had at least 2 to 5 mm pockets with bleeding upon probing. The subjects who added a dental water jet (with water) to their daily routine had

Table 3: Patient Outcomes

Condition	Investigator/Year
Crown & Bridge[1]	Krajewski, 1964
Diabetes[20]	Al–Mubarak, 2002
Implants[18]	Felo, 1997
Orthodontic Appliances including Maxillary Fixation[6,16,23,24]	Hurst, 1970 Phelps–Sandall, 1983 Burch, 1994 Sharma, 2008
Periodontal Maintenance[9,11–14,17,19]	Brownstein, 1990 Jolkovsky, 1990 Walsh, 1992 Fine, 1994 Newman, 1994 Flemmig,1995 Cutler, 2000

Figure 3: Specialized orthodontic tip



significantly greater reductions in gingival inflammation, bleeding on probing and probing depth reduction as compared to the other groups.[13] Flemmig et al demonstrated similar reductions for gingivitis, bleeding on probing and probing depth in a group of 60 subjects in supportive periodontal therapy.[17] Likewise, studies that have employed scaling and root planing followed by use of a dental water jet with the subgingival tip have also found greater reductions in inflammation.[9,14]

Floss Alternative

A 28 day clinical trial with 105 subjects was conducted by Barnes et al to determine which oral health care routine was most effective: manual toothbrush and floss, manual toothbrush and a dental water jet or sonic powered toothbrush and a dental water jet. The results showed that, when combined with either a manual or a sonic toothbrush, the dental water jet was is as effective as a manual toothbrush and floss at removing plaque and significantly better at reducing bleeding and gingivitis. The group using the manual brush and dental water jet was nearly twice as effective at reducing bleeding as the manual brush and floss.[22] Likewise, Sharma et al found that adding a dental water jet with an orthodontic tip to manual brushing was more effective than the addition of floss with a floss threader or brushing alone for removing plaque and reducing bleeding.[23]

Safety

Tissue appearance

Krejewski et al obtained biopsied specimens from patients using a dental water jet. The specimens were microscopically evaluated and the irrigated tissue was found to have less inflammation, better connective tissue organization and greater keratin layer thickness in irrigated tissue compared to non–irrigated areas.[1] In 1970, Cantor found a decrease in inflammation in central col depressions following the use of a dental water jet, but no increase in keratinization.[2] In 1988, Cobb et al compared irrigated and non–irrigated tissue under a scanning electron microscope and found no observable differences in relationship to epithelial topography, cavitations, microulcerations, spatial relationships and individual cell appearance.[36]

Bacteria

In 1970, O'Leary et al used stained carbon particles in water in 3 different types of dental water jets and found penetration into epithelial tissue regardless of the type of unit or pressure used.[39] In 1978, Manhold conducted a similar experiment and also found some penetration by carbon particles after the use of a dental water jet. However, the investigators also found carbon penetration in areas that had not been irrigated, and noted that overall, any penetration in areas, irrigated or not, seemed random. They concluded that definitive conclusions were not possible, and the issue was likely more academic than practical.[40] Since that time, numerous studies have evaluated the subgingival bacteria population and consistently found reductions.[8,9,14,15,24,36–38]

Bacteremia

Most dental procedures and self–care devices are capable of causing a bacteremia, including the use of a dental water jet.[41–44] The bacteremia produced by a dental water jet is similar to tooth brushing and flossing (20% to 68%), wooden toothpicks (20% to 40%) and mastication (7% to 51%).[41] Bacteremia resulting from the use of a dental water jet has been shown to range from 7% for those with gingivitis to 50% for those with periodontal disease.[42,43] In a population of people with healthy tissue, those using a dental water jet had a bacteremia rate of 27%.[44] Both medium and maximum settings were used, and the difference in levels did not influence the rate of bacteremia. In contrast, Tamimi et al found no evi-

dence of bacteremia following the use of dental water jet in a group of subjects whose oral health status ranged from healthy gingiva to periodontal disease.[45]

Discussion

The dental water jet has been evaluated numerous times over the last 45 years. Clinical trials began in the late 1960s and continue today. The bulk were conducted from the mid 1980s through the late 1990s and produced a solid body of evidence demonstrating its safety and effectiveness at reducing gingivitis and bleeding.[8–18,30–32,36–38] More recent work, from 2000 onward, has focused on plaque biofilm removal[35] and benefits for specific patient needs, such as orthodontic appliances,[23] diabetes[20] and non–compliant flossers.[22,23]

While the results for bleeding and gingivitis reduction have been consistent over the years, findings regarding plaque biofilm removal have been mixed.[1,3,4,6,10,13,19,20,22,33,34] One early study that looked at plaque and concluded that the dental water jet "did not fulfill the requirement of an effective plaque control device" actually found that the dental water jet as a monotherapy did significantly reduce plaque and gingivitis over no oral hygiene. The reductions were greatest interproximally. However, the dental water jet did not enhance plaque removal when added to tooth brushing.[33] Several studies concur with this result.[3,4,10,13] More recent studies did find either enhanced plaque removal with the dental water jet when added to tooth brushing or equivalent removal compared to dental floss.[19,20,22] A 2009 laboratory study that used scanning electron microscopy found that teeth treated with a 3 second pulsating lavage had 99% plaque biofilm removal.[35]

Future research endeavors need to be undertaken to provide clarity on the issue of plaque biofilm removal. Emerging findings on biofilm may produce new evaluation tools as well as philosophies about the necessity of complete plaque biofilm removal. Another area of research that would merit from additional studies is the dental water jet as an effective alternative to flossing. Due to low rates of flossing, clinicians are in need of products they can confidently recommend as an evidence–based alternative. Given that the product already does have a large body of evidence, a systematic review would be beneficial to the clinician.

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Critical Issues in Dental Hygiene

The Role of Dental Hygiene in Caries Management: A New Paradigm

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Abstract

Purpose: Dental caries is the most common disease of children and remains a significant oral health problem worldwide for both children and adults. The traditional paradigm of treating dental caries solely by "drilling and filling," brushing and flossing and lowering sugar intake has evolved. Current science in the management of dental caries suggests a clear focus on the reduction of responsible infectious agents, remineralization of non–cavitated lesions and minimally invasive restorative approaches whenever possible. The paradigm shift is away from a purely surgical approach toward more preventive and curative clinical protocols. This paper provides a review of this caries management methodology and explores the role of the dental hygienist in this paradigm change.

Key words: caries balance, CAMBRA, remineralization, non–cavitated lesion, minimally invasive dentistry

This study supports the NDHRA priority area, Clinical Dental Hygiene Care: Assess how dental hygienists are using emerging science throughout the dental hygiene process of care; Investigate how dental hygienists use emerging science to reduce risk in susceptible patients (risk reduction strategies).

Historical Role of Dental Hygiene in Caries Management

The concept of prevention as the most ideal approach to caries reduction is not new to dental hygiene. It was this very idea that motivated Dr. Alfred Fones to create the school which graduated the first formally educated dental hygienists in 1914.[1] In addition to providing clinical instrumentation, the larger historical role of dental hygiene has been in helping to prevent dental disease through education. This has been accomplished primarily by an emphasis on removal of biofilm by mechanical means including brushing, flossing, tongue scraping and, in more recent years, chemotherapeutic modalities. Data has shown that these strategies are proven to be beneficial in patients with oral biofilm control problems.[6] However, the majority of adults do not follow an adequate home–care routine. Average brushing times are low, and only a minority of patients regularly floss.[2]

The advantages of topical fluoride in a variety of forms has been firmly established.[3] In 2001 the Center for Disease Control and Prevention (CDC) advised that it was beneficial for patients of all ages to drink water with optimal fluoride concentration and brush twice daily with a fluoridated toothpaste.[4] Since then, the CDC has reported that "nearly 70% of U.S. residents who get water from public water systems now have fluoridated water."[5] The percent of caries reduction from topical fluoride varies depending on when the study was conducted and the type and frequency of fluoride used.[6] A meta–analysis consisting of 8 studies using fluoride varnish conducted by Helfenstein demonstrated an overall reduction of 38% in dental caries.[7]

Regular fluoride application has been delivered in the dental office as a preventive measure or as additional therapy for higher risk patients. However, a survey of 498 dental hygienists in the United States in 2000 revealed that, although a majority of respondents recognized that adults, including a growing number of geriatric patients with patterns of root caries, could benefit from topical fluoride application, the dental hygienists were not consistently offering this treatment in their practices.[8] The degree to which the historically low rate of third party reimbursement for preventive services contributed to the findings of this survey was not explored.[9] Data regarding use of fluoride varnishes were not included in this survey.

Dental sealants, often placed by the dental hygienist, provide a clear benefit to prevention of occlusal carious lesions.[10] A recent report of the American Dental Association Council on Scientific Affairs noted that glass ionomer sealants are an option for consideration when isolation is

compromised.[11] To further improve the cost–benefit ratio of sealant treatment, the American Academy of Pediatric Dentistry has discussed a risk–based use of sealants. Despite the considerable benefits of sealants, the long–term success of sealant therapy is dependent upon consistent follow up and repair when necessary. One–time sealant placement does not impart long–term caries protection unless the sealant remains in place and intact.[12] Dental hygienists have played an important part in the ongoing assessment of sealant integrity by evaluation at regular dental hygiene re–care visits.

Figure 1: The Caries Imbalance

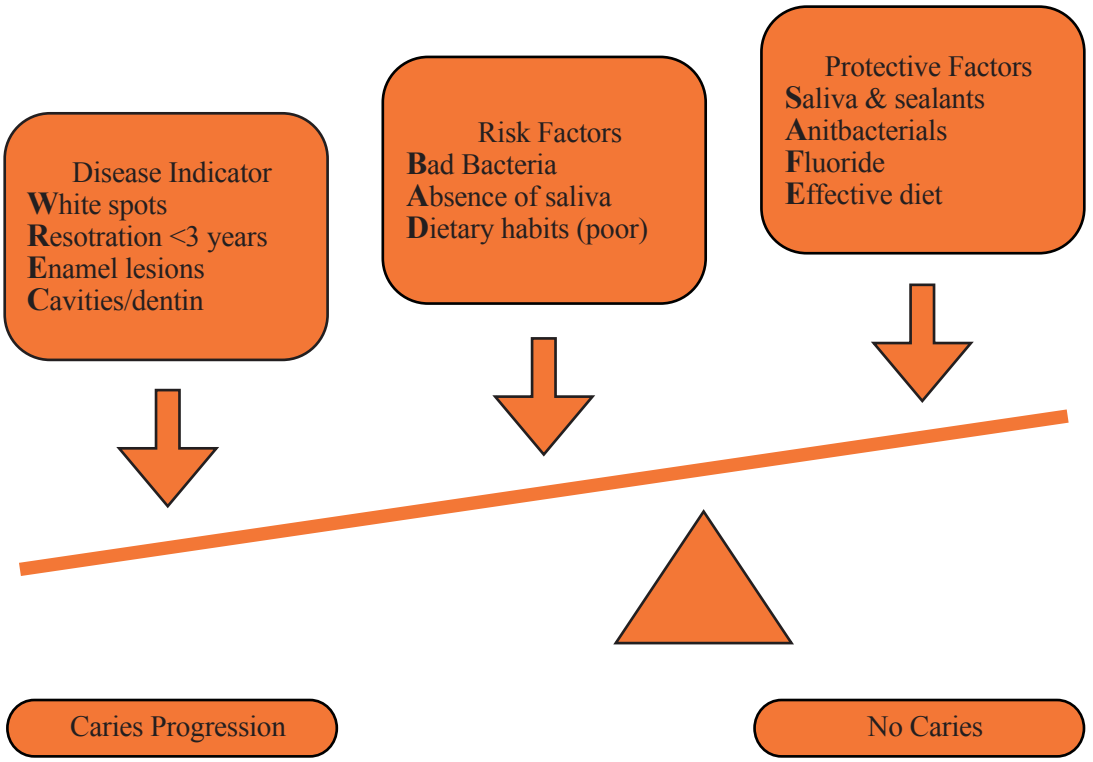


Figure 1 illustrates the caries "imbalance." The balance amongst disease indicators, risk factors and protective factors determines whether dental caries progresses, halts or reverses. Cavities/dentin refers to frank cavities or lesions to the dentin by radiograph. Restorations <3 years means restorations placed in the previous 3 years. This figure has been updated from previous version of the "caries balance" with the very important addition of the disease indicators. If these indicators are present they weigh heavily on the side of predicting caries progression unless therapeutic intervention is carried out. The leading letters that help to remember the imbalance (WREC, BAD, SAFE) have been added, as well as sealants as a protective factor. Dietary habits (poor) indicate frequent ingestion of fermentable carbohydrates (greater than 3 times daily between meals).

Given the fact that ingestion of sugars and other fermentable carbohydrates at high frequency plays a pivotal role in caries development, dental hygienists have utilized dietary counseling and home care instruction for many years with the hope of helping patients reduce or restrict related acid exposures. However, today's reality is that Americans are consuming sugars in record amounts. In 2007 the average American consumed 100.6 pounds of sugar per year, or 1.9 pounds per week.[13] Annual soft drink consumption in 2005 reached nearly 54 gallons per capita, or slightly more than 1 gallon per week per person, bringing with it a host of nutritional, as well as dental, concerns.[14,15] These trends were confirmed by a study comparing consumption of sugar sweetened beverages by adolescents via NHANES data during the years 1988 to 1994 and 1999 to 2004. This data confirmed that adolescents from the 1999 to 2004 study cohort consumed approximately 7% more sugar sweetened beverage serving equivalents per day.[16]

Although mechanical biofilm removal, fluoride, dental sealants and nutritional counseling have all been vitally important parts of disease prevention, they have not yielded the level of caries risk reduction that oral health care providers have been searching for on behalf of our patients. Current science suggests that there are updated treatment protocols based on the medical model of disease assessment and management, which can improve the oral health of patients.[17,18]

The Science and Implementation of Caries Management by Risk Assessment into Practice

The traditional method of treating dental caries was to restore resulting damage to tooth structure and return the dentition to proper form and function. In this model preventive measures often only included oral hygiene instruction and reminding the patient not to ingest refined sugar. Over the last 2 decades, science has revealed that the caries process and treatment is more complex than can be managed by this traditional model alone.

Caries management by risk assessment (CAMBRA) is an evidence–based approach to preventing, reversing and, when necessary, repairing early damage to teeth us-

ing minimally invasive restorative techniques.[19,20] In contrast to traditional management, this contemporary model places emphasis on the whole disease process, rather than just the cavitated stage of lesion progression. A number of organizations have developed protocols based on this assessment, diagnosis and treatment methodology. Among them are the American Dental Association,[21] the American Academy of Pediatric Dentists[22] and the California Dental Association (CDA),[17,23] which dedicated 4 complete journals to the subject. The first 2 issues of the CDA Journal, February and March 2003, summarized the current science of caries management. In October and November 2007, 2 additional issues were published, which focused on practical implementation of caries management by risk assessment. The CDA has generously made these journals available online (www.cdafoundation.org/journal). The October 2007 issue contains caries risk assessment forms for both the pediatric[17] and adult patients, protocols and product examples that can be downloaded for use in practice.[23] The November issue may be of particular interest to dental hygienists as it contains articles addressing the role of allied health professionals in implementation.[24,25] All 4 of these journal issues may be downloaded for additional CAMBRA information and to access forms, tables and figures for use in practice.

CAMBRA differs from the traditional restorative approach in treating dental decay by assessing each

Table 1: Caries Risk Assessment Form for Ages 6 Years Through Adult

Patient Name:_____ CHART #:_____ DATE:_____ Assessment Date: Is This (please circle) Baseline or Recall			
Disease Indicators (Any one YES signifies likely "High Risk" and to do a bacteria test)**	YES = CIRCLE	YES = CIRCLE	YES= CIRCLE
Cavities/radiograph to dentin	YES		
Approximal enamel lesions (E1, E2) (by radiograph)	YES		
White spots on smooth surfaces (Eo)	YES		
Restorations last 3 years	YES		
Risk Factors (Biological predisposing factors)		YES	
MS and LB both medium or high (by culture**)		YES	
Visible heavy plaque on teeth		YES	
Frequent snack (> 3x daily between meals)		YES	
Deep pits and fissures		YES	
Recreational drug use		YES	
Inadequate saliva flow by observation or measurement (**If measured note the flow rate below)		YES	
Saliva reducing factors (medications/radiation/systemic)		YES	
Exposed roots		YES	
Orthodontic appliances		YES	
Protective Factors			
Lives/work/school fluoridated community			YES
Fluoride toothpaste at least once daily			YES
Fluoride toothpaste at least 2x daily			YES
Fluoride mouthrinse (0.05% NaF) daily			YES
5000 ppm F fluoride toothpaste daily			YES
Fluoride varnish in last 6 months			YES
Office F topical in last 6 months			YES
Chlorhexidine prescribed/used 1 week each of last 6 months			YES
Xylitol gum/lozenges 4x daily last 6 months			YES
Calcium and phosphate paste during last 6 months			YES
Adequate saliva flow (> 1 ml/min stimulated)			YES
****Bacteria/Saliva Test Results: MS: LB: Flow Rate: ml/min. Date:**			
VISUALIZE CARIES BALANCE (Use circled indicators/factors above) (EXTREME RISK = HIGH RISK + SEVERE XEROSTOMIA) CARIES RISK ASSESSMENT (CIRCLE): EXTREME HIGH MODERATE LOW Doctor signature/#:_____ Date:_____			

patient for their unique individual risk factors, using the caries balance method first described by Featherstone.[26] Figure 1 illustrates the analogy of the "balance," where disease indicators and pathogenic factors of a patient are weighed against the competing protective factors. The dynamic interaction of these 2 sides of the balance determines risk for future disease. By evaluating the caries balance of a patient, a clinician can determine what behaviors are increasing a patient's risk for disease and take corrective action. This strategy lead to the development of an evidence–based questionnaire form to measure caries risk and to determine effective treatment options based on that risk (Table 1). Utilizing this new protocol, it has become possible to develop a treatment plan designed to reduce cavitation, arrest decay by stopping demineralization or reverse the caries process via remineralization.[27] The CAMBRA approach has proven successful in a recent blinded randomized clinical trial when compared to the traditional restorative approach.[28]

Table 2: Caries Management by Risk Assessment (CAMBRA) Cl

Risk Level ####***	Frequency of Radiographs	Frequency of Recall Exams	SalivaTest (Saliva Flow & BacterialCulture)	Antimicrobials C Xylitol
Low Risk	Bitewing radiographs every 24–36 months	Every 6–12 months to reevaluate caries risk.	May be done as a baseline reference for new patients	Per saliva test if c
Moderate Risk	Bitewing radiographs every 18–24 months	Every 4–6 months to reevaluate caries risk.	May be done as a baseline reference for new patients or if there is suspicion of high bacterial challenge and to assess efficacy and patient cooperation	Per saliva test if c (6–10 grams/day) candies. Two tabs two candies four
High Risk*	Bitewing radiographs every 6–18 months or until no cavitated lesions are evident.	Every 3–4 months to reevaluate caries risk and apply fluoride varnish.	Saliva flow test and Bacterial culture initially and at every caries recall appt. to assess efficacy and patient cooperation.	Chlorhexidine glu 10 ml rinse for or daily for one wee Xylitol (6–10 gra or candies. Two t two candies four
Extreme Risk** (High risk plus dry mouth)	Bitewing radiographs every 6 months or until no cavitated lesions are evident.	Every 3 months to reevaluate caries risk and apply fluoride varnish.	Saliva flow test and bacterial culture initially and at every caries recall appt. to assess efficacy and patient cooperation.	Chlorhexidine 0.1 CHX in water bas rinse for one minu one week each m (6–10 grams/day) candies. Two tabs candies four times

*Patients with one (or more) cavitated lesion(s) are high risk patients. ** Patients with one (or more) cavitated invasive philosophy in mind. Existing smooth surface lesions that do not penetrate the DEJ and are not cavita materials until caries progression is controlled. Patients with appliances (RPDs, Orthodontics) require excelle 3 mo. Where indicated, antimicrobial therapy to be done in conjunction with restorative work ### For all ris

How the Dental Hygienist May Implement CAMBRA

In this new paradigm of caries management, CAMBRA includes innovative procedures such as saliva assessment, bacterial culturing, a broader choice of therapeutic interventions and ongoing patient data collection (caries risk assessment) to properly diagnose and manage the disease of caries. These duties are best implemented utilizing a dental team approach.[24,25] A dental assistant trained in CAMBRA protocol may assist patients with the caries risk assessment form (Table 1), collect diagnostic data (including salivary testing) and provide initial patient education. The dental hygienist may play a key role in planning treatment recommendations based on the dental hygiene examination and data provided by CAMBRA diagnosis and assessment tools. As with all other areas of preventive care, dental hygienists should be actively involved in using the evidence gathered to determine an intervention plan including treatment and products unique to the patient's caries risk and caries balance, establishment of ongoing care frequency, reinforcement of at–home protocol implementation and treatment modifications based on future assessment or reevaluation.

An example of how an intervention plan may be developed based upon the caries risk of the patient was recently published by Jenson[4] and is summarized in Table 2. This table suggests how the appropriateness of different interventions such

inical Guidelines for Patients 6 years and Older

hlorhexidine	Fluoride	pH Control	Calcium Phosphate Topical Supplements	Sealants (Resin–based or Glass Ionomer)
lone	OTC fluoride–containing toothpaste twice daily. after breakfast and at bedtime. Optional: NaF varnish if excessive root exposure or sensitivity.	Not Required	Not Required Optional: for excessive root exposure. Or sensitivity	Optional
lone Xylitol gum or of gum or times daily	OTC fluoride–containing toothpaste twice daily plus: 0.05% NaF rinse daily. Initally,1–2 app of NaF varnish; 1 app at 4–6 month recall.	Not Required	Not Required Optional: for excessive root exposure or sensitivity	As per ICDAS Sealant Protocol
uconate 0.12% e minute k each month ms/day) gum abs of gum or times daily	1.1% NaF toothpaste twice daily instead of regular fluoride toothpaste. Initially, 1–3 app of NaF varnish; 1 app at 3–4 month recall.	Not Required	Optional Apply calcium/ phosphate paste several times daily	As per ICDAS Sealant Protocol
2% (preferably e rinse) 10 ml te daily for onth. Xylitol gum or of gum or two s daily	1.1% NaF toothpaste twice daily instead of regular fluoride toothpaste. Initally, 1–3 app. NaF varnish; 1 app at 3 month recall.	Acid neutralizing rinses as needed if mouth feels dry, after snacking, bedtime and after breakfast. Baking soda gum as needed	Required Apply calcium/ phosphate paste twice daily	As per ICDAS Sealant Protocol

esion(s) and severe xerostomia are extreme risk patient *** All restorative work to be done with the minimally ted should be treated chemically not surgically. For extreme risk patients use holding care with glass ionomer t oral hygiene together with intensive fluoride therapy. e.g. High fluoride toothpaste and fluoride varnish every k levels: Patients must maintain good oral hygiene and a diet low in frequency of fermentable carbohydrates.

as frequency of radiographs and periodic exams, saliva test, antibacterials, topical fluoride, pH control, calcium phosphate and sealants may vary depending on caries risk of the patient.

The following is a brief summary of some of products commonly used to intervene in the caries process:

- Topical fluoride: over–the–counter (OTC) and prescription high fluoride containing dentifrices such as Prevident (Colgate Oral Pharmaceuticals, New York, NY) or Control Rx (3M ESPE, St. Paul, MN), OTC 0.05% sodium fluoride rinses such as Act (ACT Products, Chattanooga, TN) or Fluorigard (Colgate Oral Pharmaceuticals, New York, NY), prescription 0.2% sodium fluoride rinses such as Oral–B Fluorinse (Procter & Gamble Company, Cincinnati, Ohio) and high concentration 5% sodium fluoride varnish such as Duraflor (A.R. Medicom Inc., Lachine, Québec) or Vanish (3M ESPE, St. Paul, MN)[29]
- Resin–based and Glass Ionomer Sealants:[11,18,30] Resin based materials are retained via a micro–mechanical bond. Glass Ionomer sealants utilize a chemical ion exchange bond and have fluoride releasing properties[31]
- Xylitol products such as chewing gum and mints have been shown to reduce dental caries[32] and the vertical transmission of caries pathogens from mother to child[33,34]
- Antibacterials may include agents such as chlorhexidine,[35,36] (Periogard, Colgate Oral Pharmaceuticals, New York, NY and Peridex, 3M ESPE, St. Paul, MN) or iodine such as Betadine (Purdue Products, Stamford, CT)[37]
- Calcium–phosphate based products may be used for sensitivity, remineralization and for patients with reduced salivary flow[38]
- pH neutralizing products, such as sodium bicarbonate rinses, CariFree rinses and neutralizing gel, Denclude desensitizing toothpaste (Colgate Oral Pharmaceuticals, New York, NY) and ProClude desensitizing prophylaxis paste (Colgate Oral Pharmaceuticals, New York, NY)may aid in combating acidity when salivary flow is reduced[39]
- Emerging products[39] such as casein phosphopeptide (CCP) and amorphous calcium phosphate (ACP) products (MI Paste, GC America, Inc. Alsip, IL) have been demonstrated to show delivery of calcium and phosphate to enamel surfaces[40] and amorphous, calcium sodium–phosphosilicate (NoveMin, NovaMin Technology Inc, Alachua, FL)[41,42] to aid in fortifying tooth structure. The CariFree system (Oral Biotech, Albany OR) presents

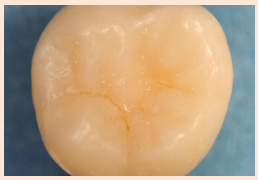
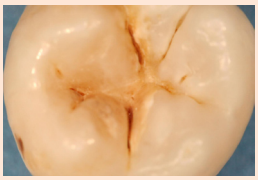
a combination of tools to screen for caries susceptibility, and facilitate rapid bacterial testing

This brief list of products provides only a few examples of those available.

The growing variety of caries–related interventions requires a well trained CAMBRA team. Given the dental hygienist's training in evidence–based evaluation of preventive care strategies and products, additional opportunity to bring knowledge and training to the dental team has presented itself with this new treatment philosophy.

For effective management of caries as a curable, preventable infectious disease, caries activity and caries risk must be assessed at regular intervals and the severity of lesion progression monitored so that treatment methods can be adjusted accordingly for ideal results.[43] Though this risk assessment approach differs somewhat with how dentistry has historically viewed and structured compensation for dental services, third party carriers are beginning to see the benefit of this model and compensate accordingly. The ADA Current Dental Terminology book (CDT7) for 2007 to 2008 contains codes for a number of preventive services, including Caries Susceptibility Testing (D 0425), Bacteriology Studies (D 0415), Oral Evaluation Patient (less than 3 years), Counseling Primary Caregiver (D0145) and Topical Fluoride Application for Therapeutic Measures Moderate to High–risk Caries Patient (D 1206). From a business standpoint, CAMBRA protocol has been recognized as good for both practices and patients.[24]

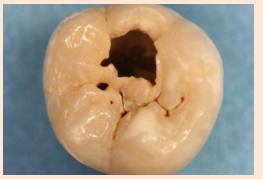
Table 3: Occlusal Protocol***

ICDAS code	0	1	2
			
Definitions	Sound tooth surface; no caries change after air drying (5 sec); or hypoplasia, wear, erosion and other non–caries phenomena.	First visual change in enamel; seen only after air drying, or colored change "thin" limited to the confines of the pit and fissure area.	Distinct visual change in enamel; seen when wet, white or colored, "wider" than the fissure/fossa.
Histologic Depth	Lesion depth in P/F was 90% in the outer enamel with only 10% into dentin.	Lesion depth in P/F was 50% inner enamel and 50% into the outer 1/3 dentin)/	Lesion depth in P/F with 77% in dentin.
Sealant/ restoration Recommedation for Low Risk	Sealant Optional DIAGNOdent may be helpful	Sealant Optional DIAGNOdent may be helpful	Sealant Optional or Caries Biopsy if DIAGNOdent is 20–30
Sealant/ restoration Recommedation for Moderate Risk	Sealant Optional DIAGNOdent may be helpful	Sealant Recommended DIAGNOdent may be helpful	Sealant Recommended or Caries Biopsy if DIAGNOdent is 20–30
Sealant/ restoration Recommedation for High Risk *	Sealant Recommended DIAGNOdent may be helpful	Sealant Recommended DIAGNOdent may be helpful	Sealant Recommended or Caries Biopsy if DIAGNOdent is 20–30
Sealant/ restoration Recommedation for Extreme Risk **	Sealant Recommended DIAGNOdent may be helpful	Sealant Recommended DIAGNOdent may be helpful	Sealant Recommended or Caries Biopsy if DIAGNOdent is 20–30

* Patients with one (or more) cavitated lesion(s) are high risk patients. ** Patients with one (or more) cavitate
*** All sealants and restorations to be done with a minimally invasive philosophy in mind. Sealants are definec
that has one part of the preparation in dentin and the preparation extends to a second surface (note: the second su
should have the most conservatively prepared fissures for proper bonding. Glass ionomer should be considere
not possible. Patients should be given a choice in material selection.

Describing different stages of occlusal decay can be problematic due to the morphology of pits and fissures. A recently proposed nomenclature system, the International Caries Detection and Assessment System (ICDAS), has been created to aid in such description and treatment planning (Table 2). For example, the occlusal pits and fissures are coded based on appearance using a numeric code from 0 to 6 that correlates clinical appearance with a definition that has been documented histologically.[44] Jenson et al published a protocol using this ICDAS information based on the caries risk of the patient which may help guide the clinician in their treatment planning decisions (Table 3).[18]

Included in Table 3 is laser fluorescence technology, which can be

3	4	5	6
			
ocalized enamel reakdown, with o visible dentin or nderlying shadow; scontinuity of rface enamel, idening of fissure.	Underlying dark shadow from dentin, with or without localized enamel breakdown.	Distinct cavity with visible dentin; frank cavitation involving less than half of a tooth surface.	Extensive distinct cavity with dentin; cavity is deep and wide involving more than half of the tooth
esion depth in P/F ith 88% into dentin.	Lesion depth in P/F with 100% in dentin.	Lesion depth in P/F 100% reaching inner 1/3 dentin	
ealant or Minimally vasive restoration eeded	Minimally invasive restoration	Minimally invasive restoration	Minimally invasive restoration
ealant or Minimally vasive restoration eeded	Minimally invasive restoration	Minimally invasive restoration	Minimally invasive restoration
ealant or Minimally vasive restoration eeded	Minimally invasive restoration	Minimally invasive restoration	Minimally invasive restoration
ealant or Minimally vasive restoration eeded	Minimally invasive restoration	Minimally invasive restoration	Minimally invasive restoration

d lesion(s) and xerostomia are extreme risk patients

as confined to enemel. Restoration is defined as in dentin. A two surface restoration is defined as a preparation rface does not have to be in dentin). A sealant can be either resin–based or glass ionomer. Resin–based sealants d where the enamel is immature, or where fissure preparation is not desired, or where rubber damn isolation is

used to help estimate the extent of occlusal decay. Although such laser fluorescence devices as the DiagnoDENT (Kavo, Charlotte, NC) may be used to assist in the decision making process of certain carious lesion presentations, research has indicated that they should not be used as the sole means of caries detection, but rather, as an adjunct to traditional forms of detection.[45–47]

The Contemporary Role of the Preventive Team

Implementing CAMBRA protocols in dental hygiene practice has provided a format for individualized treatment based upon a risk–assessment. A collaborative team of the dental hygienist, trained assistant and dentist is believed to have the greatest ability to successfully initiate CAMBRA protocols in the practice. Referral relationships with nutritional counselors, nutritionists or registered dieticians may also be beneficial and productive. Together, these allied health professionals, working with the dentist, may take responsibility for review of the medical history, risk assessment, radiographs, intraoral photos, saliva assessment and bacterial testing, treatment planning, patient education, fluoride varnish, sealants and recommendation of appropriate home care regimens. Using the team approach in delivering these services is the foundation for moving towards a more comprehensive and individualized treatment plan for the patient.

Successful integration of CAMBRA depends not just on the dental hygienist, but the entire practice. The key to successful implementation is educating the patients and team in the value of prevention and early therapeutic intervention. The dental hygienist's role in clinical practice has always supported and encouraged behavioral changes that will last a lifetime. Integrating CAMBRA into the dental hygiene process of care is a natural progression of evidence–based practice.[24,25]

As with any care a practice provides, the entire dental team must understand and support the CAMBRA treatment methodology for it to be truly successful. The dental hygiene profession has a significant opportunity to move this new information forward by demonstrating the professional roles of educators, researchers, clinicians and advocates of change on behalf of our patients.[48]

Integrating significant paradigm shifts in treatment philosophy and methodology is challenging. However, most professionals will agree that the concepts of dental disease and the practice standards for treating it are vastly different today than they were even 10 years ago. Dental hygienists can be leaders in the implementation of CAMBRA. In doing so, we honor the past as dentistry's first preventive care "specialists" and contribute to a future of exciting new preventive strategies and improved patient oral health outcomes.

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Literature Review

Effectiveness of Multimedia Instruction in Health Professions Education Compared to Traditional Instruction

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Abstract

Purpose: It is the challenge of many health care educators to find epistemological means to create learning environments that promote critical thinking, decision making and transfer of knowledge from didactic to clinical settings in order to enhance the knowledge, skills and performance of health care students. In addition, due to a rapidly changing health care environment, health professions education has been plagued with increasing quantities of complex information with waning numbers of faculty members. Investigating pedagogical strategies that address these issues is essential. Implementing carefully designed multimedia instruction (MMI) may be part of the solution. This literature review will present research regarding the effectiveness of MMI in health care education compared to traditional pedagogies. Two specific domains emerged from the literature: types of learning with MMI and the instructional design of multimedia learning environments. Regardless of the outcomes of the study, each researcher favorably described the value of MMI in health care education, citing a need for further research before universal implementation of this technology is placed in the curriculum.

Keywords: multimedia instruction, health professions education, skill acquisition, knowledge attainment

This study supports the NDHRA priority area, Professional Education and Development: Evaluate the extent to which current dental hygiene curricula prepare dental hygienists to meet the increasingly complex oral health needs of the public.

Introduction

Many studies note the need for further research in effective educational strategies for health care professionals to understand, promote and incorporate various health protocols for their patients within their discipline.[1–3] A standard established by the Commission on Dental Accreditation for Dental Hygiene Education Programs (2009, p. 21) states "Dental hygiene sciences provide the knowledge base for dental hygiene and prepares the student to assess, plan, implement and evaluate dental hygiene services as an integral member of the health team."[4] Incorporating pedagogies that promote students' awareness and appreciation of optimal care for patients while in school and which continue into practice as a health care professional will support this standard.

Students and educators have recognized that the primary source of dental information is provided in their classroom and clinical education.[5–6] In addition, dental students agreed that many procedures taught in school have value, are important protocols in health care and should be part of the dental curriculum.[5–9] Other research has indicated that knowledge acquired in academic health care programs is more likely to be incorporated into practice than information obtained in any other setting, such as a professional continuing education course or workshop.[10] Thus, including the knowledge and practice of established, evidence–based health care protocols into the curriculum during formal training is essential.

This review of the literature will examine and present the outcomes of research in health professions education using multimedia instruction (MMI) compared to traditional teaching strategies. The medical, dental and allied health care literature in education using MMI from 1997–2009 was reviewed by utilizing MEDLINE and Pub Med databases.

Multimedia Instruction (MMI)

Carefully designed MMI delivers information in a manner designed to help students learn new material or improve knowledge of materials previously studied.[11] MMI can be interactive or student–centered, in which the student is engaged in the program. Technological innovations implemented into the health care curriculum have modified the face of learning environments.[12] Highly structured environments are beneficial to the acquisition of clinical

skills.[13] MMI can be designed to create a structured learning environment that is student–centered, self–paced, interactive, beneficial in developing critical thinking skills and presented in a safe environment (practicing in a simulated setting before practicing on persons in a clinical setting). A benefit of MMI is the increased ability of the student to retain the material, therefore enabling the instructor to cover the topic in greater depth and focus on attitude of the student toward the topic.[14]

Health profession educators search for teaching strategies that employ critical and independent thinking, enhance efficiency of learning, transfer of learning, problem–solving in clinical situations, retention of material and improve manipulative and clinical skills at a faster rate.[15,16] Health profession educators and researchers have been capitalizing on technology as they sought to investigate educational strategies to meet the changing demands and challenges of health care as well as meeting the students' learning needs. Looking ahead, the waning number of faculty in health care education produces a need to consider instructional options to reduce the number of hours a faculty member spends in the classroom. MMI may fill this void if deemed equal or better to a traditional lecture. Another issue regarding further investigation of MMI in health care education relates to the rapid expansion of pertinent information in all disciplines in health care. The amount of information presented today is much greater than even a decade ago, yet the time frame to graduate remains the same. The need to learn more information in the same period of time is a challenge. MMI may provide a positive response to these and other educational dilemmas.

Types of Learning with MMI

Learning in health care involves the ability to transfer knowledge from didactic courses to pre–clinical, laboratory or clinical settings for optimum patient care.[17] Many studies evaluating the use of MMI in health care have concentrated on attainment of knowledge and/or skill.[17–21] The key to designing a learning activity is to cognitively engage the learner to think about the meaning and relevance of the material presented, its application and the various contexts to which it can be applied. Essential components of optimal practice include the retention of knowledge and/or skill throughout the program and into professional practice.

The design of MMI programs to educate health care students is typically created to measure and compare the effectiveness of the program as a supplement or replacement to traditional teaching strategies.[17–19,21–23] However, outcomes from such studies present inconsistent findings that need to be explored further. After reviewing the literature, it appears that MMI may be more beneficial when used as an adjunct to traditional pedagogies for promotion and attainment of knowledge and skills. Also, other forms of teaching strategies may be more effective and have greater gains in learning with the use of MMI, such as simulation–based programs. In addition, the acquisition and retention of a skill seems to have greater potential following the administration of MMI.

Attainment of Knowledge

The evidence is inconsistent as to whether MMI leads to gains in knowledge for didactic instruction in health care education. Much of the literature did not find significant differences. However, it demonstrated equal gains between the groups involved in MMI compared to those in traditional learning situations. With the impending dilemma of dwindling numbers of faculty members in health care, this may also be a positive outcome. Using MMI as an adjunct to the lecture, one study found significant gains in knowledge in health care students, while a second study had similar results using self–instruction.[24,25] Other researchers, on the other hand, found no difference in knowledge gained. Finally, 2 studies found the students in the traditional learning groups to have significant improvement in knowledge over those participants in MMI groups.[18,26–29]

A team of researchers examined the effectiveness of MMI to supplement a lecture for diagnosis of endodontic issues.[24] A pre–survey to measure knowledge was administered to dental students prior to the lectures. The participants were randomly assigned to 1 of the 3 groups: lecture and exposure to MMI containing case situations, lecture and participation in a seminar group containing identical cases for the same time period and lecture only. Analysis of the identical post–survey revealed the students in the computer–simulation program scored significantly higher in knowledge than the other 2 groups. There was no difference between the seminar group and the control group. A second group of researchers integrated virtual patients, designed as a web–based program, into a classroom of dental students.[30] The research concluded that there was no difference in the group using the virtual patient led by an instructor opposed to the group using the virtual patient independently. Kleinert et al integrated a virtual patient with Down syndrome into a dental course.[31] A significant difference upon completion of the program was based on a pre– and post–knowledge test.

While most studies have used MMI as a supplement to traditional pedagogies, 2 studies found a significant difference in knowledge using only self–instruction. The first study compared a group of dental students using an electronic tutorial to previous dental classes using lectures in a classroom and microscopes in a laboratory.[25] The tutorial used images of the histological slides and the existing lecture material in the form of figures and text with access to microscopes. A comparison of 2 sets of test scores found those participants using the electronic tutorial to be significantly higher than the

scores of previous students exposed to traditional instruction. DeBate et al determined that a web–based training program on various aspects of eating disorders in dental patients increased the knowledge of students and clinicians.[32] The program used text, graphics and videos to meet objectives that are both knowledge and skill based.

Studies that have found MMI to be equally as effective as traditional methods include Aly et al.[18] The MMI contained a tutorial of interactive programs in orthodontics. Each program contained graphics, text and self–assessment components and could be viewed as often as needed. The teaching objectives were identical for both groups and pre– and identical post–surveys were administered to the students to measure changes in knowledge. Williams et al also found no difference in knowledge between the MMI and conventional learning based on the results of pre– and identical post–surveys.[26] Students were assigned to a traditional lecture or worked independently with a CD–ROM. Both groups used identical time, learning objectives and case materials.

Another example of MMI found to be equally effective as lecture in attainment of knowledge was a study conducted in a science course for health care students. The treatment conditions consisted of lecture only, interactive MMI and lecture and the interactive MMI, lecture and an enhanced learning system.[27] The MMI consisted of an existing interactive videodisc including sound, text, computer graphics and videos. The enhanced learning system was the interactive videodisc with prompts that required students to make a list of unfamiliar words before moving on.

Introducing students to MMI may not guarantee achievement of the learning expectations of health care educators and may actually negatively impact learning if not adequately designed and implemented. Several researchers indicate that knowledge attainment may be better achieved by traditional teaching methods. For example, one study found that knowledge–based information that depended on memorization and recall of the material for medical students was best accomplished with a teacher–based lecture and a passive learner.[28] A second study also concluded that the attainment of knowledge is best accomplished in a didactic setting without the aid of MMI.[29] There was a significant increase in knowledge in the didactic group for the post–survey over the videotape or computer–based groups.

Attainment of Skill

MMI may prove to be beneficial for other modes of learning, such as acquisition of a skill. The capability of students to review MMI as many times as necessary and stopping the program at any procedure for further analysis is an advantage. In addition, MMI gives a bird's eye view of a procedure, guaranteeing that each student observes the identical procedure as another student. Use of MMI in simulated experiences offers an opportunity to visualize a process or procedure before the actual first encounter. This provides the potential to increase cognitive knowledge and analyze and apply the information to a situation.

Several studies used MMI as an adjunct to traditional pedagogy to enhance acquisition of a skill.[19,20,33] When combining the MMI with the lecture, these researchers found the experimental groups to have a higher level of skill than the didactic groups. Several studies found using a multimedia approach that required involvement and interaction by the student and employed the use of problem solving to yield greater learning.[17,26,33] Conversely, the outcomes attained from other researchers indicated equal attainment of skill between MMI compared to conventional pedagogical methods.[18,21,29]

Educators acknowledge the common challenge of students to apply information from the traditional dental classroom setting to a clinical dental procedure. One study designed a video to address the issues.[19] Those using the video scored significantly higher on the practical examination compared to the class with traditional learning in the classroom and lab. The video was a detailed instruction of a crown preparation and placement, followed by a group demonstration and independent practice on a mannequin. Students could view the video as many times as needed. The outcome was compared to the class of the previous year and found the video group to have better performance.

Finding a significant improvement in skill, a group of researchers used MMI as a tutorial to educate the student on information related to blood pressure and obtaining a reading.[20] In this study, nursing students were assigned to 1 of 3 groups: CD–ROM only, instruction only and a combination of both. The CD–ROM incorporated text, animated graphics, photographs and video. The objectives of the instructional methods were identical.

A significant increase in application of knowledge in a clinical setting was noted by Boynton et al when using MMI to complement the traditional lecture.[33] The dental students in the control group received lectures on child management behavior. The experimental group received the same lectures, as well as completing the web–based instructional tool. The identical exam tested knowledge and application of the material. The MMI used a text–based description of the situation that required the student to select the appropriate action, providing immediate feedback.

Another researcher reported a significant difference in interactive MMI using problem solving compared to the program that replicated a lecture.[17] One treatment group consisted of a multimedia tutorial that was didactic in nature, using text and images in a structured way. The second multimedia tutorial involved case–based teaching sessions that required more interaction with the program and application of learning to a clinical scenario. Integration of

questions throughout the case forced student involvement. In order to continue with the program, the student must answer each question correctly. The third multimedia format, requiring the greatest involvement, was the free–text version involving a series of open–ended questions in which the answers were compared to those of the author. A correct response allowed the student to continue. Learning objectives for each group were identical. Hudson concluded that all groups significantly improved in their ability to apply the information, with the "free–text" version reporting the greatest gains and the control group showing the least.[17] The free–text group showed significant improvement compared to the control group, but not when compared to the other treatment group.

Williams et al also reported a significant difference in the ability of medical students using video–clips of counseling patients with anxiety compared to those using a traditional format.[26] The MMI group used video clips of case–based material supplemented with text to describe key information. The student viewed the video clips to assess and diagnose the existing problems. Following the intervention, an existing tool was used to evaluate the students' ability to recognize and manage mental health problems. In addition, a videotape of the student conducting a session with a similar client was viewed and assessed. The authors concluded that even a slight gain in skill is an indicator of success since recognition of even one more clinical sign of anxiety is beneficial for patient care.

However, one study found that dental students using MMI along with lecture scored similarly in exposing and developing radiographs to those attending the lecture.[21] Summers et al found no difference with any mode of instruction assessing practical skills at the post–test.[29] These authors implemented a computer–based program and video on basic surgical skills using identical pictures, text and audio. The students were divided into lecture, video or computer–based training. A third study also found no difference between a group of dental students receiving MMI compared to those receiving the traditional classroom instruction for working with orthodontic appliances.[18] Although each of these studies found no significant difference, the results indicate that the effects of the pedagogical strategies were equivalent. In other words, MMI was just as effective as the traditional methods. In each of these studies, recommendations for future research in the use of MMI for acquisition of a skill were made.

Retention of Knowledge

A third category of learning identified in the health care literature is retention of knowledge. Many studies recognize a need to measure retention of knowledge. For example, Boynton et al mentioned the possibility of measuring retention of knowledge using a computer–based simulation for behavior management of children in a dental environment.[33] Future research could use a similar study format, but assess the knowledge of students at another point in their education or once practicing as dentists. A second study also identified a need for a longer period of time between the intervention and measurement to study the effectiveness of MMI for retention of knowledge and skill.[21] Further, a third study discussed the need to identify the value MMI may have on retention of psychiatric knowledge and skills as a possibility for future research.[26]

One study reported no difference in the interactive MMI compared to a didactic approach to retain information 2 weeks after the intervention.[17] However, a study by Summers et al was not as promising, and found that there was a significant increase in knowledge in the didactic group 1 month following intervention compared to the computer–based and video groups.[29] Both studies measured knowledge using an identical pre– and delayed post–test. These outcomes indicate that additional research is needed in the area of MMI and retention of knowledge of health care students.

Retention of skill

Retention of a skill is the final area of investigation into MMI. A unique aspect of health care education includes the performance of a skill at a competent level for the student to successfully graduate. Only 1 study was found that evaluated this measure. Although there was no difference in performance of a skill at the post–test, Summers et al reported a significant difference utilizing MMI for overall performance of basic surgical skills following the delayed post–test.[29] The students assigned to the videotape and computer–based groups scored significantly higher on a technical skill compared with the didactic group 1 month following the intervention. The treatment group exposed to the computer–based program showed similar scores to the video group with each group performing the skill at a faster rate. This study concluded that the use of MMI may provide long–term enhancement of students' skills.

Health education is plagued with the problem of retention of knowledge and transferring the information to practice. However, limited and inconsistent evidence exists regarding the effectiveness of MMI toward enhancing retention of skill.

Multimedia Instructional Design

Research in health care related to MMI can often be categorized into 2 instructional designs: tutorial–based and simulation–based or case–based. While most studies have dealt with the effectiveness of MMI in the classroom, little has been reported utilizing a clinical setting or simulated experience.

Tutorial–based MMI

Tutorial–based MMI allows the student to work independently on the course material for acquiring knowledge and/or skill. These programs often imitate the original

lecture. Inconsistent findings are reported from research using tutorial–based MMI that is more didactic in nature in health care courses. Three studies reported significant differences when using a tutorial–based MMI. The outcomes of a pilot study using a web–based program revealed significant improvements in knowledge on treating dental patients with eating disorders.[32] A limitation to this study, however, was that it was non–experimental and did not have a control group. Rosenberg et al found a significant difference in knowledge with implementation of a self–instructional electronic tutorial as an adjunct to the lecture for a histology course for dental students.[25] Similarly, a third study found that use of a self–instructional CD–ROM program alone showed improvement in skill over lecture alone.[19] The researchers surmised that the visual presentation offered by the CD–ROM and learning at their own pace in a safe environment contributed to these outcomes.

While some research has shown significant effects of tutorial–based MMI on gaining knowledge and/or performance of a skill, other studies have found it to be equivalent to traditional methods. For example, one group of researchers found no difference between a group of dental students receiving interactive MMI compared to a group receiving the traditional classroom instruction.[18] Students were expected to assess and diagnose the orthodontic status of given dental patients. To enhance the learning in science instruction, a second study also found no difference between 3 treatment groups in the post–test scores.[27] In both studies, there was no difference in knowledge attained or application of the information, with outcomes to support that the use of MMI is as effective as lecture.

Simulation–based MMI

MMI presents an opportunity for simulations of clinical situations. The research in health education reports the potential for simulations to create higher–quality learning environments, enhance students' clinical problem–solving skills and meet diverse subject and student needs.[17,21,24,26,33] Simulations can be designed to guide students toward diagnosis and management of health problems. Simulations also create a visual opportunity to view the performance of a skill by an expert, allowing the student to view the MMI as often as needed.

The following studies report that simulations using a multimedia medium permit the student to apply the information by engaging the learner. An example was reported by Boynton et al in which the learning acquired from an Internet–based instructional tool that simulated the behaviors of children during dental treatment were compared to a traditional learning experience.[33] The simulation group had a significant improvement in test scores over the control group. When compared to those in the control group who had completed a real–world experience in a clinical rotation, there was no significant difference in performance to those in the simulation group with virtual experience. Therefore, using simulations prior to a clinical experience may provide an effective clinical experience. Researchers in a second study found the MMI group of medical students had similar gains in knowledge, but scored significantly higher than the traditional group when identifying and treating anxiety.[26] Kleinert et al reported significant gains in knowledge using a virtual patient in an interactive MMI for dental students to practice care on special needs patients.[31] The module incorporated points in which the student needed to make a decision regarding treatment and care of the patient.

A similar study showed a significant difference in the ability to diagnose endodontic problems using a computer–simulation program compared to groups receiving a small–group seminar and a third group receiving no additional instruction.[24] Both the computer–simulation program and the small–group seminar contained similar patient simulations. Those in the computer–simulation program were able to cover more simulations in the same 1 hour session as the small–group seminar.

Using a different approach, Hudson reported a significant difference when utilizing MMI that required a greater level of involvement by the student.[17] Three self–directed multimedia programs (repeat of a lecture and 2 versions containing case scenarios, differing only in magnitude of interaction) were implemented to measure the impact on the retention of knowledge and application of information of medical students.

One study found no difference in the quality of radiographs of dental students utilizing a simulation–based MMI integrated into a lecture when compared to the traditional teaching methods.[21] Although the MMI was deemed as effective as traditional instruction, Howerton et al questioned the time it took to design, develop and implement the multimedia program.

In summary, the studies implementing MMI to measure learning in both the tutorial–based and simulation–based or case–based components of health care education have consistently used the same learning objectives with a comparison of MMI to traditional teaching pedagogies. Several studies converted the materials used in the traditional classroom to a self–directed MMI while other research used existing software programs.[18,33,34] Further, the research on MMI in health care is often measuring independent adult learners from an academically homogeneous population without embracing the direction of theory, therefore, reaching conclusions that may be data–driven as opposed to theory–based. Future research that is based on a theoretical framework with a focus on existing studies and their limitations will be more robust.

Future Direction for Research and Education

Much is yet to be learned regarding MMI in health professions education. A review of the health care literature suggests MMI is equivalent to or more effective than traditional learning environments for application of the material, knowledge attainment and skill acquisition.

No study measured the retention and application of knowledge following MMI once the student was working as a practicing health care provider. Retention of information may not change much in the same evaluative period, such as a 15 week semester, but may diminish over several months. A suggestion for future research emerged from many studies citing a need to study the effects of MMI over a longer period of time. It would be productive to explore the knowledge and/or skill at several points during the student's academic program and after graduation while working as a health care professional.[21]

Regardless of the outcomes of the study, each researcher favorably described the value of MMI in health care education, citing a need for further research before universal integration of this technology into the curriculum.

Conclusion

The use of MMI in health professions education has been a popular pedagogical strategy that may be equal to or more effective than traditional instructional modalities for attainment of knowledge, skill and performance. Health care education today places much emphasis on developing and implementing pedagogical strategies that foster the development of students' critical–thinking abilities and transfer of knowledge from the classroom to clinical situations. The challenge for future research on MMI is the need to concentrate on development of learning environments that are specific to the discipline of dental hygiene.

Table I: Definitions of Education Terms

Constructivism	a philosophical view emphasizing meaningful, authentic activities that help the learner to construct understandings and develop skills relevant to solving problems; learning that is self–directed, self–paced, and interactive
Critical thinking	higher–level thinking and reasoning abilities
Didactic	instructive
Epistimology	the study or a theory of the nature and grounds of knowledge; constructing knowledge
Learning environments	a coherent curriculum and a suite of technologies to support teachers and students in learning, instruction, and assessment15
MMI	implementing a variety of digital media into instruction, the use of computer technology for supplementing the distribution of course content with that of traditional methods13
Pedagogy	teaching
Retention of knowledge	the ability of the student to remember information following an assessment or evaluation of the material, such as weeks or months later
Simulation–based MMI	MMI that allows the student to work independently or as a group on a clinical situation, which can be designed to meet diverse subject and student needs without fear of harm to the patient; requires application of information
Tutorial–based MMI	MMI that allows the student to work independently or as a group on the course material for acquiring knowledge and/or skill
Traditional teaching strategies	conventional pedagogical strategies for student learning; often teacher–centered and involves passive learning; examples include lecture and use of a textbook.

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Research

An Oral Health Survey of the Lumbee Tribe in Southeastern North Carolina

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Abstract

Purpose: The Lumbee tribe, North Carolina's largest American Indian tribe, is located in Robeson County, where there is an access to dental care crisis. There is a high incidence of systemic diseases, including coronary heart disease (CHD) and diabetes. The tribe also has a higher rate of adverse pregnancy outcomes compared to Caucasian populations. There is little information available regarding the oral health of this population. The aim of this study was to evaluate access to dental care issues, oral health knowledge and oral health–related quality of life of the Lumbee tribe.

Methods: A self–administered survey was developed to assess factors influencing access to dental care, oral health knowledge and oral health–related quality of life. The survey was administered to a convenience sample of 118 Lumbee Indians at the Lumbee Homecoming Festival in Pembroke, NC.

Results: Barriers to accessing dental care included being unable to leave work to find a dentist and cost of dental services. Many believed that it is natural to lose teeth as one ages. There was low oral health knowledge regarding oral and systemic health. Oral Health–related quality of life was affected. There was an association between poor access to dental care and poor oral health–related quality of life.

Conclusion: Lumbee Indians reported barriers to accessing dental care. There was a significant relationship between difficulty accessing dental care and poor oral health–related quality of life.

Key Words: access to dental care, Lumbee Indians, oral health–related quality of life, oral health knowledge

This study supports the NDHRA priority area, Health Promotion/Disease Prevention: Investigate how diversity among populations impacts the promotion of oral health and preventive behaviors.

Introduction

The Lumbee Indian tribe, located in Robeson County, a rural area of southeastern North Carolina, is the largest of North Carolina's eight American Indian tribes. It is the largest American Indian tribe east of the Mississippi River and the ninth largest tribal band in the United States.[1,2] In Robeson County, American Indians make up 37.2% of the population compared to 36.4% Caucasian and 24.6% Black.[2] The Lumbee tribe does not receive funding from the United States Bureau of Indian Affairs that would give them access to the Indian Health Service (IHS).[3] The IHS provides medical and dental care to federally recognized American Indian tribes.[4,5] Although there is a significant amount of data on the oral health needs of American Indians receiving dental services from the IHS, no data are available which report the needs of American Indians like the Lumbee tribe, who do not receive federally funded medical and dental services.[5–8]

Review of the Literature

Oral diseases are common among American Indian tribes monitored by the IHS,[5–9] with dental decay and periodontal disease among the most common.[9] A study reporting data collected by the IHS in 1991 found that American Indian adults had a higher prevalence of dental decay compared to the general population of the United States. They also found that, although there had been a decline in decay among American Indian children, American Indian adults did not show the same trend. Compared to data collected in 1984 by the IHS, American Indian children had a 47% reduction in caries experience. However, American Indian adults aged 35 to 44 showed a 3% increase in caries experience in the same time period.[7] Further data reported by the IHS showed that American Indians have a high rate of periodontal disease compared to Caucasian populations in the United States. In all age groups, American Indians with diabetes had significantly higher rates of severe periodontal disease compared to those without diabetes.[9] Recent research has found that there is an association between periodontal

disease and systemic diseases like diabetes and coronary heart disease (CHD).[10–15] Researchers have also found a possible relationship between periodontal disease and pre–term, low birth–weight babies.[16–19] American Indians in North Carolina have higher rates of CHD and diabetes compared to North Carolina's Caucasian population. American Indians in North Carolina also have a higher infant mortality rate and nearly twice the incidence of low–birth weight babies compared to Caucasian populations.[1,20]

One of the goals of The National Call to Action to Promote Oral Health by the United States Department of Health and Human Services (USDHHS) is to increase the awareness of all Americans regarding the seriousness of oral disease and other systemic conditions like diabetes, CHD and adverse pregnancy outcomes. According to the USDHHS, it is important to educate the public about their oral health and how it relates to their overall well–being.[21]

When assessing CHD and diabetes, as well as oral disease, it is necessary to consider how these conditions affect the quality of life for people who are afflicted by them. Health care policy includes both the prevalence of disease and how those diseases affect quality of life.[22] Various data, including the presence and severity of oral diseases and oral health–related quality of life measures, have been collected to assess how much a population suffers from oral related disease.[23,24] In a study performed in the early 1990s by Slade et al, data which included decayed, missing or filled scores and clinical attachment level, along with the Oral Health Impact Profile–14 (OHIP–14), a quality of life survey, were taken from adults 65 years or older in Canada, Australia and North Carolina. The data were compared among the 3 populations. Researchers found that older adult minorities from the Piedmont area of North Carolina had a greater prevalence of oral disease and that they suffered from those diseases more than other study populations.[25]

Another research study performed in China assessed the severity of periodontal disease and its effects on quality of life.[26] Periodontal status was determined by clinical attachment level. Subjects aged 25 to 64 were divided into 2 groups that depended on the average amount of attachment loss for each individual. The OHIP–14 was used to assess how quality of life was affected by periodontal disease. Results showed that 22% of subjects reported that "their oral health status impacted on their quality of life in one or more ways," and that "the OHIP–14 score was significantly associated with occurrences of swollen gums, sore gums, receding gums, loose teeth, bad breath and tooth ache."[26] All of the studies that utilized the OHIP–14 provided researchers with a better understanding of the negative effects that oral disease has on quality of life.[25–27]

In North Carolina, it is often difficult for low income and poor people to access dental care, especially in rural Robeson County, where the Lumbee tribe is located.[28–30] North Carolina ranks 47th out of 50 states in its dentist to patient ratio. Robeson County has 1.1 to 2 dentists per 10,000 people. This places Robeson County well below the national (6.0 dentists per 10,000) and state (4.1 dentists per 10,000) averages.[28,30] One objective of the Healthy People 2010 report by the Surgeon General is to increase the use of dental services by all Americans.[31] To meet this objective, the state's public university system is working to increase the enrollment in its dental schools. Emphasis is also being placed on recruiting dentists into rural areas of North Carolina.[28,30] The American Dental Hygienists' Association (ADHA) revised its National Dental Hygiene Research Agenda in 2007 to identify how the dental hygiene profession can help meet the Healthy People 2010 objective to increase access to dental care.[32] North Carolina has doubled its dental safety net programs from 43 in 1998, to 115 in 2004.[28] Dental safety net programs provide dental care for low–income patients in North Carolina.[33] However, concerns by the North Carolina Office of Research, Demonstrations and Rural Health Development regarding accessibility of the program by those who need it most have arisen. "Many of the patients most in need of safety net services do not have employment that allows them to leave work (with or without pay) for dental appointments."[30] This has prompted the Office of Research, Demonstration and Rural Health Development to consider creating dental safety net programs with more flexible hours to meet the dental needs of low–income working individuals.[30,33] Increasing the number of people who seek dental care is also a matter of creating value for oral health through education by culturally competent oral health care professionals.[21,30,34,35]

The aim of this study was to evaluate access to dental care issues, oral health knowledge and oral health–related quality of life, as well as determining if access to dental care was associated with oral health knowledge and oral health–related quality of life.

Methodology

A self–administered survey was created to assess access to dental care issues, self–reported oral health status, oral health knowledge and demographic information. The OHIP–14 survey was chosen to assess oral health–related quality of life in this study due to its high validity. It was also used so that comparisons could be made to other North Carolina populations whose oral health–related quality of life was evaluated using the same survey instrument.[23–25] Approval for the survey was obtained from the

University of North Carolina Institutional Review Board. The survey was pilot tested at Mt. Elim Baptist Church, which has a predominantly Lumbee Indian congregation, prior to the Lumbee Homecoming Festival. With a population of approximately 22,500 Lumbee Indians attending the event within the ages of 18 years or older, a sample size of at least 109 completed surveys was determined using a prevalence estimate of 20% +/– 7.5% of the Lumbee population having their quality of life affected due to low oral health knowledge and poor access to dental care. The sample size was calculated using EpiInfo version 3.3.2 software.

The survey was administered to a consecutive convenience sample of 118 American Indians during the Lumbee Homecoming Festival in Pembroke, NC on July 7, 2007. A covered tent with tables and chairs was set up at the festival where the surveys were completed. A flyer describing the survey and participation requirements was distributed by a volunteer from the Lumbee community to recruit participants for the survey. The principal investigator was present during administration of the survey to aid in completing the survey for participants who could not read. Cold beverages were offered and dental hygiene supplies were distributed once the survey was completed.

Survey sections which evaluated access to dental care issues and oral health knowledge contained Likert–type scale questions to measure the level of agreement with each statement. The responses included "strongly agree," "somewhat agree," "don't know/not sure," "somewhat disagree" and "strongly disagree." Summary scores were calculated to identify subjects with poor access to dental care, low oral health knowledge and poor oral health–related quality of life. A value of 1 was assigned for responses of "somewhat agree" or "strongly agree" to statements regarding barriers to accessing dental care. A summary score value of 1 was assigned for responses of "somewhat disagree" or "strongly disagree" to statements in the oral health knowledge section. The OHIP–14 is also rated on a Likert–type scale response of "never," "hardly ever," "occasionally," "fairly often" or "very often," respectively.[23,24] Summary scores from the OHIP–14 section were obtained by assigning a value of 1 for responses of "occasionally" or more often. Therefore, high summary scores represent more barriers to accessing dental care, low oral health knowledge and low oral health–related quality of life. "Missing" and "Don't Know" responses were excluded from analysis.

The summary scores were used to assess the relationship between covariates and access to dental care issues, oral health knowledge and oral health–related quality of life. The summary scores were also used to determine if poor access to dental care is associated with poor oral health–related quality of life and low oral health knowledge. The p–value was set at ≤0.05 to report significance within the sample population. Descriptive statistics were assessed using Pearson's Chi–squared test for nominal and ordinal variables. T–test, Pearson's Correlation and ANOVA were used for continuous variables. Statistical analyses were performed using JMP version 6.0 software.

Table I. Demographic characteristics of Subjects (n=118)

Demographic characteristics	% Subjects	% Robeson County
Gender		
Male	45	49
Female	55	51
Age (years)		
18–25	20	*
26–35	20	*
36–45	21	*
46–55	19	*
56 or older	21	*
Marital status		
Never married	26	*
Married	56	*
Separated/divorced/widowed	18	*
Education		
Less than high school graduate	7	*
High school graduate/GED	23	65
At least some college	43	*
Bachelor's degree or higher	27	11.4
Income		
<$19,999	20	*
$20,000 to $34,999	21	*
>$35,000	60	*

Results

Table I contains demographic information of the survey population. Of the 118 participants, most had at least some college education, and 55% were females. The majority of respondents had an income of at least $35,000. Only

58% had any dental insurance coverage.

Table II describes the distribution of responses to the oral health knowledge and access to dental care sections of the survey. The majority of respondents had knowledge about fluoride use, daily flossing and dietary considerations for oral health. However, many did not know that oral disease may affect the heart, pregnancy and diabetes. Access to dental care was affected by cost, an inability to miss work and dental fear. Many also reported that it was too far to travel to visit a dentist or could not find a dentist to take care of them.

Table III describes the distribution of participants with poor oral health–related quality of life. Many participants had poor oral health–related quality of life due to oral pain and were self–conscious because of problems with their teeth/mouth. Some found it difficult to relax and had decreased taste.

Table IV describes the characteristics of those with problems accessing dental care, low oral health knowledge and low oral health–related quality of life. Those with an income of less than $35,000 had more problems accessing dental care compared to those with an income greater than $35,000 (p=0.0008). Males had less oral health knowledge than females (p=0.0072). Participants age 36 to 45 had the most trouble accessing dental care (p=0.043). Having no dental insurance was also a deterrent to receiving dental care (p=0.048). Those with less than a high school education had significantly less oral health knowledge than those with at least some college education (p=0.0072). Current tobacco use was also associated with poor oral health–related quality of life (p=0.022) (Figure 1). There was not a significant association between low oral health knowledge and poor access to dental care (r=0.11, p=0.23). However, there was a significant association between poor access to dental care

Table II. Distribution of responses to oral health knowledge and access to care questions

	Agree %	Don't Know %	Disagree %
Oral Health Knowledge (n=115)			
Problems with the teeth/mouth may cause problems with:			
the heart	52	39	9
pregnancy	50	45	5
diabetes	57	38	5
It is natural to loose your teeth as you age	39	25	36
Daily flossing makes your teeth /mouth healthier	89	10	<1
Access to Dental Care (n=117)			
I want to go to the dentist but cannot or do not because:			
it is too far to travel	20	10	70
I am afraid	27	4	69
it costs too much	50	1	49
I cannot miss work	34	<1	65
I cannot find a dentist	30	7	63
I do not want to go to the dentist	18	3	79

Table III. Distribution of responses to Oral Health Impact Profile–14 (OHIP–14) item responses (n=117)

	Occasionally/fairly/very often %
Functional limitation	
Trouble pronouncing words	13
Taste worsened	21
Physical pain	
Painful aching	30
Uncomfortable to eat	31
Psychological discomfort	
Self–conscious	33
Tense	25
Physical disability	
Diet unsatisfactory	15
Interrupt meals	19
Psychological disability	
Difficult to relax	21
Been embarrassed	22
Social disability	
Irritable with others	13
Difficulty doing jobs	9
Handicap	
Life unsatisfying	16
Unable to function	8

Table IV. Characteristics of subjects' summary scores in oral health knowledge, access to dental care and poor oral health–related quality of life

	Oral health knowledge Mean (SE)	P Value	Access to dental care issues Mean (SE)	P Value	oral health–related quality of life Mean (SE)	P Value
Gender						
Male	2.69 (0.22)	0.0072*	2.21 (0.31)	>0.05	2.91 (0.55)	>0.05
Female	1.90 (0.19)		1.92 (0.26)		2.73 (0.45)	
Age (years)						
18–25	2.36 (0.34)	>0.05	1.22 (0.44)	0.043*	1.43 (0.76)	>0.05
26–35	2.22 (0.33)		1.91 (0.44)		3.09 (0.76)	
36–45	2.67 (0.32)		2.96 (0.43)		4.21 (0.91)	
46–55	2.18 (0.34)		2.50 (0.45)		2.68 (0.78)	
56 or older	1.91 (0.33)		1.63 (0.43)		2.21 (0.75)	
Income						
<$19,999	2.68 (0.32)	>0.05	3.00 (0.43)	0.0008*	4.00 (0.85)	0.02*
$20,000 to $34,999	2.13 (0.31)		3.00 (0.42)		4.35 (1.02)	
>$35,000	2.14 (0.19)		1.46 (0.25)		2.09 (0.39)	
Education						
Less than high school graduate/GED	4.14 (0.83)	0.0072*	2.88 (0.97)	>0.05	2.38 (1.33)	>0.05
High school graduate/GED	2.52 (0.26)		2.33 (0.39)		4.07 (0.73)	
At least some college	2.02 (0.16)		1.89 (0.24)		2.47 (0.42)	
Dental insurance						
No dental insurance	2.60 (0.26)	>0.05	2.64 (0.56)	0.048*	3.67 (0.56)	0.031*
Dental insurance	2.08 (0.26)		1.68 (0.31)		2.15 (0.38)	
Tobacco use						
Current tobacco use	2.41 (0.24)	>0.05	2.86 (0.45)	>0.05	3.96 (0.76)	0.022*
Past tobacco use	2.76 (0.30)		1.91 (0.36)		3.17 (0.74)	
Never user	1.90 (0.21)		1.66 (0.27)		1.72 (0.38)	

*=Statistically significant p value of≤0.05

and poor oral health–related quality of life (r=0.46, p=0.0001).

Discussion

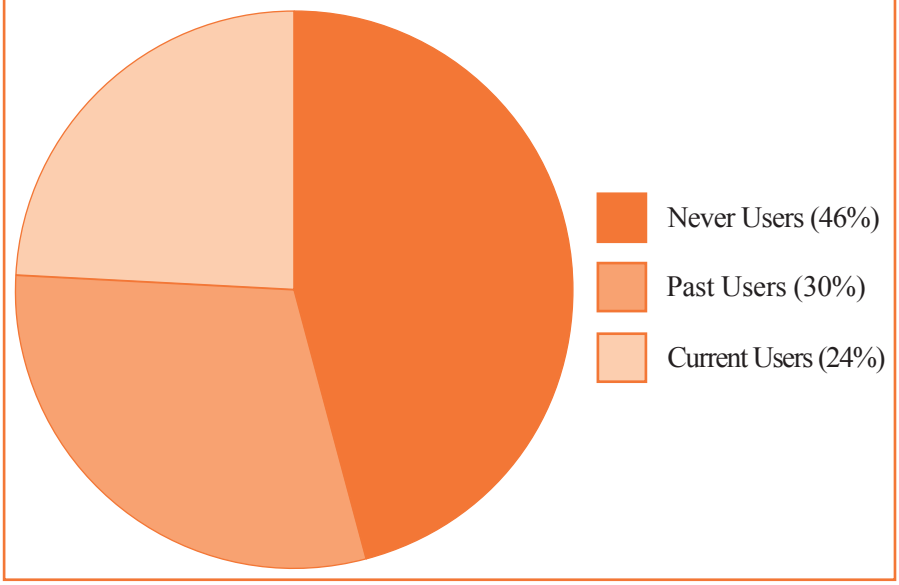
The purpose of this study was to assess oral health knowledge, barriers to accessing dental care and oral health–related quality of life of the Lumbee tribe. There was evidence of low oral health knowledge regarding the link between oral and systemic disease among those surveyed at the Lumbee homecoming Festival in Pembroke, NC. Although subjects had a high level of knowledge about oral health topics, such as daily flossing and fluoridated toothpaste and its positive effect on oral health, many had low knowledge about oral health and its relationship with systemic diseases like CHD and diabetes. Even though recent research shows a significant relationship between periodontal disease and adverse pregnancy outcomes, many of the female participants in this study did not know that oral health may affect pregnancy outcomes.[16,17] The results of the OHIP–14 survey suggest that the Lumbee population surveyed at the Lumbee Homecoming Festival have low oral health–related quality of life. Slade et al reported a mean OHIP–14 score of 1.64 in South Australian populations aged 60 and older.[24] The present study found a mean OHIP–14 score of 2.74 for the population surveyed. Those age 36 to 45 years had the lowest oral health–related quality of life. Those aged 56 or older had better oral health–related quality of life than those aged 36 to 45. This suggests that the Lumbee population surveyed may experience poor oral health–related quality of life at a younger age than some populations. Data from the IHS revealed that American Indians had an increase in caries in those aged 35 to 44.[7] The current study found a lower oral health–related quality of life in a similar age group. This suggests that future research efforts may need to focus on those aged 30

and older.

One observation of interest was that, although recruitment was performed in the same manner by all of those involved, subjects were more willing to participate when recruited by the Lumbee community volunteer than when recruited by the principal investigator or student volunteer who were not American Indian. Without the efforts of the Lumbee volunteer, it is unlikely that there would have been enough subjects recruited into the study. This finding supports recommendations from the USDHHS and the United States Surgeon General that oral health professionals need to be culturally competent in order to have effective communication and increase access to dental services.[21,30,31,35] To address this and other findings from this study, North Carolina's public universities may need to focus on recruiting students from the Lumbee tribe. It is also important that future oral health research with the Lumbee community be conducted by a research team that includes qualified members of the Lumbee tribe.

There were some limitations to this study. There may have been some bias in the survey instrument because the data were self–reported. Since the population surveyed tended to be well–educated and had a high household income compared to the general population of Robeson County, the results may not be generalized to the entire Lumbee population of Robeson County. However, since the sample population had a higher socioeconomic status than Robeson County's general population, there may be greater difficulty accessing dental care and lower oral health–related quality of life than the current study found. Many of the Lumbee community were unintentionally excluded from the study because they did not have financial or transportation resources to attend the Lumbee Homecoming Festival. Therefore, it is only representative of a portion of the Lumbee population. Further investigation of the oral health needs of the entire Lumbee community is needed.

Figure 1: Distribution of Tobacco Use by Participants



Conclusion

This study found that there is an association between low oral health–related quality of life and barriers to accessing dental care. This may be related to the access to dental care crisis in North Carolina. Because of the rural location of the Lumbee tribe, dental offices may be a long distance away for many of Robeson County's population.[1,20] This is especially true for those with low socioeconomic status. Because of the recent economic decline in the Unites States, traveling far distances to receive dental care may use up monetary resources needed for traveling to work. Therefore, driving a far distance to receive dental care may become an unaffordable expense, even for those who carry dental insurance. For many respondents, the cost of receiving dental services was also a deterrent to accessing care. Many were unable to find a dentist to take care of them. This is due in part to the low dentist to population ratio in Robeson County.[28,29] Many reported that although they wanted to go to the dentist, they were unable to take time off from work. This finding is in agreement with concerns raised over accessibility of dental safety net programs by working individuals.[30] The current study provides preliminary data for further research by organizations like the ADHA. Future research efforts need to focus on how dental hygiene services might improve oral health outcomes of this underserved population.[32]

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Research

Bisphenol A Blood and Saliva Levels Prior To and After Dental Sealant Placement In Adults

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Abstract

Purpose: This study examined the effects of a widely used (Delton® Pit & Fissure Sealant – Light Cure Opaque, DENTSPLY Professional, York, PA) pit and fissure sealant material on bisphenol A (BPA) levels in blood and saliva, among both low and high–dose groups over time.

Methods: A convenience sample of 30 adults from the Old Dominion University population were randomly and evenly divided into 2 independent variable groups: a low–dose group (1 occlusal sealant application) and high–dose group (4 occlusal sealant applications). A 2 group, time series design was used to examine the presence and concentration of BPA in serum and saliva after sealant placement. Differences comparing low–dose and high–dose groups were examined 1 hour prior (baseline), 1 hour post, 3 hours post and 24 hours after sealant placement, as measured by a direct–competitive BPA Enzyme Linked ImmunoSorbent Assay (ELISA). Hypothesized outcomes were evaluated by applying a parametric, 2 way ANOVA for repeated measures technique to data on the 30 participants ranging in age from 18 to 40 years, and were of mixed gender and ethnicity.

Results: BPA was detected in the saliva of all participants prior to sealant placement and ranged from 0.07 to 6.00 ng/ml at baseline. Salivary BPA concentration levels peaked over a 3 hour period following sealant placement and returned to baseline levels within 24 hours. BPA was significantly elevated at all post–sealant placement time periods for both the low–dose (1 occlusal sealant application) and high–dose (4 occlusal sealant applications) groups with peak levels of 3.98 ng/ml and 9.08 ng/ml, respectively. The blood serum did not contain BPA at any point in this investigation.

Conclusions: Exposure to BPA from sources other than dental resins contributes to salivary baseline concentration levels and indicates environmental exposure and use of products containing BPA. Use of specific molecular formulations of dental sealant material determines the release of BPA, therefore, dental sealant materials should be reviewed independently when questioning the release of BPA from dental sealants. In addition, dosage amounts of the dental sealant material used in this study do not influence the serum concentration levels of BPA. Further research is needed to examine the cumulative estrogenic effects of BPA from dental sealants.

Keywords: sealants, dental, bisphenol A, estrogenic

This study supports the NDHRA priority area, Occupational Health and Safety: Investigate methods to decrease errors, risks and or hazards in health care and their harmful impact on patients.

Introduction

Occlusal sealants in permanent molars demonstrate caries–preventive effects, lasting 15 to 20 years.[1,2] Dental sealants differ from restorative composite fillings. Unfilled pit and fissure dental sealants contain only the dimethacrylate resin component of composite dental materials made of an organic monomer, bisphenol A–diglycidyl methacrylate (bis–GMA). This is the most commonly used resin matrix which is formed by reacting glycidyl methacrylate with bisphenol A (BPA).[3] Additional monomers, including acrylates and methacrylates, may be added to bis–GMA to dilute the resin and make the sealant material more flowable.[4] One of the most common monomers added to bis–GMA is BPA, which is a hormonally active, synthetic chemical and part of a broad group of chemicals known as endocrine disrupting compounds.[4] More specifically, BPA is a xenoestrogen, which mimics the relative bioactivity of estrogen.[5]

Among all xenoestrogens, BPA has received increased attention due to its pervasive presence in the environment and ubiquitous human exposure. BPA is used in the manufacture of polycarbonate plastics and epoxy resins and leaches from food and beverage containers, baby bottles, children's toys and dental sealants.[6–8] BPA leaches from some formulations of dental sealants, if not completely polymerized, may be released into the oral cavity as a result of enzymatic activity within saliva, and may be systemically absorbed by the patient.[9–11]

Perinatal low–dose exposure to BPA results in functional and morphological alterations of the rodent

genital tract and mammary glands, which may predispose the tissue to earlier onset of disease, increased infertility and mammary and prostate cancer, as demonstrated in vitro.[12] Fluctuations in hormonal exposure, especially estrogen during fetal development, is also thought to be a factor in prostate, breast and uterine cancers.[13–16] Although research shows that BPA leaches from the dental sealant into the saliva, the idea that it may be absorbed systemically into the blood or may have cumulative effects in the body should be a concern to all oral health care professionals because of the known xenoestrogenic effects of BPA.

It is crucial for dental professionals and the public to know if pit and fissure dental sealants that contain BPA pose a hidden risk to BPA exposure. This study measured BPA in the serum and saliva of adults after placement of dental sealants and the rate and time BPA might be released from a light cured dental sealant.

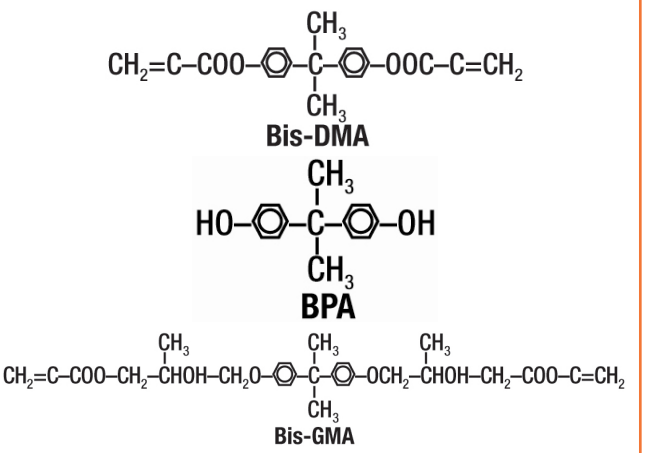
Dental Sealants

Dental caries is a preventable disease, but still remains the most common chronic disease of childhood in the United States, occurring 5 to 8 times more frequently than asthma, the second most common chronic childhood disease.[17] According to Healthy People 2010, focus area 21, the increased use of dental sealants and fluoridated toothpastes, community water fluoridation and stable dietary practices are all needed to continually reduce dental caries rates in the United States.[17]

Biochemistry of Dental Resin

Most dental sealants contain an organic resin matrix only, and therefore differ from resin composite material. The commonly used resin matrix bis–GMA has a foundational structure similar to an epoxy resin with a methacrylate group attached to each end of the carbon molecule, thus, bis–GMA is known as a dimethacrylate.[18] Monomers are added to dilute the viscous bis–GMA and enhance flow and mixing abilities.[4] These lower–molecular weight monomers may include triethylene glycol dimethacrylate (TEGDMA), ethylene glycol dimethacrylate (EGDMA) and BPA. If additional BPA is added to bis–GMA, dimethacrylate (BPDMA, bis–DMA) is created.[19] All monomers, including BPA, which are added to bis–GMA are based on carbon–carbon double bonds and react by polymerization, which links compatible monomers into a larger molecule called a polymer (Figure 1). As a result of the process of polymerization (curing), a chemical by–product is produced following the hardening of dental sealants.[18,19] This by-product presents itself as a tacky surface layer which varies in depth with different sealant products.[20] This layer of unpolymerized resin has been associated with BPA controversy.

Figure 1. Chemical structure of bisphenol A and related compounds



Pharmacokinetics of Bisphenol A

Olea et al[8] provided one of the earliest cell culture studies regarding the possible estrogenic activity of both bis–GMA resin–based composites and resin–based dental sealants. These bis–GMA materials included 3 different brands of composite resin and 2 batches of a single brand of a dental sealant material. To determine the estrogenicity of bis–GMA–based resins used in this study, experiments were conducted both in–vivo and in–vitro. The cell yield obtained with a 5 µg/ml sealant sample was 6–fold greater than in the control cultures, and demonstrated proliferative effects equal to the most potent estrogen hormone, estradiol. In contrast to the sealant sample, cell proliferation did not occur when exposed to the 3 resin–based composites at a maximum concentration of 1 mg/ml. The authors attributed these low cell proliferation rates of the composite resin to the high proportion of inorganic filler used in the formulation. As confirmed by the analysis profile, BPA and BPA dimethacrylate were present in all sealant samples. The study by Olea et al[8] initiated concern in the dental community and prompted dental researchers to examine the xenoestrogen threat from bis–GMA–based materials used in dentistry.

At the inception of the current study, only 1 other in vivo research project had been reported. The study was conducted by Fung et al,[9] and it evaluated whether BPA was being released from a particular dental sealant product. BPA in saliva was detected at a concentration of 5.8 to 105.6 ppb, collected at 1 and 3 hours after sealant application. This rate differed from findings of Olea et al, which revealed 3,300 to 30,000 ppb.[8] Fung did not detect BPA in saliva after 3 hours, and was not able to detect the compound in blood specimens.

A recent study evaluating the release of BPA following the placement of dental sealants was published in 2006 by Joskow et al.[11] This study examined 3 different brands of sealant material. The researchers examined BPA in saliva and urine samples at varying time intervals. One of the sealant material released more BPA than the other brands of dental seal-

ant material used in this study. The authors emphasized that the American Dental Association (ADA) only grants its Seal of Acceptance to those materials that do not release detectable levels of BPA (>5 ng/mL) prior to the cessation of this program.[11,21,22] The ADA recognizes that laboratory research demonstrates a xenoestrogenic effect from BPA that may affect reproduction and development. Based on present research evidence, BPA has no effects observed in humans. Although BPA is present in biological specimens after the placement of dental sealant, the ADA states that mere presence of this xenoestrogen in the environment or in human blood or urine samples "does not mean that the substance is necessarily causing harm."[22]

Effects of xenoestrogens and fluctuations in estrogen exposure have become the focus of current research. Scientific data suggests that changes in the fetal environment may predispose individuals to disease and/or organ dysfunction, which may not become evident until adulthood.[13-15,23] Scientists hypothesize that fetal exposure to environmental estrogens may be the underlying cause in an increased incidence rate of some cancers, including breast and testicular cancer.[2,23] For example, women aged 40 years and older who were exposed in utero to diethylstilbestrol (DES) have a 2.5–fold increase in the incidence of breast cancer when compared to unexposed women of the same age.[24,25]

BPA is present in the environment and is the principal monomer used to manufacture polycarbonate plastic at a rate of 6.4 billion lbs/year.[26] Heat and contact with acidic and basic compounds accelerate hydrolysis and degradation of the ester bond linking BPA molecules in polycarbonate and resins. Heating of cans to sterilize food and repeated washings of polycarbonate products have all been shown to increase exposure to BPA.[25] A daily ingestion value can be estimated at <1 µg BPA/kgBW/day, and is believed to be the main source of human exposure.[27,30] The U.S. Environmental Protection Agency estimates a safe dose calculated at 50 µg BPA/kgBW/day.[30]

Methodology

Prior to the start of this investigation, the protocol was reviewed and approved by the Old Dominion University Institutional Review Board ensuring the protection of human subjects. Participants comprised a convenience sample of 16 females and 14 males, 18 to 40 years of age with no history of dental sealants or composite material placement, and no previous exposure to BPA in its raw form. All data collection occurred at the Old Dominion University Dental Hygiene Research Center.

The researcher selected a widely used, commercially available light cured sealant material (Delton® Pit & Fissure Sealant – Light Cure Opaque, DENTSPLY Professional, York, PA). This sealant material uniquely contained 91.2% aromatic and aliphatic dimethacrylate monomers, 1.5% titanium dioxide (colloidal), 5.4% silica (colloidal), 1.0% ethyl–p–dimethyl–aminobenzoate and <1.0% light activators as described in the Material Safety Data Sheet.[32]

The participants were randomly divided into 2 groups a high–dose group and low–dose group. Participants were selected for each group based on the availability and eligibility of surfaces. Subjects in the low–dose group received 1 occlusal sealant only. Subjects in the high–dose group received 4 occlusal sealants. The amount of sealant material placed was reflective of clinical relevance and was applied according to the manufacturer's instructions.

This study utilized a BPA Enzyme Linked ImmunoSorbent Assay (ELISA) (Abraxis LLC, Warminster, Pa) to detect and quantitate levels of BPA in saliva and serum prior to and after placement of dental sealants in adults. The direct competitive ELISA protocol was used on the recognition of BPA by specific monoclonal antibodies. Distinctively, the BPA ELISA used in this study provided a high level of sensitivity, with a detection range from 0.05 µg/L to 10 µg/L and coefficient of variation less than 10%.

Quality control measures included performing sample titrations and spike recovery tests. Results of the sample titration produced 82% of maximum binding. Spike recovery tests were performed on 3 BPA ELISA plates to establish reliability and instrument validity. The average recovery rates were 86.83% and 80.18% for the spiked serum and saliva samples, respectfully.

Statistical Analysis

Parametric tests were chosen to allow testing of multiple variables and their interaction. Data collected were analyzed using a 2 way ANOVA for repeated measures. Dosage was used as the grouping factor and time was the repeated factor.

T–tests provided an indication of significance and direction (positive or negative) of sample differences. Statistical analysis for all data was accomplished using the Statistical Analysis System, SAS® version 9.1.

Results

The repeated measures of ANOVA for within subject effects revealed a statistically significant effect of time on salivary BPA levels of all samples (Table I). Further, the t–test revealed a statistically significant difference in the salivary BPA levels between the 1 hour pre– and 1 hour post–dental sealant placement (Table II). BPA was detected in all baseline saliva samples, and there was an increase in salivary BPA levels after placement of the dental sealant in all samples. The increase in BPA concentration readings 1 hour after sealant application suggests that BPA was released from the dental sealant material.

Although only slight, the t–test revealed a statistically significant difference in the salivary BPA levels between the 1 hour prior and 24 hours post (Table 2, Figure 1). A statistically significant difference at the 0.05 level established a difference in the amount of BPA detected in saliva

samples 1 hour prior to and 1 hour, 3 hours and 24 hours post–dental sealant placement in all samples. The serum BPA levels were below the limit of quantitation (<0.05 ng/mL).

The repeated measures of ANOVA for between subjects effects revealed a statistically significant effect of dose on salivary BPA levels (F=11.12, p=<.0001) (Table III). A post–hoc test (Tukey's) revealed a statistically significant difference between the mean salivary BPA concentration levels in the low–dose and high–dose groups at both the 1 hour (p=<.0001) and 3 hours post (p=0.0027) time periods. No statistically significant difference was revealed between the mean salivary BPA concentration levels in the low–dose and high–dose groups at either 1 hour prior (p=0.4328) or 24 hours post (p=0.3283) time periods. Figure 1 displays the mean BPA levels for both low and high–dose groups at all time periods.

Discussion

This exploratory investigation replicated the in vivo study conducted by Fung, et al.[9] Analysis of saliva samples at baseline revealed detectible levels of BPA (0.06 to 4.02 ng/mL) in each of the 30 samples measured 1 hour prior to dental sealant placement. The detection of salivary BPA in every participant suggests either short term or long term exposure levels. Detection of BPA in baseline readings from the current study differed from the findings of Fung et al, which did not detect salivary levels of BPA in any baseline samples.[9]

In vivo results from the current study, Fung et al[9] and Joscow et al[11] consistently reveal detectible levels of BPA in saliva at the 1 hour and 3 hours post–sealant application collection times, thus indicating the release of unpolymerized or leachable BPA from the same dental sealant material used in all 4 studies.[8,9,11] The dental sealant material used in all 4 studies contained bis–GMA combined with an additional monomer, BPA, result-

Table I. ANOVA Test for Saliva 1 hour pre– and 1 hour post–Sealant Placement

Source (n=30)	Sums of Squares	Degrees of Freedom	Mean Squares	F–Statistic	P–Value
Time	193.69	3	64.56	90.32	<.0001

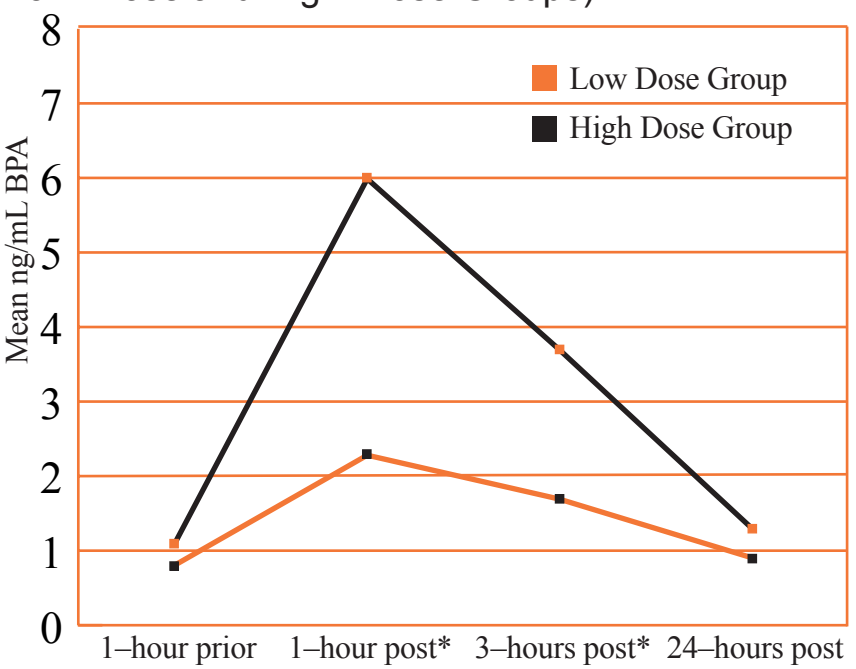
Table II. T–Test Results for Salivary BPA at the 1 hour Prior, 1 hour, 3 hours and 24 hours Post Time Periods

Difference (n=30)	Degrees of Freedom	t–Value	p–Value
1–hr prior 1–hr post	29	7.20	<.0001
1–hr prior 3–hrs post	29	6.34	<.0001
1–hr prior 24–hrs post	29	3.93	0.0005

Table III. Analysis of Variance Test for Salivary BPA Levels Between Low–Dose and High–Dose Groups

Source n=30	Sums of Squares	Degrees of Freedom	Mean Squares	F–Statistic	P–Value
Low–Dose and High–Dose Groups	84.38	1	84.38	11.12	<.0001

Figure 2. Overall Salivary BPA Concentration (*Indicates statistical Significant Difference Between Low–Dose and High–Dose Groups)



ing in bisphenol A dimethacrylate (BPDMA, bis–DMA)), however, the manufacturer's of these dental sealant products maintain the specific proprietary chemical formulation.

Salivary BPA levels demonstrate a peak level between the 1 hour and 3 hour post–application collection time. BPA levels began to reduce in concentration between the 3 hour and 24 hour post–application collection times, almost equating baseline with the final collection.

There was no BPA detected in the serum samples collected at the 1 hour and 3 hour post sealant application times. These findings are similar to those of Fung et al,[8] who did not detect BPA in any of the serum specimens examined in the study.[9] Implications from the findings of this study are that BPA is not absorbed into the blood circulatory system after exposure has occurred from the dental sealant formula used in this and previous studies.

Although not statistically significant, salivary BPA levels were different between the low–dose and high–dose groups when measured at baseline. This finding indicates a possible influence from an extraneous variable such as age. Additional extraneous variables that may have influenced differing salivary BPA levels between the low–dose and high–dose groups include gender, ethnicity and other demographic variables.

The specific molecular formulation of dental sealant material differs between manufactured brands of dental sealants, depending on chemical additives to bis–GMA[4] and may not be recognized by dental professionals. The amount of BPA exposure encountered in this study is below the allowable safe dosage/day as established by the U.S. Environmental Protection Agency, calculated at 50 µg BPA/kgBW/day.[31,33,34] It has not been established that this level of short-term (24–hour) exposure causes irreversible damage or poses a true health threat. Further research is needed to establish health effects of this short–term exposure.

National data confirms that 80% of dental caries risk is among children and the adolescent population, known as a focus group of dental sealants.[17] Considering sealants are applied during these adolescent, pubescent years of development, all precautions to reduce BPA exposure should be taken. It is important that dental professionals still apply dental sealants in the nation-wide effort to reduce dental decay.

Dental sealant formulations differ among manufacturers and may not directly specify if BPA was a precursor included in the foundational bis-GMA product, or if it was added as a monomer. BPA may not be indicated as a direct ingredient indicated on the Material Safety Data Sheet. Therefore, dental professionals should consult with each individual sealant material manufacturer and frequently review each product among the evidence-based clinical and laboratory research. To further reduce BPA exposure after sealant application, a pumice wash should be delivered to the surface with a prophylactic rubber cup and followed by a water rinse.[35,36]

Conclusion

Dental professionals should reduce BPA exposure to patients from dental sealants by using products that have the ADA Seal of Acceptance and adopt the accepted protocols for use. Future research should investigate the cumulative exposure effects of BPA on humans from dental sealants considering environmental influences. Studies should also analyze existing demographic data generated in this study to determine if there is a relationship between salivary BPA concentration levels and gender, ethnicity, age, marital status or household income. Replication of this study is recommended, using a larger sample population and analysis of biological specimens including semen, vaginal fluid, dental pulp tissue and hair follicles.

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Research

Anxiolytic Intervention Preference of Dental Practitioners in the Savannah, Chatham County Area: A Pilot Study

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Abstract

Purpose: The purpose of this study was to identify preferred anxiolytic interventions (AI) employed by dental practitioners in the Savannah, Chatham County area.
Methods: A questionnaire was developed to test dental practitioner preferences of 11 AIs shown to reduce anxiety in dental patients. The sample consisted of dental hygienists, dental assistants and dentists, randomly selected via the telephone book. A total of 305 surveys were distributed. Prior to voluntary completion of the questionnaire, respondents received oral and written instructions regarding the purpose of the study.
Results: A 43% return rate (n=131) was achieved. Results from analysis with the Median and Kruskal–Wallis tests suggested that the most commonly used AI was ambient background music (n=109, 83.2%). The second most commonly used AI was having literature available for patients to read (n=99, 75.6%), followed by providing a way for the patient to inform their provider of their anxiety (n=88, 67.2%), the use of pharmaceutical agents (n=79, 60.3%) and decorating the walls (n=68, 51.9%).
Conclusion: It is important for dental professionals to employ interventions and management techniques that may reduce dental anxiety.

Keywords: Anxiolytic intervention, dental anxiety, dental stress

This study supports the NDHRA priority area, Clinical Dental Hygiene Care: Assess how dental hygienists are using emerging science throughout the dental hygiene process of care.

Introduction

Dental anxiety presents a challenge that dental practitioners often face in their daily practice. Hainsworth et al has shown that approximately 31% of the adult population may suffer from some degree of dental anxiety.[1] Negative oral health consequences tend to arise in patients with dental anxiety. Patients who suffer from dental anxiety are nearly 5 times more likely to need immediate treatment to relieve oral–related pain or infection, and they tend to have fewer restored, and more missing, teeth.[2,3] Another significant factor associated with increased levels of dental anxiety is dental decay. Patients who have dental anxiety show significantly more carious lesions which are more likely to be extensive, painful and expensive to restore than less anxious patients.[3,4] A contributing factor to this phenomenon may be that patients who experience dental anxiety are more likely to stop or delay receiving dental treatment than those with less anxiety. Dental anxiety may also contribute to difficult patient management by dental practitioners.[3,5] Use of methods that may reduce dental anxiety may prove beneficial to both the patient and the dental provider. The purpose and focus of this study was to determine the anxiolytic interventions (AI) preferred and utilized by dental professionals in the Savannah, Georgia area.

Review of the Literature

Sources of Anxiety

Appreciation of the sources of patient dental anxiety may lead to the development of strategies and/or interventions that reduce anxiety. Patients' anxieties often arise from trypanophobia (fear of injections and needles), pain and sounds from dental drills and hand pieces. Moreover, the odor of tooth debris from the dental hand piece may also trigger anxiety.[6] Patients have also reported that they experience pseudodysphagia (fear of choking) during dental treatment.[6] Other common sources of dental anxiety are memories of pain previously experienced during one's own dental visit, knowledge of another person's negative dental experience or locus of control. Researchers have found that dental hygiene treatment is strongly correlated with pain perception.[7,8] According to de Jongh and Stouthard, merely the expectation of pain tends to increase patient anxiety levels during oral hygiene procedures.[7] Investigators have noted a positive correlation between the level of dental anxiety and the level of dental pain fear.[9]

Additionally, the lack of explanation about the treatment plan may cause the patient to feel anxiety about the proposed procedures.[5]

In a randomized, controlled study of 119 patients, Dailey et al found patient anxiety levels decreased significantly when the dentist was made aware of the patient's anxiety prior to dental treatment.[10] Having the anxious patient complete a survey, such as the Dental Anxiety Scale or Dental Fear Survey by which fear levels can be assessed, may be helpful to the dental team in reducing patient discomfort.[11] In fact, Eitner et al revealed that when anxious patients are referred to an office where the staff does not utilize anxiety reducing methods, the anxiety is renewed.[4] Locker, et al reported that initial incidences of fear occur during childhood and adolescence for the majority of patients who report dental anxiety.[12] It also has been reported that anxiety levels increase when a dental professional does not seem empathetic, personable or supportive of the patient's fears.[13,14] Additionally, Levin et al concluded that, during childhood, the patient's regularity of dental visits played a significant role in the development of dental anxiety. If, during childhood, the patient sporadically attended dental visits, then the patient was more likely to become an anxious dental patient. Alternatively, those who visited dental offices on a regular basis tended to have less dental anxiety.[13,15] Firat et al also detected a positive statistical relationship between dental fear and age – as one ages there is a tendency to be more fearful.[16] Similarly, Kumar et al concluded in a study of 1,235 individuals that older patients experienced significantly higher dental anxiety levels than those who were younger.[17] However, Udoye et al found opposing results, i.e., the Dental Anxiety Scale scores for older individuals were significantly lower.[14] Settineri et al found that gender also plays a role in dental anxiety, as female patients tended to have higher rates of dental anxiety than male patients due to chair positioning. The researchers reported that the supine position of the chair caused the female patient to have a feeling of lack of air, an absence of muscle tension and being in a subordinate position.[6] Similarly, Firat et al found that females scored higher on the Dental Fear Scale.[16] Researchers agree that, although men frequently experience genuine dental fear and phobia, women tend to be more likely to have dental anxiety.[18–21]

Anxiolytic Interventions

As previously noted, studies have been conducted to determine the interventions most effective in reducing anxiety in dental patients. Interventions range from simple environmental changes (i.e. aromatics) to more involved interventions such as relaxation, hypnosis and guided imagery techniques.[22,23] Bare et al found in their study that patients tend to prefer dentists who are friendly and talkative.[5] It was found that anxious patients preferred a male dentist (93%) more than a female dentist (73%). Hainsworth et al suggest that the fear of the unknown may underscore a patient's anxiety, so it is recommended that the dentist keep the patient well informed about their treatment[1] and to reassure them that treatment will be completed with minimization of pain or discomfort.[5,23] A study by Dailey et al found that patients who inform the dentist about their apprehension can significantly reduce anxiety.[10] Eitner et al found that many patients expected they would receive better treatment if their dentist understood their anxiety.[4]

Most dental anxiety is caused by the anticipation of and the use of drills, hand pieces and needles.[24] In an effort to avoid use of such instruments, an alternative approach to restoration procedures that may be utilized is the Atraumatic Restoration Treatment (ART) approach.[25] This technique uses hand rather than mechanized instruments for restorative procedures, thereby often eliminating the need for local anesthesia.[25]

Subtle changes in the dental office environment may also be helpful. Investigators have found that patients prefer pleasant brightly decorated walls and the availability of a large selection of magazines, books, background music and pleasant scents while they await treatment.[5,13] Moreover, the available reading material should include information packets or leaflets about the services or treatments available. Additional studies have shown that aromatics in the dental environment have the capability to change one's emotional state. Lehrner et al found that aromatics of orange and lavender in the dental office reduced patient anxiety and increased a sense of mood enhancement and calmness.[26] Hainsworth et al found that the use of basil, chamomile, cypress, jasmine, juniper, rose and sage scents were beneficial in reducing patient anxiety.[1]

According to Buchanan and Coulson, support groups were beneficial for individuals suffering from dental anxiety.[27] The growth of the internet has increased the opportunity for people to find help and support for dental health related issues online. The authors claim that support groups give patients the ability to share experiences from the past and discuss their dental fears in an environment that is supportive.[27] These groups may not eliminate their participants of their fears in every case, but they can help participants realize that others share their apprehensions about dental procedures, which may improve their coping strategies and bolster their confidence to confront their fears.

According to researchers, relaxation therapies, breathing techniques and biofeedback have proven to be beneficial for the treatment of adults with dental anxiety and/or fear.[1,28] Through the use of these

techniques, a patient can explore ways to self–cope with their dental anxiety. Patients have successfully used relaxation and breathing techniques because they are easily learned, unobtrusive and quickly utilized in a dental environment.[1] According to Bare and Dundes, a more common method of managing an anxious patient prior to dental treatment is by the administration of pharmacological agents. Nitrous oxide and other compounds have been known to significantly reduce dental anxiety.[5]

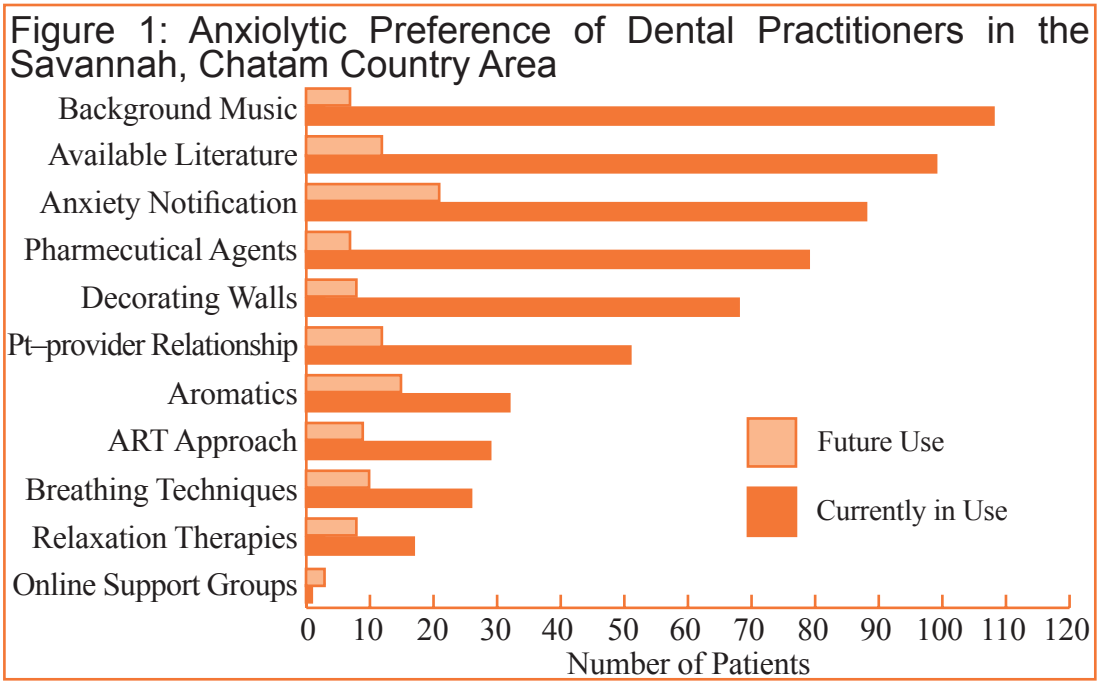

Figure 1: Anxiolytic Preference of Dental Practitioners in the Savannah, Chatam Country Area

Equipped with the knowledge of previous and ongoing studies regarding AIs, dental practitioners have numerous AI options from which to choose. Results from this literature review suggest that little data exists concerning the use of AIs and, if interventions are used, how often specific AIs are incorporated into dental practices. Therefore, the purpose of this pilot study was to determine the current use of anxiolytics and plans for future use in private dental practices in the Savannah, Georgia area.

Methodology

This descriptive study was conducted in the Savannah, Chatham County area, after Institutional Review Board approval was granted from Armstrong Atlantic State University. A total of 305 surveys were hand delivered to 45 dental offices during the winter of 2008. Using simple random sampling, the dental offices selected for the survey were found in the Yellow Pages telephone book for the Savannah, Georgia area. Each office representative received a brief verbal introduction to the study and was instructed to make the surveys available to all dental hygienists, dental assistants and dentists for voluntary completion. The office representative also received a plain white envelope in which the completed survey was to be placed, a measure to maintain anonymity. Each office staff was allowed a period of 2 weeks to complete the survey, at which time the survey was collected by the researcher. For this study, AI is operationalized as a method used to reduce dental anxiety.

The Survey

A survey questionnaire was created by the researcher to inquire about dental practitioner preference of 11 interventions that suggest reduction of anxiety in dental patients (Table I). Each intervention was ranked according to a Likert Scale of: (1) unlikely, (2) somewhat likely, (3) neutral, (4) likely, (5) most likely and (6) currently in use.

The survey also asked for participant demographic information, such as role in dental office (e.g., dental assistant, dental hygienist or dentist), gender, ethnicity and age. These factors were collected to determine if relationships existed among specific interventions. A cover letter accompanied the survey to describe the purpose of the study and to obtain informed consent.

Statistical Analysis

Using the statistical software SPSS 15.0 for Windows, each demographic factor was cross analyzed with each of the 11 AIs. The Kruskal–Wallis test was used to investigate statistically significant differences in the data at the $p=0.05$ level.

Results

The surveys were distributed to 305 potential participants. A total of 131 surveys were returned for a response rate of 43%. Usable surveys totaled 124 (41%). Eighty–three percent of the respondents were female (n=100) and approximately 49% were dental hygienists (n=61).

Figure 1 displays the current and future uses of AI in the dental offices studied. The most commonly used AI was ambient background music with 83.2% (n=109) participants currently incorporating it into their practices. The second

most commonly used AI (75.6%) was having available literature such as magazines, books and dental literature for patients to read. The third, fourth and fifth most commonly used AIs were provision of ways for the patient to inform their provider of their anxiety (67.2%), the use of pharmaceutical agents (60.3%) and decorating the walls (51.9%). Projected future use of AI, those interventions dental practices were "most likely" to incorporate, included anxiety notification (n=21), the use of aromatics (n=15), making literature available (n=13) and altering the patient–provider relationship (n=13).

The Kruskal–Wallis Test cross–analysis of the demographic factors and the AIs enabled possible relationships to be recognized. Specifically, statistical analysis of the median tests of each gender with each AI revealed no association between gender and any ranking of AI except the ART approach ($p<0.001$). Comparison of reported intention to utilize AI techniques by dental office role (i.e., dental assistant, dental hygienist or dentists) resulted in no statistically significant differences. Other than with the ART approach, the participants of each gender appeared to have similar preferences of the AI. Only 20% of male participants (n=25) versus 52% of female participants (n=64) reported a likelihood greater than "neutral" of incorporating the method into their practice. Similarly, no statistically significant differences existed between the participants' roles in any AI except the ART approach ($p=0.001$).

Discussion

This study was a pilot test to investigate the current and future use or AI in dental practices. Due to the small sample size and the limited location of the study, the results cannot be generalized to the rest of the population. However, the study may enhance the body of knowledge regarding the frequency of and types of AIs used in dental offices. The results may also add support to previous studies regarding various AIs in the reduction of dental anxiety.

The study did reveal similar results of previously conducted studies regarding the types of AIs used. Bare and Dundes found that up to 89% of the patients in their sample population reported that music, available literature and decorated walls in a dental office setting were helpful in reducing anxiety.[5] Likewise, in our study, the same 3 AIs ranked in the top 5 most commonly applied AIs. Additionally, anxiety notification, included in the top AIs in the Bare and Dundes' study, ranked third overall in our study. De Jongh et al concluded that one of the best AIs for patients with mild dental anxiety is establishing their trust, and that a part of developing this trust is having the practitioner acknowledge the patient's dental anxiety. In addition to developing patient–provider trust, pharmacological support may also be necessary.[29] Incorporation of conscious sedation has proven to be "reliable and safe" and has traditionally been used to help manage dental anxiety.[1] Not surprisingly, the application of pharmacological agents was reported the fourth most commonly used AI in the Chatham county area. Although the results from this study showed AI preference of practitioners rather than AI preferences of patients, it seems that the preferences are similar for both patient and practitioner. Similarities in the results of provider AI preferences and patient AI preferences from other studies were also consistent with the least preferred AI online support groups. Although this manner may be easy and effective, this result is not surprising, considering the idea of online support groups is still relatively new.[27] "To date, there has been relatively little attention given to understanding the online experiences of dentally anxious or phobic patients."[27] Therefore, it is recommended further studies pursue this area of research. Excluding the ART approach, results indicated that the respondents in this study appeared to have similar preferences for AI use as were reported in previous studies. Since the majority of the dentists were male and nearly all dental assistants and dental hygienists were female, one may explain similarities in association of roles in the dental office and gender with the ART approach. This study raised perhaps as many questions as were answered. Therefore, additional research is warranted in this type of patient management.

Conclusion

Dental anxiety represents an important issue among the adult population. Study results, as well as anecdotal findings, reveal that there are detrimental effects that dental anxieties can have on a person's oral health. Therefore, it is important for dental professionals to employ interventions and management techniques that may reduce dental anxiety. Further research may suggest broader applications.

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