



American
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Association

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- Antimicrobial Resistance – The Global Threat: State of the Science
- Considerations for Treating Women with Cancer
- Thirty Years of HIV/AIDS and Related Oral Manifestations and Management
- Medical and Dental Implications of Eating Disorders
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- A Racial Comparison of Sociocultural Factors and Oral Health Perceptions
- In Vitro Effect of Over-the-Counter Probiotics on the Ability of *Candida Albicans* to Form Biofilm on Denture Strips

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STATEMENT OF PURPOSE

The *Journal of Dental Hygiene* is the refereed, scientific publication of the American Dental Hygienists' Association. It promotes the publication of original research related to the profession, the education, and the practice of dental hygiene. The Journal supports the development and dissemination of a dental hygiene body of knowledge through scientific inquiry in basic, applied and clinical research.

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Editorial

Ann Eshenaur Spolarich, RDH, PhD; Jane L. Forrest, RDH, EdD

The Value of Dental Hygiene Research Conferences



The National Center for Dental Hygiene Research & Practice (NCDHRP) is pleased to announce the upcoming 3rd North American/Global Dental Hygiene Research Conference, "Beyond the Boundaries: Discovery, Innovation and Transformation," on October 16 through 18, 2014 in Bethesda, Maryland. This is the third major conference hosted by our organization.^{1,2} In addition to our major conferences, the NCDHRP hosts regional conferences to disseminate knowledge about significant oral health topics and the delivery of oral health care services. We invite you to read several papers from the conference, "Advances in Practice," which are published in this issue of the Journal of Dental Hygiene.

It is essential that members of the dental hygiene research community join together to purposefully address the oral health objectives prioritized by our respective professional organizations. Dental hygienists must work together to gather information in a logical and structured manner in order to have the scientific database capability to answer important oral health research questions to improve patient care outcomes. A collaborative model allows researchers to maximize the utilization of limited resources and to share expertise for developing strategies to study common global oral health problems.

A coordinated effort also will promote contributions to the literature that add to the unique body of knowledge needed for the growth of the profession. Further, this knowledge will be based on sound scientific research that translates to an evidence-based approach to dental hygiene education and practice. The growth of the profession through published research is a critical aspect of professionalization, and enables those outside of the profession to learn about efforts made in meeting oral health objectives. Research conferences are important vehicles to bring members of the global dental hygiene community together to share their efforts in these activities, receive training, build new skills and discuss strategies for moving the profession forward.

Dental hygiene theory and practice must be based on sound research and scientific information. A research infrastructure provides the organization and resources that enable both the systematic and pur-

poseful building of a rigorous body of knowledge.^{3,4} A research infrastructure fosters the development and advancement of long-term research programs, enables discussion and dissemination of research findings, and supports the systematic building of a scientific knowledge base that informs practice. There are 5 essential and interrelated elements of a research infrastructure:

- A critical mass of researchers/scientists
- Research priorities that produce clinically relevant knowledge
- Communication systems that promote linkages among researchers and increase access to research findings
- Funding mechanisms to support research
- Demonstrated value for research and its relationship to practice^{3,4}

Research conferences play a significant role in bringing together the growing critical mass of dental hygiene researchers, who are dispersed geographically and across a multitude of diverse employment settings throughout North America and abroad. Conferences enable dental hygienists from academia, industry, government, public health and clinical practice to network and share their interests to help each other better address the significant oral health needs of the public. It is a logical and cost-effective strategy to engage more dental hygienists in oral health research, as they possess expertise in health prevention and behavioral change, and because so many are already working with underserved and underrepresented populations using many different models of care delivery. Conferences facilitate collaboration, knowledge exchange, prioritization of research pathways and funding strategies, and dissemination of funding opportunities to support projects. Identifying and securing funding is an essential element to building a research infrastructure. Establishing relationships through shared commonalities and research interests results in partnerships which broaden the efforts of dental hygiene investigators through intra- and interprofessional collaboration. Thus, research conferences support the socialization of the profession around its scientific base and other essential components of a successful research infrastructure.

Recommendations for Future Research Activities

In order to systematically and purposefully advance our oral health research efforts, we suggest that the global dental hygiene research community consider the following recommendations for achieving common objectives:

- **Recommendation #1:** Initiate long-range planning to guide research efforts and to promote the continued development of a unique body of knowledge for the profession.
- **Recommendation #2:** Create a database of researchers, proposed investigations, research in progress, and completed research in order to monitor ongoing efforts, and to exchange ideas for future research.
- **Recommendation #3:** Educate dental hygienists to evaluate the scope, quality, merit and utility of research studies used to guide evidence-based practice.
- **Recommendation #4:** Utilize national oral health and dental hygiene research agendas as the driving forces behind the primary work efforts of our professional organizations to support the objectives of our respective strategic plans.
- **Recommendation #5:** Create opportunities for faculty to share effective strategies for teaching and mentoring novice researchers.
- **Recommendation #6:** Increase the number and preparation of dental hygiene researchers.
- **Recommendation #7:** Utilize our graduate dental hygiene programs as a resource to assist in our efforts to accomplish the objectives set forth by our research agendas.
- **Recommendation #8:** Work collaboratively within the global dental hygiene community to generate ideas for targeted research projects,

and to identify researchers and potential sources of funding.

- **Recommendation #9:** Host research conferences on a regular basis to facilitate networking, sharing and disseminating research findings, and keeping current with trends and innovations.

Dental hygiene research conferences contribute to strengthening the infrastructure critical for the growth of our profession. The small community of dental hygiene researchers, coupled with the limited availability of funds and competitive nature of grant awards, requires a careful examination of and consensus as to how to move forward with our plans for research. Clearly, a coordinated, viable structure for the conduct of research will allow for maximum gains in attaining and disseminating new knowledge that will ultimately translate into practice.^{3,4} We invite all members of the dental hygiene community to participate in these conferences, as our collective input is essential for advancing the profession.

Sincerely,

Ann Eshenaur Spolarich, RDH, PhD
Clinical Associate Professor, Division of Dental Public Health and Pediatric Dentistry; and
Associate Director, National Center for Dental Hygiene Research & Practice
Ostrow School of Dentistry of USC

Jane L. Forrest, RDH, EdD
Professor of Clinical Dentistry and Section Chair, Behavioral Science
Division of Dental Public Health and Pediatric Dentistry; and
Director, National Center for Dental Hygiene Research & Practice
Ostrow School of Dentistry of USC

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Antimicrobial Resistance – The Global Threat: State of the Science

Louis G. DePaola, DDS, MS

Introduction

Before the discovery of antibiotics, millions of people died from a multitude of infectious diseases (IDs). Completely vulnerable populations died from tuberculosis (TB), syphilis, pneumonia, diphtheria and other IDs. Bacterial infections with *Staphylococcus* and *Streptococcus* had a sudden onset, progressed rapidly and were often fatal. In 1900, the 3 leading causes of death were pneumonia, TB and diarrhea/enteritis, with >30% of all deaths occurring in children <5 years old.¹ Prevalence of syphilis in the U.S. was estimated to be 5 to 10% in the general population, and as high as 25% in lower socioeconomic groups.¹ Medical science searched desperately for safe and effective antimicrobial drugs to treat these infections, which resulted in the trial of many formulations. Most of these had little or no efficacy, while some also caused serious, and sometimes fatal, adverse side effects. However, one formulation proved to be effective. In the early 1930s, sulfa drugs were found to have antibacterial properties and the sulfonamides became the first antibiotic drugs. Although these drugs were very limited in efficacy and caused numerous side effects, the sulfonamides started the antibiotic revolution in medicine. In 1928, Alexander Fleming observed that a culture of *Staphylococcus aureus* had been contaminated by a blue-green mold and bacterial colonies adjacent to the mold were killed. He isolated this mold, which he called penicillin, and found that it had significant antimicrobial properties.^{1,2} By the early 1940s, penicillin proved to be much more effective and safer than sulfa drugs and was produced in substantial quantities for medical use.^{1,2} The antibiotic era was born.

Penicillin quickly became the standard of care for most bacterial infections. During the 1950s and 1960s, new antibiotics were developed and immediately prescribed in clinical practice. During this "Golden Age of Antibiotics," death rates due to IDs in children <5 years of age plummeted from 30.4% in 1900 to 1.4% in 1997.² Between 1944 and 1954,

Abstract

This manuscript was part of the proceedings from the conference Advances in Practice, hosted by the National Center for Dental Hygiene Research & Practice, held in Phoenix, Arizona, on June 12, 2012.

Keywords: antibiotics, antimicrobial resistance, infection control

This study supports the NDHRA priority area, **Clinical Dental Hygiene Care:** Assess the use of evidence-based treatment recommendations in dental hygiene practice.

rates of reported cases of syphilis decreased by more than 75%; by 1975, syphilis had declined by almost 90%.² Deaths from TB, diphtheria, Streptococcal and Staphylococcal infections, gonorrhea, and other IDs were dramatically reduced.² There was a 25% decline in deaths due to community-based pneumonia, a mortality decrease of 30% in hospital-based pneumonia, a 75% decrease in deaths from bacterial endocarditis (almost 100% fatal) and a 60% decrease in deaths from brain infection.² Additionally, mortality from complex skin infection was reduced by 3%. To put this into perspective, treatment of all heart attacks with aspirin and clot busting drugs combined has only reduced mortality by a total of 3%. Accompanied with other improvements in public health practices, such as immunizations and improvements in sanitation, housing and nutrition, antibiotics significantly contributed to the increased life expectancy of almost 30 years in the last century and radically reduced the morbidity and mortality from bacterial pathogens.¹

The remarkable success of antibiotics cannot be overstated; however, their success, in large part, has contributed to their decreasing effectiveness. Almost immediately after introduction into clinical use, antimicrobial resistance (AMR) began to be reported.³⁻⁶ However, the prevailing beliefs at the time were that:

1. Frequency of mutation to AMR would be too low to be of consequence
2. Resistance to more than 1 class of antibiotic at

the same time could not occur

3. Mutations to AMR would make bacteria less fit and virulent
4. Microorganisms were not capable of horizontal gene transfer³⁻⁶

All of these beliefs about AMR have been proven to be false and very little was done to address the issue of AMR. New antimicrobial drugs would be developed that would treat any emergent resistant infections and resistance to that drug would invariably develop. As the cornerstone of medicine, antibiotics were used almost universally to treat every type of infection in all disciplines of health care, regardless of the indication(s).³⁻⁶ Today we are confronted with numerous, highly resistant organisms, some of which have developed novel resistance mechanisms that make it very difficult and more expensive to treat these infections.³⁻⁶ Some organisms, commonly referred to as "superbugs," have developed such a high degree of resistance that antimicrobial agents remain ineffective.³⁻⁶ Some infections from these superbugs, such as the carbapenem-resistant *Enterobacteriaceae*, are simply not treatable.⁷

An antimicrobial is a substance that kills or inhibits the growth of microorganisms (bacteria, virus, fungus, parasites).³⁻⁶ AMR is defined as the ability of a microorganism to grow in the presence of a drug that would normally kill it or inhibit its growth, granting that particular bacteria, virus, fungus or other microbe the ability to resist the effects of an antibiotic/antimicrobial agent.³⁻⁶ There are a multitude of mechanisms that lead to the development of AMR resulting in the partial or complete reduction of efficacy of the particular antimicrobial drug that was previously effective in killing the organism.³⁻⁶ Once resistant organisms develop, they can rapidly replicate and pass to their progeny this newly acquired trait perpetuating the resistant strain.³⁻⁶

AMR is a worldwide problem and has resulted in a dramatic increase in antimicrobial-resistant health care-associated infections, as well as community-acquired infections.³⁻⁶ The development of AMR is complex and multifactorial. However, 4 recognized and significant factors play a major role in the development of AMR:³⁻⁶

1. Indiscriminate/inappropriate use of antibiotic/antimicrobial agents in all health care settings
2. Overuse and/or misuse of antibiotics in farming/animal husbandry
3. Noncompliance with infection control practices
4. Adaptability of the organisms and natural biological changes (mutation and gene transfer)³⁻⁶

In order to survive in unfavorable environments, microorganisms are very adaptable and are constantly changing. Thus, the development of drug resistance is a natural evolutionary biological process.³⁻⁶ When an organism is exposed to an antimicrobial agent, the organism is either killed or it is not. The surviving organisms are resistant and by natural selection, these organisms thrive.³⁻⁶ Therefore, one of the most significant factors in the development of AMR has been the indiscriminate and inappropriate use of antibiotics which has occurred over many decades and in almost every health care setting.³⁻⁶ Throughout the world, antibiotics, which act only on bacteria, are routinely and inappropriately prescribed for colds and other viral infections for which they are ineffectual and not indicated.^{3,4} According to the World Health Organization, up to 50% of antimicrobial use is inappropriate.^{4,6} Antibiotics are routinely:

1. Given when they are not needed
2. Continued when they are no longer necessary
3. Given at the wrong dose
4. Broad spectrum agents are used to treat very susceptible, non-resistant bacteria
5. The wrong antibiotic is given to treat an infection^{4,6}

Additionally, the increase in the number of bootleg drugs has compounded the problem. Patients may be given drugs with little or no active drug, or even a different drug. In the U.S., the FDA estimates that 1% of prescription drugs are actually counterfeit. The Internet is a perfect avenue for the sale of bootleg or counterfeit pharmaceuticals.⁶

The excessive and widespread use of antibiotics in animals cannot be underestimated. Identical antibiotics/antimicrobials used in humans are also used extensively in all aspects of agriculture and veterinary medicine. Sub-therapeutic doses of antibiotics are used in animal industry to promote growth or prevent diseases.⁶ This can result in resistant microorganisms which are transmissible to humans. It is estimated that as much as 70% of the antibiotics produced in the U.S. are used in animals.

Non-compliance with infection control amplifies and perpetuates drug resistance throughout a health care facility.^{5,8,9} Health care workers' compliance with hand hygiene is low, usually around 40%. Needles are often reused, drugs are improperly administered, and reusable medical instruments and devices are not properly cleaned, disinfected and/or sterilized.^{5,8,9} Clearly, improvement in compliance with standard precautions and safe injection practices is warranted and CDC recommendations

for infection control must be implemented and adhered to for every patient everyday.^{5,8,9}

Finally, microorganisms can acquire AMR by development of a genetic mutation (biological evolution), some of which confer drug resistance to that organism.³⁻⁶ Additionally, non-resistant bacteria receive the new DNA and become resistant to drugs by a process known as gene transfer, which can occur across multiple microbial species.³⁻⁶

In order to minimize the impact and development of drug resistance, all clinicians must prescribe antimicrobial drugs, inclusive of antibiotics, antifungals and antiviral agents, only when indicated and in the proper formulation and dosage.^{5,8,9} Compliance with standard precautions and the principles of infection control as recommended by the CDC and other public health agencies must be enforced in every setting in which health care is performed.^{5,8,9}

The purpose of this article is to raise clinician's awareness about the very grave problem that an-

timicrobial resistance poses in all health care settings (including dental) throughout the world. Translating the science and microbiology into clinical practice, while not addressed here, will require life-long learning, compliance to recommended guidelines and constant modification of how health care is delivered. The recent breach in fundamental infection control in a dental office in Oklahoma clearly illustrates the adverse sequelae of failure to comply with the principles of infection control and has prompted the following statement: "ADHA urges all dental hygienists to maintain the highest standards and employ the best practices for infection control."¹⁰ The Organization for Safety, Asepsis and Prevention is a valuable asset that can help clinicians incorporate the state of the science into their dental practices.¹¹

Louis G. DePaola, DDS, MS, is a Professor and Assistant Dean of Clinical Affairs at the Department of Oncology and Diagnostic Sciences, School of Dentistry, at the University of Maryland.

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Short Report

Considerations for Treating Women with Cancer

JoAnn R. Gurenlian, RDH, PhD

Introduction

It is estimated that approximately 44.85% of the U.S. population will develop cancer at some point in their lives.¹ According to the National Cancer Institute and the American Cancer Society, over 1.6 million new cases of cancer will occur in 2012, with over 577,000 cancer related deaths. Cancer accounts for 1 in 4 deaths and is the second leading cause of death in the U.S.^{1,2}

With respect to cancers affecting women, Table I highlights current statistics concerning incidence and survival.¹⁻³ As can be seen from this table, women remain challenged to address this health concern. Current approaches to prevention of women's cancers include screenings such as a PAP test, HPV DNA test, self-examinations and clinical examinations by specialists during routine gynecologic visits. Approaches to diagnosing women's cancers range from physical examination and blood studies to radiography evaluations (ultrasound, CT/PET scans, diagnostic mammograms and MRI) and biopsy. Treatment of women's cancers consists of surgery, radiotherapy, chemotherapy, nutrition and complementary medicine. Although these methods are beneficial, there remains room for improvement. Fortunately, numerous research studies are being conducted to address women's cancer prevention, diagnosis and treatment. The purpose of this paper is to highlight current research related to women's cancers demonstrating the prospect of hope for the future health of women.

Preventing women's cancers requires due diligence on the part of females, their sexual partners and health specialists. Surgeries, vaccinations, healthy lifestyle choices and medication supplements are being investigated to determine the impact of prevention in lowering cancer risk. Table II presents preventive approaches that have shown promise in this regard.⁴⁻⁶

Diagnostic markers are being studied to determine if there are other means of identifying early female cancers. Although the blood marker CA-125

Abstract

This manuscript was part of the proceedings from the conference Advances in Practice, hosted by the National Center for Dental Hygiene Research & Practice, held in Phoenix, Arizona, on June 12, 2012.

Keywords: women's cancers, HPV testing, cancer prevention

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.

has been available as a marker for ovarian cancer, it has limitations in terms of sensitivity and specificity. Current studies have been evaluating the effectiveness of lysophospholipids, growth factor, soluble urinary type plasminogen activator, matrix metalloproteinases, hypermethylated gene products, extracellular matrix proteins, HE4-protein overexpression and ovarian screening using saliva testing as mechanisms for the detection of ovarian cancer. In addition, gene expression profiling and biomarkers, such as clusterin, TP53 and HE4, are being evaluated to predict ovarian cancer tumor behavior. In the near future, diagnostic markers for ovarian cancer may be available that are more accurate than CA-125.

Considerable research is being devoted to diagnostic HPV testing across the globe as it relates to cervical cancer. Studies are examining high risk types of HPV, the safety of delaying cervical cancer screening if HPV testing is negative, if the HPV test may be used as a reliable screening test for women in multiple age groups, the possibility of home kits for HPV testing and the use of computerized PAP tests for cervical cancer screening. A new vaccine to target L2, a minor surface protein for HPV, for broader protection is being evaluated, as well as the efficacy of HPV RNA testing. The overexpression of DEK oncogene is being studied to determine if it may be useful as a diagnostic test for cervical tumors and cancers. These studies may help to refine screening and diagnostic procedures for cervical cancer.

Diagnostic procedures being investigated for

Table I: Cancer Statistics¹⁻³

Cancer Type	Rate in 2012	Mortality in 2012	Survival
Ovarian	<ul style="list-style-type: none"> 22,281 new cases 	<ul style="list-style-type: none"> 15,550 will die Fifth leading cause of cancer death in women age 35 to 74 Highest mortality of all cancers of the female reproductive system 	<ul style="list-style-type: none"> 90% if detected early Only 20% found at an early stage Stage III or higher, survival rate is ~29%
Cervical	<ul style="list-style-type: none"> 12,170 new cases 	<ul style="list-style-type: none"> 4,220 will die Number one cause of cancer-related deaths among women in developing countries 	<ul style="list-style-type: none"> 68.6%
Breast	<ul style="list-style-type: none"> 226,870 new cases in women 2,190 new cases in men 	<ul style="list-style-type: none"> 39,920 women will die; 410 men will die Breast cancer kills someone in the world every 69 seconds 	<ul style="list-style-type: none"> 89%

Table II: Prevention of Women’s Cancers⁴⁻⁶

Cancer Type	Prevention Strategies Investigated Showing Favorable Outcomes
Ovarian	<ul style="list-style-type: none"> Oral contraception (lowers risk 30 to 50% if used 3 years or more) Breast feeding Pregnancy (first born before age 25) Tubal ligation (including removal of fallopian tubes) Hysterectomy Prophylactic oophorectomy (does not lower the risk for primary peritoneal carcinoma) Maintain healthy weight/eat healthy Exercise/be active
Cervical	<ul style="list-style-type: none"> Vaccinations (protects against cervical pre-cancers and cancers associated with HPV) Limit number of sexual partners Maintain monogamous relationship with someone who has had few sexual partners Use condoms (areas not covered by a condom are still exposed to skin-to-skin sexual contact)
Breast	<ul style="list-style-type: none"> Use of tamoxifen, raloxifen to lower hormone levels Use of aromatase inhibitors (anastrozole, letrozole, exemestane) to reduce the risk of developing breast cancer in post-menopausal women Use of fenretinide to reduce the risk of breast cancer

Table III: Types of Investigations for Treatment of Women’s Cancers⁷

Cancer Type	Types of Clinical Trials
Ovarian	<ul style="list-style-type: none"> Poly (ADP-ribose) polymerase (PARPs) – helps fight cancers caused by mutation in BRCA 1 and BRCA 2 Tumor vaccines that program the immune system to better recognize cancer cells Monoclonal antibodies (farletuzumab, catumaxomav, apomab) that specifically recognize and attack ovarian cancer cells Consolidation therapy – chemotherapy, growth factor inhibitors, and monoclonal antibodies
Cervical	<p>Pre-Cancers</p> <ul style="list-style-type: none"> Diindolylmethane (DIM) used for 12 weeks Cidofovir applied to cervix <p>Cancer</p> <ul style="list-style-type: none"> Surgical approaches – laparoscopic radical hysterectomy, robotic radical hysterectomy, total mesometrial resection, radical trachelectomy, laparoscopic radical trachelectomy Intensity-modulated radiation therapy (IMRT) Brachytherapy Targeted therapy – Pazopanib, bevacizumab and lapatinib
Breast	<p>Targeted Therapies</p> <ul style="list-style-type: none"> HER2 –TDM-1, pertuzumab and neratinib Anti-angiogenesis drugs – bevacizumab Epidermal growth factor – cetuximab, erlotinib Everolimus with letrozole Bisphosphonates – Aredia and Zometa Vitamin D Denosumab – inhibits RANKL

Table IV: Examples of Current Clinical Trials with Contact Information

Cancer Type	Trial	Contact Information
Ovarian	<ul style="list-style-type: none"> • Bevacizumab (advanced ovarian cancer) • Morab-003 (relapsed ovarian cancer) • Bevacizumab (relapsed ovarian cancer) (study ID: GOG-0213) • Vargatef (BIBF 1120) (ovarian cancer) • AMG 386 (ovarian cancer) 	<ul style="list-style-type: none"> • Lillian Hu 415-885-7206 • Susan C. Weil, MD 610-423-6182 • NCI –multiple locations 800-422-6237 • Boehringer Ingelheim Call Center 800-243-0127 • Amgen Call Center 866-572-6436
Cervical	<ul style="list-style-type: none"> • PARP inhibitor and chemotherapy (for women who have not responded to previous treatment) NCI-11-C-0022 • Ixabepilone (advanced cervical cancer that has recurred or demonstrated resistance prior to chemotherapy and cannot be treated surgically) • Paclitaxel in combination with cisplatin or topotecan hydrochloride with vs without bevacizumab in patients with Stage IVB, recurrent or persistent cervical cancer • Vaccine for testing HPV-16 positive patients with atypical squamous cells of undetermined significance or low-grade squamous intraepithelial lesions of the cervix 	<ul style="list-style-type: none"> • NCI Clinical Trails Referral Office 888-NCI-1937 888-NCI-1937 • NCI Cancer Information Service 800-422-6237 • NCI Cancer Information Service 800-422-6237
Breast	<ul style="list-style-type: none"> • Sister Study (collects information about genes, life-style, and environmental factors that cause breast cancer) • Two Sister Study (looks at causes of early onset breast cancer) 	<ul style="list-style-type: none"> • 1-877-4-SISTER (1-877-474-7837) www.sisterstudy.org

breast cancer include combinations of radiologic procedures, including mammograms and ultrasounds, mammograms and PET scans, scintim-magraphy, tomosynthesis, and magnetic resonance elastography. Ductal lavage and a breath test identifying markers for those with breast cancer are being investigated. These studies may allow for more sophisticated evaluations of smaller and earlier breast cancer lesions.

Intervention trials for the treatment of ovarian, cervical and breast cancer are based primarily on the use of medications, vaccines, monoclonal antibodies and consolidation therapy. Table III highlights descriptions of current research in women’s cancer treatment.⁷ Many of these targeted therapies focus on both treatment and prevention of recurrence offering opportunities for changing the landscape of treatment options for women.

Women who are experiencing ovarian, cervical or breast cancers may wish to participate in clinical trials. Table IV presents examples of ongoing research studies that may be supported by active involvement as a subject. Further, additional organizations and website information is provided in Table V to assist those female patients who present with newly diagnosed cancer conditions.

Table V: Organizations and Websites

Organization	Website
National Ovarian Cancer Coalition	<ul style="list-style-type: none"> • nocc@ovarian.org 888-ovarian
Ovarian Cancer National Alliance	<ul style="list-style-type: none"> • ocna@ovariancancer.org 866-399-6262
National Cancer Institute	<ul style="list-style-type: none"> • www.cancer.gov 800-4-CANCER
National Center for Complementary and Alternative Medicine	<ul style="list-style-type: none"> • www.nccam.nih.gov 866-464-3615
National Cervical Cancer Coalition	<ul style="list-style-type: none"> • www.ncccconline.org
National HPV Cancer Coalition	<ul style="list-style-type: none"> • www.ncccconline.org
National Cancer Institute	<ul style="list-style-type: none"> • www.cancer.gov 800-4-CANCER 1-800-422-6237
Susan G. Komen Foundation	<ul style="list-style-type: none"> • www.komen.org 1-800-GOKOMEN 1-877-465-6636

Although cancer impacts the health of women, research demonstrates continued efforts in addressing factors that improve prevention, diagnosis, treatment and recurrence.⁸ It is anticipated that

results of these clinical investigations will provide for more sophisticated regimens that will positively impact a return to health that is safe and effective.

JoAnn R. Gurenlian, RDH, PhD, is Professor and Graduate Program Director of the Department of Dental Hygiene at Idaho State University.

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Thirty Years of HIV/AIDS and Related Oral Manifestations and Management

Mahvash Navazesh, DMD

Introduction

The early 1980s brought the explosion of information availability and the emergence of Human Immunodeficiency Virus (HIV) infection. Advances in information technology enabled humans to get access to information instantly. On June 5, 1981, Morbidity and Mortality Weekly Report published a rare type of pneumonia (pneumocystis carinii) in 5 previously healthy homosexual men in Los Angeles.¹ On the other side of the world, in Uganda, the emergence of a severe wasting syndrome locally known as "slim disease" was reported. What was originally perceived as a rumor turned to a stigma, fear, an epidemic and eventually a tragedy. The rare reported cases with respiratory diseases in Los Angeles were later marked as the beginning of the HIV epidemic. Slim disease was soon found to be associated with Acquired Immune Deficiency Syndrome (AIDS), an advanced stage of HIV infection. In 1984, LAV virus was discovered in France, and a year later HTLV III was isolated in the U.S. Both viruses were later found to be the same virus and renamed HIV. In 1999, HIV was found to be a variation of the Simian Immunodeficiency Virus (SIV) found in a chimpanzee species in West Africa.

At the beginning, not much was known about the etiology of HIV infection and its mode of transmission. Because the disease was more prevalent among men who had sex with men, sex workers and IV drug users, public anxiety grew and led to fear, prejudice and stigmatization. Ryan White, a 13 year old hemophiliac boy with AIDS, was banned from school, and gay men and drug users were seen as having brought the disease upon themselves. What was perceived as "a gay epidemic" started turning up in children, blood transfusion recipients and heterosexuals. On a global level and at the World Health Organization summits, the need for every country to have a supportive and non-discriminatory social environment was recognized. The U.S. Public Health Service added AIDS to its list of diseases for which

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Keywords: HIV/AIDS, HIV infection, HIV oral conditions

This study supports the NDHRA priority area, **Clinical Dental Hygiene Care:** Investigate how dental hygienists identify patients who are at-risk for oral/systemic disease.

people on public health grounds could be excluded from the U.S., a ban which was only lifted in 2010 by President Barack Obama. The first World AIDS Day took place on December 1, 1988.

Throughout the 1990s, awareness of HIV and AIDS continued to grow, as information about HIV infection and its mode of transmission in high profile figures such as movie star Rock Hudson, iconic musician Freddie Mercury, pianist and entertainer Liberace, basketball player Magic Johnson and tennis player Arthur Ashe became public knowledge. The late 1980s through the mid-1990s introduced antiretroviral medications such as azidothymidine, dideoxyinosine, dideoxycytidine, protease inhibitors, combination drug therapy and Highly Active Antiretroviral Therapy (HAART). HIV infection is no longer looked at as a death sentence, however, there is still no available cure.

The estimated number of adults and children living with HIV worldwide in 2010 was 34 million. Newly infected individuals accounted for 2.7 million. The estimated number of children less than 15 years of age living with HIV is 3.4 million, and newly infected individuals account for 390,000.^{2,3} In the U.S., the CDC estimated the number of individuals living with HIV as of the end of 2008 to be 1,178,350, and an estimated 594,496 having died of AIDS since 1981. The racial/ethnic distributions of AIDS diagnoses during 2009 in adolescents 13 to 19 years of age, young adults 20 to 24 years of age, and adults 25 and over in the U.S. and dependent areas revealed that in all 3 age groups, African Americans had the largest

percentage of AIDS diagnoses (68, 62 and 47%, respectively). In 2009, African Americans made up approximately 13% of the population of the 40 states, but accounted for 52% of diagnoses of HIV infection. Whites made up 68% of the population of the 40 states but accounted for 28% of diagnoses of HIV infection. Among Hispanic/Latino males in 2009, an estimated 71% of diagnosed HIV infections were attributed to male-to-male sexual contact, while in females, 83% of diagnosed HIV infections were attributed to heterosexual contact.^{4,5}

In general, the advancement of science and enhancement of public knowledge have significantly contributed to the following facts:

- The number of people living with HIV infection in the U.S. (HIV prevalence) is higher than ever before
- The annual number of new HIV infections (HIV incidence) has remained relatively stable in recent years
- The great majority of persons with HIV infection do not transmit HIV to others
- More people in the U.S. with HIV know of their HIV infection
- Diagnoses of HIV infection reported to CDC have remained stable in recent years
- HIV diagnosis rates have remained stable in recent years

The following challenges still exist:

- HIV disproportionately affects certain populations
- Despite many prevention and treatment successes, people are still dying from AIDS
- Too many people are diagnosed with HIV late in the course of infection
- AIDS disproportionately affects different parts of the country/world

Many individuals who are 60 or older are sexually active and are at risk for sexually transmitted diseases. Older women may be especially at risk because age-related vaginal thinning and dryness can cause tears in the vaginal area. Some older persons inject drugs or smoke crack cocaine, which

can put them at risk for HIV infection. Some older persons, compared with those who are younger, may be less knowledgeable about HIV/AIDS and therefore less likely to protect themselves. Many do not perceive themselves as at risk for HIV, do not use condoms and do not get tested for HIV. Older persons of minority races/ethnicities may face discrimination and stigma that can lead to later testing, diagnosis and reluctance to seek services. Socioeconomic barriers, limited access to care, cultural differences and lack of compliance with recommended therapy have impact on the prevalence of HIV infection.

Fungal, viral and bacterial infections are often listed as common causes for oral lesions associated with HIV infection.⁶ The prevalence of pseudomembranous candidiasis, erythematous candidiasis, HIV associated periodontal diseases and hairy leukoplakia is lower in some regions in the presence of HAART.⁷ Salivary gland hypofunction leading to dental caries is a potential HIV associated condition as well as an adverse effect of some antiretroviral medications.⁸

The management of HIV infected individuals should include a thorough history and clinical evaluation, as well as diagnostic laboratory work up, that may include: sialometric, serologic, microbial, histologic and/or imaging evaluations, nutritional counseling, medical consult, and psychological evaluation. The treatment plan should focus on oral and systemic health promotion and disease prevention, salivary gland stimulation, salivary substitution, caries control and prevention, fungal infection prevention, and palliative therapy.

HIVdent is a good resource for dental professionals to use to find current information about HIV-related oral conditions and treatment. Oral health care providers continue to play a significant role in the early detection of signs and symptoms of HIV infection and its progression to AIDS.

Mahvash Navazesh, DMD, is a Professor, Diagnostic Sciences, and Associate Dean, Academic Affairs and Student Life, at the Ostrow School of Dentistry of USC.

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Short Report

Medical and Dental Implications of Eating Disorders

Barbara J Steinberg, DDS

Introduction

Eating disorders are syndromes characterized by significant disturbances in a person's eating behavior, such as extreme over- or under-eating, accompanied by intense focus or distress related to food consumption, body shape or weight.¹ Eating disorders are both serious and potentially dangerous and are associated with medical and psychological complications that give eating disorders a higher mortality rate than any other psychiatric disorder.¹ Morbidity and mortality rates may be even higher than officially reported because these patients often deny or hide the extent of their fasting, binge-eating and purging behaviors. Early detection and treatment are critical, and oral health care professionals are in an ideal position to help identify these disorders, which primarily affect women.

Classification

Originally conceptualized as discrete illnesses, eating disorders are now viewed as falling along a continuum between anorexia nervosa, bulimia nervosa and eating disorders not otherwise specified. There can be crossover behaviors among all of these disorders.²

Anorexia nervosa is defined by the American Psychiatric Association's Diagnostic and Statistical Manual on Mental Disorders, 4th edition (DSM-IV) as a refusal to maintain body weight at or above 85% of the normal weight for a particular age and height, accompanied by an intense fear of gaining weight, an undue emphasis on body shape or weight and amenorrhea for 3 consecutive months.² Anorexia nervosa is further subdivided into restricting and purging subtypes.² Patients with the restricting type will severely limit food intake and often over-exercise, whereas patients with binge-purge type will engage in purging behavior after eating in addition to food restricting.²

Bulimia nervosa is defined in DSM-IV as episodes of binge eating that recur at least twice weekly for

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This study supports the NDHRA priority area, **Clinical Dental Hygiene Care:** Investigate the links between oral and systemic health.

3 months or longer.² The bulimic presents with the same undue emphasis on body weight and shape as seen in the anorexic, but weight loss may not be as remarkable or even noticeable as with anorexia.³ There are 2 subtypes of bulimia: purging and non-purging bulimia. In the purging type, binges are followed by inappropriate compensatory behavior to avoid weight gain, such as self-induced vomiting or misuse of laxatives, diuretics or enemas. In the non-purging type, the inappropriate compensatory behaviors typically include intermittent fasting and excessive exercise, but not purging or misuse of laxatives, diuretics and enemas.² The third DSM-IV category is eating disorder not otherwise specified. This includes all eating disorders that do not meet the strict criteria for either anorexia or bulimia and accounts for about 50% of eating disorders overall.² For example, binge eaters fall into this category, but unlike patients with bulimia, they do not undertake the compensatory behaviors to avoid weight gain.⁴

Epidemiology

Eating disorders occur primarily in women, who comprise 90% of patients affected. For anorexia nervosa, the lifetime prevalence is 0.5 to 1.5%, and the male-to-female ratio is 1:10. For bulimia nervosa, lifetime prevalence is 1 to 4.4%, with a male-to-female ratio of 1:20.¹ Some experts estimate that 16 to 25% of college students have symptoms of an eating disorder.¹

Etiology

Eating disorders arise from a complex combina-

tion of genetic, biologic, psychological, family and cultural factors. Some researchers suggest that a cultural value on thinness accounts for the growing incidence of eating disorders in the U.S. and other Westernized countries.⁴ Likewise, the media's ongoing depiction of digitally altered or otherwise unrealistic female bodies may also play a role. Activities that reward thinness or promote a particular weight classification, such as ballet dancing, modeling, gymnastics and wrestling, can also predispose someone to develop an eating disorder.⁵ Personality traits, such as low self-esteem, difficulty expressing negative emotions, difficulty resolving conflict and being a perfectionist, are also contributing factors.⁶

Some individuals may be genetically predisposed to developing eating disorders. Family studies show that first-degree relatives of patients with eating disorders have a 10-times greater lifetime risk of developing an eating disorder than do relatives of unaffected individuals.⁷

Systemic and Psychosocial Manifestations

Eating disorders negatively affect every system in the human body. Some medical complications are manifested soon after the onset of an eating disorder, whereas others smolder and emerge years later. Malnutrition is the primary cause of most medical complications seen in patients with anorexia, and purging leads to most medical complications seen in patients with bulimia. Systemic, physical and psychosocial manifestations that may be associated with eating disorders are located in Tables I, II.⁸

Underscoring the seriousness of eating disorders is the fact that women with anorexia nervosa have approximately a 50-times higher suicide rate than do similar-age women in the general population.¹ Prognosis is better for patients with anorexia nervosa than with bulimia nervosa. Approximately 50% of patients with anorexia nervosa will achieve a normal weight with treatment. Patients with bulimia nervosa have a higher rate of severe psychological disturbances and medical complications, and relapse is common after treatment.³

Oral Manifestations

Dentition: The most extensive oral problems seen in patients with eating disorders are caused by self-induced vomiting.⁹ Perimylolysis, a smooth erosion of the tooth enamel, is common and manifests as a loss of enamel and eventually dentin on the lingual surfaces of the teeth caused by the chemical and mechanical effects of chronic regurgitation of low-

Table I: Systemic and physical manifestations of eating disorders⁸

- Abdominal pain
- Bradycardia
- Carotenosis
- Constipation
- Decreased metabolic rate
- Dehydration
- Dry, scaly skin
- Dysphagia
- Dysrhythmias
- Esophagitis
- Gastroesophageal reflux disease
- Hypotension
- Malnutrition
- Osteopenia/osteoporosis
- Russell's sign (callus on knuckles from self-induced vomiting)
- Sore throat

Table II: Psychosocial manifestations of eating disorders⁸

- Anxiety
- Depression
- Obsessive compulsive disorder
- Personality disorders
- Physical abuse
- Sexual abuse
- Social phobias
- Substance abuse

pH gastric contents and movements of the tongue. Initially, this erosion can be observed on the palatal surfaces of the maxillary anterior teeth and has a smooth, glassy appearance. There are few, if any, stains or lines in the teeth, and when the posterior teeth are affected, there is often a loss of occlusal anatomy. Perimylolysis is usually clinically observable after the patient has been binge eating and purging for at least 2 years.^{9,10} There appears to be a relationship between the extent of tooth erosion and the frequency and degree of regurgitation, as well as with oral hygiene habits.^{9,10} The patient may complain of severe thermal sensitivity, or the margins of restorations on posterior teeth may appear higher than adjacent tooth structures. There may be occlusal changes, such as an anterior open bite and loss of vertical dimension of occlusion caused by loss of occlusal and incisal tooth structure.^{9,11}

Salivary Glands: Enlargement of the parotid glands and occasionally of the sublingual and submandibular glands are frequent oral manifestations of the binge-purge cycle in patients with eating disorders. The incidence of unilateral or bilateral parotid swelling has been estimated at 10

to 50%.^{9,10} The occurrence and extent of parotid swelling usually follows a binge-purging episode by several days.¹¹ Parotid swelling is soft to palpation and generally painless. In the early stages of the disorder, the enlargement is often intermittent, appearing and disappearing for a time before it becomes persistent. At that point, the cosmetic deformity tends to impart a widened, squarish appearance to the mandible, compelling the patient to seek treatment. Possible spontaneous regression of gland enlargement may occur with cessation of purging.¹¹

The precise etiology of salivary gland swelling has not been determined, but most researchers associate it with recurrent vomiting. Mechanisms may be cholinergic stimulation of the glands during vomiting or autonomic stimulation of the glands by activation of the taste buds.^{9,12}

In some patients who binge and purge, there may be reduced unstimulated salivary flow. Flow may also be reduced by overuse of laxatives and diuretics. As such, xerostomia may occur in bulimic patients due to reduced salivary flow and/or from chronic dehydration from fasting and vomiting.^{9,11} Xerostomia combined with poor oral hygiene can increase risk for periodontal disease.³

Periodontium: Poor oral hygiene is more common in anorexic than bulimic patients.¹¹ As such, higher plaque indices and gingivitis may be more common as well. Some investigators have observed that xerostomia and nutritional deficiencies may cause generalized gingival erythema.¹¹

Oral Mucosa: The oral mucous membranes and the pharynx may also be traumatized by bingeing and purging, due to the rapid ingestion of large amounts of food and by the force of regurgitation. The soft palate may be injured by objects used to induce vomiting, such as fingers, combs and pens. Dryness, erythema and angular cheilitis have also been reported.¹¹

Dental Management

If the oral health care professional suspects that a patient may have an eating disorder, a general screening question regarding any difficulty with eating or maintaining weight is recommended. This may lead to more direct questions and conversation, especially if there is a noticeable dental involvement. Oral manifestations should be brought to the patient's attention in a non-confrontational manner. The patient may or may not admit to having an eating disorder on initial questioning. The oral health care professional can persevere gen-

tly during initial and subsequent appointments to open communication about the problem and make appropriate referrals when indicated. It is important to point out the serious medical complications that can occur with eating disorders and to mention that these may be avoided with proper medical and psychological therapy.³

Rigorous hygiene and home care are recommended to prevent further destruction of tooth structure.¹¹ As previously reported, such measures should include the following:^{9,11}

- Regular professional dental care
- In-office topical fluoride application to prevent further erosion and reduce dentin hypersensitivity
- Daily home application of 1% sodium fluoride gel, either applied in custom trays or with a toothbrush, to promote remineralization of enamel, or daily application of 5,000 ppm prescription fluoride dental paste
- Use of artificial saliva for patients with severe xerostomia
- Rinsing with water immediately after vomiting and followed, if possible, by a 0.05% sodium fluoride rinse to neutralize acids and protect tooth surfaces (patients should be discouraged from toothbrushing right after vomiting, as the abrasive action may accelerate enamel erosion)

Regarding definitive dental treatment, most clinical authorities urge delaying complex restorative or prosthodontic treatments until the patient is adequately stabilized psychologically.¹¹ The exceptions may include palliation of pain and temporary but non-traumatic cosmetic procedures. The rationale for this recommendation is that an acceptable prognosis for more complex dental treatment depends on cessation of the binge-purge habit.¹¹

Members of the dental team play critical roles for identifying undiagnosed eating disorders. In fact, because of the visibility of oro-facial manifestations, oral health care professionals may be the first to encounter such patients and to play the important role of making appropriate referrals for further diagnostic work-up and treatment. Effective treatment requires a multi-disciplinary team of health professionals to provide medical/dental, psychological and nutritional support. It is important to keep in mind that eating disorders are silent killers that should not be taken lightly or ignored. Patients with suspected eating disorders should be confronted gently about suspected disorders, informed of potential complications, and encouraged to seek medical and psychological help. Considering that eating disorders have the highest mortal-

ity of all psychiatric disorders, early detection and intervention are vital.¹

Barbara J. Steinberg received her DDS from the University of Maryland School of Dentistry and completed a residency at the Medical College of

Pennsylvania. She is Clinical Professor of Surgery at Drexel University College of Medicine, as well as Adjunct Associate Professor of Oral Medicine at the University of Pennsylvania School of Dental Medicine. She is a Diplomate of the American Board of Oral Medicine.

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A Qualitative Study of Extended Care Permit Dental Hygienists in Kansas

Janette Delinger, RDH, MSDH, FAADH; Cynthia C. Gadbury-Amyot, MS, EdD; Tanya Villalpando Mitchell, RDH, MS; Karen B. Williams PhD, RDH

Introduction

Access to oral health care is a long standing national problem, brought to the public eye by the first ever Surgeon General's Report on Oral Health, released in May 2000. This report identified the scope and impact of oral health disparities in America.

Since its release, there have been several more reports dealing with access and disparity in oral health care in the U.S.¹⁻⁴ Collectively, they highlight similar themes: that prevalence and severity of dental disease are linked to socioeconomic status and inadequate access, that oral diseases have a negative impact on quality of life and that poor oral health has an economic impact at the individual and national level.

National data suggests that the number of dentists is declining across the U.S. and the ratio of dentists to patients is decreasing.⁵ Similar to national data, the state of Kansas suffers from a mal-distribution of dentists which has resulted in numerous underserved areas. Of 105 counties in Kansas, 95, or approximately 90.5%, are designated as dental health professional shortage areas.⁶ As a result, organized dentistry is looking for solutions to addressing these barriers and be more responsive to the public, especially the needs of children. Kansas currently has 5 dental hygiene programs throughout the state, with 3 located in rural underserved areas. Graduation trends, nationally, have increased steadily with a projected increase of 36% through the years 2008 to 2018.⁷ Similarly, the number of graduates in Kansas has increased over the last 10 years with the addition of 3 newly accredited programs and expanded enrollment at existing programs. As a

Abstract

Purpose: Currently, 37 states allow some type of alternative practice settings for dental hygienists. This qualitative study was designed to explore the experiences of the Extended Care Permit (ECP) dental hygienist in the state of Kansas. As a first ever study of this workforce model, a qualitative research design was chosen to illuminate the education and experiences of extended dental hygiene practitioners in order to understand the impact ECP legislation has had on increasing the public's access to oral health care services and define the advantages and limitation of this model as one potential solution to access to oral care. Snowball sampling was used to identify study participants who were actively engaged in extended care practice. Nine subjects, which included one ECP consultant and eight ECP providers, participated in this study. Data obtained via personal interviews and through document analysis data were subsequently coded and thematically analyzed by three examiners. An independent audit was conducted by a fourth examiner to confirm dependability of results. Seven major categories emerged from the data analysis: entrepreneur dental hygienist, partnerships, funding, barriers, sustainability, models of care and the impact of the ECP. The findings of this study revealed that ECP hygienists are making an impact with underserved populations, primarily children, the elderly and special needs patients.

Keywords: Access to Care, preventive dental services, underserved/unserved, dental hygienist

This study supports the NDHRA priority area, **Health Services Research:** Assess the impact of increasing access to dental hygiene services on the oral health outcomes of underserved populations.

result, utilization of dental hygienists as a mid-level oral health provider was proposed as one solution to improved access in reports such as the Kansas Health Institute Workforce Survey.⁸ In 2003, Kansas passed legislation to expand the scope of practice for dental hygienists, and is 1 of 37 states that have statutes supporting direct access for dental hygienists.⁹ The Extended Care Permit (ECP) legislation allows dental hygienists to provide preventive services, to underserved and unserved populations in explicit locations, through an agreement with a sponsoring dentist (Table I). In 2007, the Kansas legislature passed an amendment to the

Table I: Description of the Kansas Statutes Relative to ECP I and ECP II Scope of Practice and Requirements

Statutes 65-1456 (f) and (g)	ECP I	ECP II
RDH with clinical practice in the past 3 years or an instructor at an accredited dental hygiene program for 2 academic years within the past 3 years	1200 hours required	1800 hours required
Sponsoring dentist agreement	X	X
Proof of Liability Insurance	X	X
General Supervision	X	X
Removal of extraneous deposit, stain and from the teeth to the depth of the gingival sulci	X	X
Topic anesthetic (certification required)	X	X
Fluoride	X	X
Oral hygiene Instruction	X	X
Assessment and referral	X	X
Other duties as delegated by sponsoring DDS	X	X
Advises patient or legal guardian that these are preventive services, not a diagnosis	X	X
Provides an assessment report to sponsoring DDS	X	X
Payment through DDS or other entity (no direct reimbursement)	X	X
Patients do not need any type of dental examination by a dentist prior to the ECP providing services.	X	X
Perform services with consent on children or adults that fall within the criteria specified by Kansas statute 65-1456(f)	X	X
Perform services with consent on adults that are developmentally disabled or over the age of 65 that fall within the criteria specified by Kansas statute 65-1456(g)		X
Six hours of CE in special needs or other training		X

ECP legislation to expand the settings and populations expanding the scope of practice for the ECP dental hygienist.⁹ There are currently 1,750 dental hygienists practicing in Kansas, with approximately 124 (7%) possessing an ECP.¹⁰ Of the 124 ECP providers, 43 have an ECP I and 82 have an ECP II. Each permit has specified requirements in order to apply for each certificate from the Kansas Dental Board (Table I). While these efforts have the potential to improve access to care, to date little is known about the impact of the ECP legislation.

The purpose of this project was to explore the experiences of Kansas ECP providers who are offering services to unserved and underserved populations. By doing so, the goal was to illuminate the stories of those with firsthand knowledge and experience in extended dental hygiene practice in order to understand the impact of ECP legislation in practice, the impact it has had on increasing the public's access to oral health care services in Kan-

sas and to define the advantages and limitations of this model as a potential solution to access to oral care in the state. Studying the outcomes of this ECP legislation allows for the evaluation of the results of this direct access model of preventive oral health care.

Methods and Materials

Qualitative methodology was used to explore the experiences of ECP dental hygienists currently practicing in the state of Kansas. This method allows for the examination of this new delivery of care model and can provide data for future research initiatives. This study was approved by the UMKC Social Science Institutional Review Board.

Purposeful sampling was used to ensure that the selection of persons would be appropriate for gaining deep understanding of the phenomena.¹¹ Specifically, snowball sampling was employed

as follows - a consultant hired to promote ECP legislation and who has been involved from the early stages of the development of the ECP provider initiative was recruited as the initial informant. This individual facilitated initial contact with active ECP providers, who then served as additional informants from which subsequent subjects were identified. Saturation of data was achieved through interviews with the consultant and eight ECP providers.

Multiple methods of data collection and data analysis, known as triangulation,¹¹⁻¹³ were utilized. Face to face interviews of the ECP providers using a digital recording device, field notes from the interviews, review of the ECP statutes and the primary investigator's (PI) personal experience as having been one of the originators of the ECP legislation served as data sources. Data gathered from interviews were transcribed verbatim by a transcriptionist. Member checking was accomplished by having participants verify accuracy of their transcribed data and reduce potential bias in interpretation. Once validated, the PI reviewed data several times to look for emerging patterns to code together.

Termination of further interviews occurred when saturation had been reached and no new information emerged. The PI forwarded the reviewed transcribed documents to 2 co-investigators who also reviewed the documents. To ensure dependability and credibility of the thematic analysis and resulting categories, a data audit was conducted independently by an individual who was not associated with data collection or data analysis. The auditor reviewed the broad scope of the data, as well as the deconstruction (unitized and coding) and reconstruction of the material. An audit trail combined with the audit analysis is an important step in ensuring the dependability and credibility of the data analysis.¹²

Seven categories emerged from the thematic analysis (Table II). To ensure dependability and credibility of the thematic analysis and resulting categories, a data audit was conducted independently by a fourth examiner. The auditor reviewed the broad scope of the data, as well as the deconstruction (unitized and coding) and reconstruction of the material. An audit trail combined with the audit analysis is an important step in ensuring the dependability and credibility of the data analysis.¹²

Results

The thematic analysis yielded 7 major emergent categories: 1) Entrepreneur RDH, 2) Part-

Table II: ECP Category Analysis, By Number of Total Responses

Category	Number
Entrepreneur RDH	97
Partnerships	71
Funding	36
Barriers	25
Models of care	131
Sustainability	22
Impact of ECP	39

Table III: Characteristics of Study Participants (n=8)

Gender	
• Female	8 (100%)
Age	
• 30 to 35	2 (25.00%)
• 36 to 40	1 (12.25%)
• 41 to 45	-
• 46 to 50	1 (12.25%)
• 51 to 55	3 (37.50%)
Ethnicity	
• Caucasian	8 (100%)
ECP Permit	
• ECP I	3 (37.5%)
• ECP II	5 (62.5%)
Location of ECP in Kansas	
• Northwest	1 (12.25%)
• Northeast	5 (62.50%)
• East Central	1 (12.25%)
• South Central	1 (12.25%)

nerships, 3) Funding, 4) Barriers, 5) Models of Care, 6) Sustainability and 7) Impact of an ECP.

Entrepreneur RDH

"I believe the ECP who is the leader, whether it's with a safety net clinic, or on her own, has to have a very rare set of skills as a trailblazer and an entrepreneur, meaning that she has to be very clear about her vision. She has to have a very good skill set to go in and convince people to do something new. She has to be able to sustain her own energy, while still dealing with barriers regularly."

Results from the data within the emergent category of Entrepreneur RDH yielded 4 main sub-categories: Pre ECP, Characteristics of a Successful ECP, Working Relationships with Sponsoring

Dentist and Legislation Requirements. The following details for the reader the information gleaned from the data analysis and resultant sub-categories.

Pre-ECP: The 8 ECP providers interviewed for this study have similar backgrounds and experience as clinicians. The majority worked in clinical practice for many years. Statements by these participants indicated that their desire to apply for and use an ECP was driven by their need to feel some satisfaction for giving back and making a difference to the unserved and underserved populations. Table III provides demographic information of the ECP providers in this study.

Characteristics of a Successful ECP: Having worked in private practice settings for most of their professional careers, participant indicated a need to develop additional skills that would enable them to expand themselves outside the traditional fee-for-service private practice settings. Essential skills sets that emerged in the interviews included: good communication skills and the ability to network, ability to conceptualize something that didn't currently exist and develop a plan for bringing it to fruition, ability to think critically and problem solve, administrative or management skills and ability to overcome challenges in order to achieve a successful outcome. Some possessed these skills from the start, whereas others had to learn quickly through networking with other ECP dental hygienists.

(ECP) "[...] I had been in private practice for [...] years, and most of that was...well all of that was back in a clinical room working with patients. I had very little experience with the [...] administrative part of the dental office, so lots of trial and error, lots of learning, lots of tenacity and stubbornness; however you want to call that."

Data revealed a predisposing sense of confidence, determination and willingness to confront a challenge and creatively problem solve. These characteristics appeared to be critical for success since they were entering into a practice setting that to date had never existed in their state.

Working Relationship with the Sponsoring Dentist: In order to apply for an ECP, participants had to have a written signed agreement with a sponsoring dentist in the state of Kansas. All those interviewed mentioned having a good relationship with their sponsoring dentist. Trust and communication were mentioned throughout the interviews as an essential part of having that initial relationship for the agreement. One participant

mentioned that public health dentists were more apt to be sponsoring dentists and said "... we also have our best luck with the safety net dentists because they get it. They understand how important it is reaching out to the underserved population". One ECP participant stated the following about the relationship with sponsoring dentists:

"It is trust and respect. Different dentists and hygienists have different ways that they define trust and respect. There are a couple of dentists who are so committed to community based hygiene, and community based services that they will underwrite someone that they just happen to know."

Legislation Requirements: The ECP legislation, originally passed in 2003 and amended in 2007, allows ECP providers to treat additional underserved populations in more locations/facilities while concomitantly reducing the number of hours of clinical experience required for obtaining an ECP I from 1,800 hours to 1,200. Once the dental hygienist has received an ECP, they are bound to the limitations noted in the statutes. Participants revealed frustration with the many of the barriers that limited the population base that they could see as outlined in the legislation. Although they are allowed to treat those that are underserved and fit the parameters of the statutes, the ECP providers reported that they sometimes had to deny necessary care because of limits in the legislation. Payment to the ECP provider is also dictated by the legislation which specifies that they can only be reimbursed by their sponsoring dentist and/or from the administration of the facility where they are providing their services. Direct third party payment is prohibited as stated in the statutes. Most participants were receiving reimbursement for services through the dental clinic they primarily worked with or a dentist who was a Medicaid provider.

Partnerships

"...and so the networking skills, the ability to establish relationships, and to be very clear about a business plan, and to set up a business plan, is very important for people."

One thing all the ECP providers mentioned was the number of partnerships it took to get their programs initiated and make it successful. From this four sub-categories emerged: Start Up for an ECP, Partnerships, School Nurses and Building an ECP/Dentist relationship (local private practice).

Start Up for an ECP: Because this was a new

practice setting for these dental hygienist, participants reported that it was extremely helpful to have an online ECP Toolkit document as a resource. This Toolkit was created by the consultant working for Oral Health Kansas to assist the ECP dental hygienist with a starting point on how to develop a program. Previous to the development of the toolkit, many of the early and enterprising ECP providers reported that they had to independently develop forms (consent, assessment, treatment) that eventually became part of the toolkit. One interviewee noted: "...all those different little details that have to be customized community site by community site whether it's a long term care facility, or a school, or a Head Start program, or a WIC clinic, or health department...all those different places all have their own procedures, and so they're going to tweak yours (forms) in each of those." Some early participants reported that they started with old heavy donated dental equipment that was only portable because it had wheels on it but it was still cumbersome and difficult to transport. A new skill-set that many found critical to understand and develop was that of grant writing. Grant application information, included as part of the toolkit, allowed several to take advantage of their newfound skills and submit grants to entities that had a focus on supporting oral health initiatives. One study participant said: "...and so the networking skills, the ability to establish relationships, and to be very clear about a business plan, and to set up a business plan, is very important for people".

Partnerships: All participants had a group of people that were instrumental in collectively working together to get programs started. A few of the ECP dental hygienists work within safety net clinics and/or community health centers with the benefit of an incredible support system including both staff and administrative support. They work together as a team creating opportunities to engage more populations to provide preventive services. In some cases, they reported the need to develop relationships outside of the dental community in order to have access to the specific underserved populations. A few ECP dental hygienists contacted and built partnerships with directors of nursing homes, school Superintendents, school nurses and Head Start programs in order to initiate the opportunity to develop an oral health program within their facilities. All individuals involved were aware of the need and were willing to work together collectively to make a difference for those in need.

(ECP) "[...] it brought a new awareness to the surveyors, nursing home staff and care givers on

what does and does not happen in nursing homes regarding oral health for the residents [...]"

School Nurse: Participants who work in the schools mentioned that administrators have been instrumental in allowing them into their school programs, but it is the school nurse who assists with the program to make it a success. One of the ECP school-based providers in this study stated: "School nurses are the Golden Gate keeper which I'm sure you've heard. Generally they have a heart, they want to help the kids, they can be very persuasive and they're trusted already."

School nurses have direct contact with students and understand the issues with the lack of dental care. The importance of the school nurse supporting the idea was detailed by one interviewee who said: "that school nurse actually individually called each parent. There were thirty three kids seen on that day. Each parent was called and asked, 'Do you mind your child being seen...I am taking them out of class for this service. Do you want that?' and all 33 parents said yes."

However, not all school nurses are inclined to have a dental hygienist come into their programs. One dental hygienist noted the barrier of a school nurse: "... just getting the schools to allow us to come in...there were some blocks with the school nurses as they sometimes didn't want us. They felt that they were already taking enough time out of class with these kids, because the kids we see are the kids who really need to be in class."

Participants stated that they learned the importance of educating all involved on what is exactly entailed in the program and how the staff and children will be impacted. In many instances, participants reported that they and the school nurse worked through concern's with the goal to ensure that the kids received much needed oral health care. Some of the greatest frustration expressed is trying to find a dentist who can treat those children with urgent needs. Since the ECP is unable to provide restorative care, this was often reported as a challenge. In working with school nurses, participants learned that this has been a real dilemma as there may not be a dentist within a 50 mile radius and/or no dentist who, even if available, is willing to accept Medicaid patients.

Building ECP/DDS Relationship (Local Private Practice): All participants reported that they make an effort to let the local dentist(s) know what their program entails and who they are working with in terms of populations and facilities. While some dentists are supportive, even going as far

as to work with the ECP and provide some limited services to patients with urgent care needs often pro bono, others are not. Some ECP providers are focusing on newborns to age five and trying to prevent early childhood caries (ECC) and have told the local dentist: "...what we're trying to do here is create really good dental patients for you. They're already going to have that comfort level. [...] they're going to come in and be that much more cooperative for them (the dentist)."

Funding

"In Missouri, they (public health dental hygienists) have their own NPI's (National Identifier) and when they bill Medicaid, they bill under their NPI. As (ECP) hygienists (in Kansas), we still bill under the doctor's NPI, or the facilities NPI, ... so that's something that needs to be changed ultimately, and then (ECP) hygienists can go in with a sponsoring dentist (who may not be a Medicaid provider) and they can bill it themselves. I mean, I see that as a good way, if they really want to utilize ECP hygienists they have to do something, in my opinion, to make that process a little bit easier."

Funding emerged as a unified category that includes start up costs, reimbursement/billing and salaries. All participants applied for and received initial grant money for start up, usually in conjunction with other agencies or groups. It wasn't easy to get that initial funding, as one dental hygienist noted: "...they kind of gave me the idea and [...] helped me write a grant that we didn't get and then I sought financial support through other places here in [...] and it just keeps building every year."

An ECP working for a non-profit talked about the initial funding through grant money for start up: "they (the non-profit) had already received \$65,000 from a (funder) to help us with start up. They also received a \$100,000 from a (funder) to be disbursed over 3 years once start up actually happened and they had to because everything was donated." She took on the administrative roll and got the program initiated.

Of the 9 ECP study participants, 7 are paid by the agency with whom they work on an hourly basis or salary, while 2 are paid through their sponsoring dentist (Medicaid providers) or other health care facility that can bill for Medicaid.

"For many of the hygienists starting out, the reimbursement had come from Medicaid. And it was particularly for children. And so we had to clarify

for them, who were potential Medicaid providers. Most of the ECP hygienists were not working for a dentist, or did not have a sponsoring dentist, who billed for Medicaid. So they ended up working for health departments. For example, Head Start in Kansas can be a Medicaid provider and submit for reimbursement. That is how several of the hygienists working for Head Start and Early Head Start are compensated. And so we had to help them broker that relationship with the health department or with the Head Start and then teach the health department how to bill for Medicaid and how to use the online system for billing Medicaid."

Currently, there are 15 states that contain statutory or regulatory language that permits direct reimbursement from Medicaid to hygienists for services rendered (ADHA, 2011). One participant noted she gets paid less than she would in private practice, but gets full benefits through a community health center since she is full time with them. Two continue to work in private practice and use their ECP providing services on 1 to 2 days a week. One responded: "I'm paid through them (county health department) hourly. It's a part time position that varies. It can be 10 hours a week or less." The other part-time ECP gets reimbursed for the Medicaid/HealthWave services rendered which are paid to her through her sponsoring dentist who has a Medicaid number. One participant who is working within school systems is billing through a dental school: "They (the patients they treat) can't have private insurance, so we don't have any of that. We do take Medicaid and HealthWave and file it through the dental school."

An ECP that works for a non-profit stated: "the alternate way you set that up (in a nursing home) is you have a flat fee...and the nursing home collects that from the family. There are a couple of nursing homes in our area that aren't so good at paying their bills. So on those particular facilities, we just bill the family the flat fee. Basically it's just a break even to what the cost is...we're a non-profit. We're not out to make money, we want to get the service there, pay our hygienist, pay for supplies, and that's it. On the schools, we bill Medicaid and if they do not have Medicaid then it's a \$25 flat fee. ...for sealants and cleanings, just \$25 and we'll do it all and just bill the family. They consent to that. That is on-site. We can't do exams on-site, or diagnose...that will be just \$25 and that's to do everything, and basically help defray all our expenses."

Barriers

"The skepticism, is it okay? Is it legal? I love

that question, "Well, is it legal?" and dentists don't think it could be legal,[...] a lot of dentists have really no clue what an ECP is and that's been a barrier."

The emergent category of Barriers resulted in 2 sub categories being identified: general barriers and barriers to start-up.

General Barriers: A few participants noted a general barrier being that of local dentists not supporting their programs when they came to town to work in the school programs or nursing homes. One mentioned: "[...] I guess my major barrier is the dentist not understanding...with the Extended Care Permit sometimes they find me a threat coming into town and I don't want to be."

One of the other major barriers to many of the ECP programs is getting these patients that have been provided preventive services to see a dentist for urgent care treatment. Although there have been a few dentists that have been very proactive in treating some of these patients (often pro bono), especially in the larger cities, others have not wanted to be involved in any kind of support. Getting the children restorative care was cited as a major barrier by several participants. ECP providers continue to make strides in collaborating with local dentists to overcome barriers to restorative treatment on a case by case bases and immediate care for those with urgent needs.

(ECP) "[...] and another major barrier through this program has been getting the restorative care completed. I mean that's like the kingpin of the whole thing. You can treat them with the preventive (services)...because we do the sealants, the radiographs, the prophys, the fluoride and all that. [...] the year before last we had 11% get their restorative done. This past year we had 15%."

Barriers to Start Up: The first ECP providers were the pioneers that encountered many barriers to start up. Initially, a few of those that wrote grants for their start up efforts reported they were denied funding. In many instances, initial funds were used for equipment and supplies to get their programs started. Developing consent forms, an initial barrier, was corrected by adding the appropriate questions: Is your child eligible for free and reduced lunch? Do you have a medical card? Do you have private insurance? These questions were important to ensure that children were eligible to meet the requirements of the statutes. Some participants reported having limited space within the facility to set up their equipment. One provider

said: "...we worked, literally, in a 5x5 closet with one outlet with all this equipment. I mean it, we didn't have really ideal accommodations and so that was a major barrier."

Another major barrier for 2 of the study participants has been getting access to start their program in some of the schools. While many schools have welcomed the ECP providers into their institutions, some schools were reluctant to share information about the children to the ECP which limited the children that could be treated.

Nursing homes are another entity that participants reported encountering some barriers as well. One interviewee noted: "[...] in 2008, the legislature granted funds for the adults with disabilities, and frail elders on home and community based service waivers to have dental services."

Unfortunately, because of the state budget, the funding was cut so now there are no dental services except for emergency care available for those noted. The legislation is still in place, but no funding. This study participant mentioned that other ECP providers started to work for nursing homes but it was not sustainable. It took quite some time to develop the service, market the service, writing contracts and agreements. There was a great amount of work with medical histories, nursing home staff cooperation and then there may only be 2 to 3 patients to see on the day they were there to provide services. Those programs dissolved due to the time it took to get the program up and running and not enough reimbursement to make it a long term venture.

Models of Care

"So, as well as it's another service that they (long term care facility) can say (to the family/individual), "You need to come here because we have dental that's being provided. Hygienists are coming and doing cleanings and they're screening, and if they see any concerns they will help facilitate in getting your elderly loved one to a (dentist)...so basically you've got to find out what's important to that particular facility and sell the points (about ECP) that are on it."

Within the Models of Care category there were 7 sub-categories that emerged in data analysis: Use of ECP, ECP practice setting, target populations, working within a school system, non-traditional dental hygiene services, services provided by a volunteer dentist and student dental hygiene providers.

Use of ECP: All of those interviewed have successful programs using their ECP. Most of these hygienists have other ECP hygienists that work with them providing clinical services. There are 3 study participants that are not doing as much clinical since their main focus is managing the program where additional ECPs are being utilized. However, they all have an administrative role of some type which is very typical of an ECP. The ECP dental hygienists interviewed for this study sometimes found themselves a solo entrepreneur, even when working with a health department, and having to manage both positions as administrator and clinical dental hygienist. One dental hygienist said: "I have the [...] program that I started and I do it in the schools. I'm the only employee. I have portable equipment, chair, stool and I use a head lamp."

When most of these ECP student participants started, there were no "positions" for ECP providers, per se, so they created their own programs and then marketed themselves to the local community health centers, Head Start programs, nursing homes and school systems.

ECP Practice Setting Characteristics: ECP practice settings can certainly be different than private practice. When you develop a program, you are often the manager, administrator, clinician and the staff. Those that become an ECP hygienist can learn from this study that in their position they may be moving portable equipment from facility to facility in order to offer their clinical services. Having the space to set up can sometimes be an issue within schools and nursing homes. Often times they have minimal spacing for their equipment as one ECP hygienist said: "...you know, a lot of times we would be in a multi-purpose room or something...or the nurses office if it was large enough. Some of the nurse's offices, I swear, were closets in a former life so there were times that I had my chair sitting in the doorway and then the patient chair was completely filling up the nurse's office..."

The study participants that work within a federally qualified health center (FQHC), safety net clinic or community health center tended to have a more stable environment much more similar to private practice. One interviewee specifically mentioned how much she enjoyed the autonomy of being an ECP provider at a community health center.

Target Populations: The Kansas statutes dictate the specific populations that the ECP dental hygienists can treat with preventive oral health ser-

vices. All but 1 treats children, whereas 4 of them also work with the residents in nursing homes and special needs individuals. One program has seen tremendous success: "In the first year we did...I think around 36 kids at 1 school (pilot program in March)...and then through the next school year we did 4 schools and we did 400 kids...and the next year we did 521 kids...6 schools." One provider, regarding working onsite with a special needs patient, said: "...we'd just seen them in the office, but it was impressive on how much better they did with less medication when we did it on site...I think they respond better in their own setting." One specifically liked the focus of working with the birth to 3 year olds and educating their parents to make an impact on reducing Early Childhood Caries (ECC). One noted: "...you know, the kids that need you the most are the kids that aren't coming into your dental office." Some of these dental hygienists also cover several counties to access their targeted populations and do so for both nursing homes and school programs.

Working Within a School System: The majority of school boards, superintendents and school nurses have been extremely proactive in inviting the ECP hygienists to set up their equipment in their facilities and treat eligible children with preventive services. One dental hygienist sees the kids from kindergarten through twelfth grade and offers screenings, prophylaxis, fluoride varnish and, if needed, sealants. She mentioned that having someone at the school willing to help her really makes the program that much more successful. Consent forms are necessary for treating the children and initially, just getting the consent forms back was a barrier. However, that was resolved when they had the forms signed at the fall registration. Each provider has a unique system that they developed with the nurses and teachers on how they retrieve the children for their appointments to try and keep them out of the classroom as little as possible. Depending on the arrangements with the time the kids take to getting to the chair and what services are given that day, the clinician may see anywhere from 5 to 16 children.

(Interviewer) "[...] how did you get the schools on board? What...how did you get through to get people on board and what did you do?"

(ECP)"[...]well, we had to talk to the principal and he accepted it right away...he and the school nurse know the need. They see the kids come in with their bombed out teeth and ...oh, nowhere to send them. And so they knew that I could be the guide for screening and trying to help them find (dental) homes, which I have not been successful

either in finding...I mean anywhere close. Everyone (dentist), everyone's an hour away..."

Non-Traditional Dental Hygiene Procedures: There are many additional aspects of the ECP provider position that go above and beyond a typical clinical dental hygienist's daily job description. Many of the ECP hygiene study participants do several administrative duties such as the development of initial consent and treatment forms, checking children's eligibility for Medicaid/Health-Wave, hauling heavy equipment/supplies and setting up in less than ideal spaces (poor ergonomic situations), and picking children up from their classrooms for scheduled appointments. There are a few providers that are in management positions within their programs and have additional duties such as writing grants, daily scheduling and administrative paperwork. Some actually spend nearly as much time on paperwork and administrative time as they do providing clinical care; some are paid for all their time, others donate some of their time as part of the commitment to the program.

(ECP) "[...]and you figure the hours that you're in doing a school, kids, you're figuring almost that many hours for the time I go home and fill out all the paperwork for the [...], all my paperwork for the state, because they give us grant money so we have state papers to do besides all the forms we have to send to the parent...beside those kids who really need to be seen right away by (a dentist)...that I have to call the parents and talk with them."

Services Provided by Volunteer Dentists: As stated earlier, getting children a referral for restorative care has been a challenging process for many of the ECP study participants. However, it seems that the best source for the children to receive operative care is having the ECP provider connected with a safety net or community health department. A few interviewees mentioned that they have anywhere from 10 to 15 dentists in the area that volunteer and it seems to work best if the dental clinic is flexible to the times the dentist is willing to provide services. There are other volunteer dentists that will actually see the children in their offices. One ECP provider said: "We have a list of about 7...well, we have a list of 10 (dentists) that each one has agreed to take 1 child a month. When there are 521 patients and the decay rate's like 86%, you end up running out of dentists really fast. [pediatric dentist] has done a ton of pro bono stuff...he has done a surgical case for us, and I mean he's done a ton of stuff. And so he's on board, and we're going to start next year busing

one day a month. I'm going to take a bus load of kids to his office...and he's going to treat them all right then and there..."

Student Dental Hygiene Providers: Two ECP providers interviewed mentioned that they are able to have dental hygiene students do a rotation through their programs. The students benefit from being able to work with more children than they might generally see in their school clinics as well as the direct public health atmosphere. The ECP hygienists are the dental hygiene students' evaluators while they are treating patients. This is a great opportunity to reach the underserved population with preventive services as well as give the students experience encouraging them to seek employment in underserved areas.

Sustainability

"(One) dental hygienist who was invited (to work in) an Alzheimer's unit, and a step down unit, and a rehab unit, and huge numbers of apartments, assisted living. So she travelled about forty-five minutes from her home. Picked up the equipment from a safety net clinic, ten minutes over...it took her about twenty minutes to set up the equipment. And sometimes, even though they had eight people scheduled, maybe three would show up. Now that was the job of the social worker and the nursing department. So she had to rely on these people delivering patients to her. And there were probably a number of good reasons why they didn't show up. So she had to clean up the equipment, take it back, and go home, and she did stop that service."

The emergent category of sustainability did not result in any sub-categories but rather stood as a unified category. Nursing homes and working with the elderly seem to be a real challenge to the ECP providers as far as being sustainable due to the nature of the environment, the bulkiness/weight of the portable equipment, and the frail nature of their patients making it more likely they might fail their appointment. The invested time of the ECP provider to offer services in a nursing home is short lived due to numerous obstacles that keep the program from being sustainable. The time it takes to set up equipment (which is often bulky and heavy) and provide care to only a few patients (in an 8 hour day) does not allow the ECP hygienist to gain much income to make this a long term program. Reimbursement plans vary for elder care, but it is common for the ECP provider to get reimbursed on a per patient basis, so when the chair is empty, they are not getting paid. It takes collaboration with the nursing home

staff, the residents and the ECP provider to make it a successful program. All those involved must value the oral health services and understand the importance of providing the care so that it can become a sustainable plan. One dental hygienist stated: "it's 50 pound equipment....I'm hauling it in and out. I just can't do it anymore, you know, I've got to (do all that) and all the paperwork."

Two big safety net clinics were mentioned with success stories by 1 of the study participants. "... In both cases, the agency, the health center employs full time a person who does all the marketing, all the setting up, all the coordination, all the agreements, and makes sure there is a sufficient number of people that the hygienist can serve before they bring them into the...everything from assisted living, to a school to a job care program."

Several ECP providers that started with grant monies are working to develop ways to have their programs made sustainable just from the services they provide whether it's in the safety net clinic, community health centers or through their individual programs with schools in several counties. An ECP working within a safety net clinic said: "... in the bigger cities that have the Safety Net systems, their private insurance patients are generally going to a different dentist. Where we're at (located), there's not a dentist to go to. So that is a very key part of being able to be self sustaining, hopefully without grant dollars...so that we won't need primary clinic money. We won't need to have to rely on that." A few interviewees mentioned that they are still unsure of how their programs will be maintained after the initial grant funding for supplies has been utilized. However, they have been able to defeat other complications and they are all looking to find ways to continue to their work using their ECP's and making a difference in these unserved and underserved populations.

Impact of the ECP

"There was a resident in one of the facilities we were in and ...every time this resident would come to the table, she would start to eat and she would become combative. [...] staff couldn't understand and they just kept upping her dose of antipsychotics, upping it and upping it. So then, once we brought the program (oral care education) in and they did the assessments, they found that she had all six of her lower anterior teeth were abscessed. They took her in (to the dentist), took the teeth out, put in a partial and were able to get her completely off antipsychotic drugs."

This study revealed that the ECP providers

were definitely making an impact. Within this final emergent category, Impact of the ECP, 3 sub categories were identified: positive change from ECP intervention, unintended consequences of an ECP, and access to oral health care.

Positive Change from ECP Intervention: The ECP dental hygienists that were interviewed had a definite impact with positive change from their intervention. One dental hygienist provided several occasions where she received positive feedback from children: "we had barely gotten into the room before he (a young boy she had treated before) said, 'Look, Look, Look' and he grabbed his lip and he pulled it down and said, 'Look, it's pink, it's pink. It doesn't bleed when I'm brushing.'" She also mentioned a young junior high school boy that was a huge Mountain Dew drinker and had several large areas of decay: "we got him hooked up with a (dental) clinic and he was able to get taken care of. But I didn't think I was really going to get anywhere... The next time I saw him...he said, 'I'm not drinking Mountain Dew anymore.'" Another respondent mentioned "I do more dental health talks in February, you know, because all the teachers ask 'Will you come talk to our class?' I feel that's fine and something I can do for the community." Another ECP mentioned that providing sealants has been successful since very few sealants have been placed according to the school screenings.

Training the nursing home staff to be able to identify oral care issues has had a tremendous positive effect on the residents. This ECP stated: "if a resident stops eating, I would ask the staff what they would look for when a resident stops eating and they would say they're going to look to see...they'll probably think about giving them more anti-depressant medicine. Or because they're you know, they might be depressed, or they might have a stomach ache, but never once did any of them say that they first place they looked was in the mouth. And so now, when a resident stops eating, the first place they look is in the mouth. So awareness is slow, but it's coming." Another statement from her cited the impact of the program: "...in the first year of the program...[nursing staff] kept track of hospital (visits). But in the second year of the program...they did not have one pneumonia case that they sent to the hospital. And the DON (Director of Nursing) thought it was definitely due to the oral care program, improved oral care." This dental hygienist also reported that elderly resident facilities that kept up with the elderly patients oral care got these patients referred when they had a problem and they also noticed less weight loss. An ECP working

with special needs patients on site mentioned: "... it was very impressive on how much better they did with less medication when we did it on site, so I thought that was a very interesting thing to see and perhaps maybe a way to go with dental procedures for some developmentally disabled that wouldn't need, you know if you could just do simple fillings or extractions, I think that they respond better in their own setting."

Unintended Consequences of an ECP: It was evident in speaking with this group that a few of them had actually carved out a 'niche' as a result of obtaining their ECP. One of the study participants wrote a grant for an agency to develop a screening/fluoride program for the 0 to 5 year old age group. Once the grant was approved, she applied and was offered the position of the project manager. Another ECP study participant got her start with the Head Start program and went on to develop her own program working with children in eight counties. One ECP provider turned her opportunity into a business through grant funding that allowed her to hire ECP's to provide an oral care training program for staff working in 13 nursing homes throughout the state of Kansas. These clinical dental hygienist have not only benefited the populations they serve with preventive services, but have also had opportunities to use their ECP to advance themselves as programs developers and project managers.

Access: The ECP provider is working with targeted populations that have limited or no access to dental offices or do not have a dental office in the city/town where they reside that take Medicaid or HealthWave insurance for children. One interviewee stated: "over the past few years, from 2007 to 2010, safety net clinics have been expanded in the state significantly. In 2006, there were 5 dentists working in safety net clinics, and I think there are 37 now (2010). We've gone from serving maybe 5,000 patient contacts to maybe 30,000 patient contacts. Most of the dental clinics, the safety net dental clinics dotted throughout the state, and we just opened a couple of new ones and are about to open another new one... they have been the ones hiring hygienists, and they've been the ones hiring the Extended Care Permit hygienists."

These clinics provide a 'hub' that the ECP can work from and allows them the mobility of providing care for these populations of children in their school or Head Start program, the elderly in long term care facilities and/or special needs/developmentally disabled in their care homes. ECP providers are making an impact by accessing children,

who may not otherwise receive dental care, within schools, providing preventive treatment such as prophylaxis, assessments, sealants and fluoride applications. One dental hygienist noted: "it's a whole community out there so hungry for dental. They have to drive to (...) or (...) or (...), we kind of meet in the middle out there... they need to find help in some way." They team with the school advocates to get children with urgent needs referred for further care, however, it is often not possible due to the lack of a Medicaid dental provider in the area.

Discussion

With the increased awareness of the need for oral health care to unserved and underserved populations on a national level, allowing dental hygienists direct access to those populations that have limited access to dental care is a viable solution to providing preventive dental care. The ECP providers very closely resemble the Limited Access Permit (LAP) dental hygienist in Oregon.¹³ The population base is very similar as well as the practice locations that are established in the legislation.

ECP dental hygienists that were participants in this study had a very entrepreneurial spirit. Their passion for working with these specific populations was a major driving force for them to consider applying for an extended care permit. Written agreements with a sponsoring dentist, development and implementation of their programs and perseverance through obstacles and challenges were well outside the norm of clinical practice, but they were determined to succeed. This kind of determination of the ECP provider parallels the findings in a qualitative study of the limited access permit (LAP) hygienist in Oregon.¹³ The LAP hygienists in Oregon also had to develop their own systems and strategize how to get their programs started and make them successful. Unable to receive direct reimbursement, per the statutes, the ECP dental hygienists all developed payment plans through a facility that already had a Medicaid number or through a dentist that was a Medicaid provider in order to process services for reimbursement. Although Medicaid covers children's oral health, one of the biggest barriers to accessing adults and the elderly is the fact that there is no dental care funding for a majority of this population. The lack of funding and the lack of value of the preventive services may be a significant barrier that will not allow the ECP provider to sustain a successful program for the elderly. It would seem that all those involved would benefit from an arrange-

ment of a specified number of patients having preventive dental care services provided and the ECP would receive a regular consistent salary allowing her to continue this program in facilities such as long term care.

These ECP hygienists have been able to develop their programs in just about any kind of location. They adapt to whatever situation they are given and are flexible to overcome whatever hurdles they encounter. Their experiences have increased their motivation to provide care to these targeted populations, even if the reimbursement was minimal. It is often the satisfaction of making a difference in someone's oral health and overall health while increasing access to care that keeps them sustaining their programs.

One limitation of this study is that it is a first of its kind to examine the ECP dental hygienists in Kansas and therefore is hypotheses generating versus hypotheses testing. A second limitation is the nature of this type of study being qualitative with interviews consisting of self-reported data. While a great deal of effort was put into verifying the data through the methodology, self-reported data contains several potential sources of bias such as selective memory, attribution and exaggeration.

Conclusion

The ECP providers are a group of entrepreneurial dental hygienists willing to work outside the traditional clinical practice setting. They had to learn to develop/strengthen skills to achieve funding, develop partnerships, and excel in their communication and networking skills in order to create

a successful oral health program. Although they encountered barriers along the way such as financial reimbursement and finding restorative care for those unmet needs, they increased access to preventive oral health services to those in unserved and underserved areas of Kansas.

Future research should begin to test the hypotheses generated in this study. One example would be to quantitatively examine increased access by comparing treatment procedures provided by the ECP providers with improved oral health of their patients who are identified as unserved or underserved prior to the introduction of the ECP provider. Another example may be to investigate all ECP dental hygienists on what would be necessary to practice with their ECP status full time and creating a sustainable position to increase the access to care for the unserved and underserved populations. With thirty-five states having some form of direct access, there is an absolute necessity for initial research of each of these individual state models to further understand the expanded scope of practice of dental hygienists and the effect they have on the underserved and underserved populations with regard to access to oral health care.

Janette Delinger, RDH, MSDH, FAADH is the Academic Relations Manager, Midwest at Colgate Oral Pharmaceuticals. Cynthia C. Gadbury-Amyot, MS, Ed. D is the Associate Dean of Instructional Technology and Faculty Development at University of Missouri-Kansas City School of Dentistry. Tanya Villalpando Mitchell, RDH, MS is Associate Professor and Director of Graduate Studies at the University of Missouri – Kansas City School of Dentistry Division of Dental Hygiene. Karen B. Williams, PhD, RDH is the Chair and Professor of Biomedical and Health Informatics at UMKC School of Medicine.

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A Racial Comparison of Sociocultural Factors and Oral Health Perceptions

Nicole Kelesidis RDH, MS

Introduction

In the U.S. oral health care disparities exist between minority and other mainstream populations.¹ By 2025, non-white racial groups are expected to approach 40% of the U.S. population, which include African Americans (AA) and Asian Americans (AS).² Although the prevalence and incidence of various forms of oral disease have declined in the last few decades, the present rates of oral disease among minority groups are distressingly high.^{1,3-5} The percentage of AA who have lost 1 or more natural teeth is more than 3 times as great as Caucasians. One study indicated that AA display the highest prevalence of periodontal disease followed by Hispanics and AS.⁶

These oral health disparities can be explained by various sociocultural factors. Differences in access to care, education level and socioeconomic status may explain racial and ethnic differences in the use of preventive services.⁵ A Medical Expenditure Survey revealed that low socioeconomic status, lack of insurance, and lack of a usual source of care represent significant barriers to preventive care.⁷

Another significant factor in sociocultural variance is cultural beliefs and perceptions of oral health care. Perceptions of oral health have been linked to predisposing sociodemographics and dental utilization.⁸ Individual patient preferences and behavioral risk factors are often a reflection of their sociodemographic and cultural backgrounds. The oral health beliefs and correlated risk behaviors of patients are intricately related to patients' health-related risk behaviors, openness

to change, and ultimately health outcomes. Variations of theoretical frameworks and conceptual models have been applied to dentistry in order to understand oral health outcomes and to create effective oral health interventions.⁹ A prior study determined that age and race were major predictors

Abstract

Purpose: There are limited data regarding race, sociocultural factors and dental outcomes such as oral health perceptions. The purpose of this study is to recognize and determine whether sociocultural factors impact oral health practices, and how these relate to oral health care perceptions among African American (AA) and Asian American (AS) comparison groups.

Methods: In this cross-sectional study, participants were selected using a purposive sampling technique among new enrolling patients of AA and AS origin at the New York University College of Dentistry (NYUCD). Sociocultural factors such as low education level, poor access to care, limited financial status and perceptions of oral health such as brushing and flossing were studied.

Results: Among 139 participants, 86 (61.87%) were AA and 53 (38.13%) were AS. Compared to AS, AA had poorer access to care (58.14% vs. 43.40%, $p < 0.01$) and cost was a greater financial barrier for dental care (41.86% vs. 26.41%, $p < 0.01$). Race was the strongest predictor of oral health perceptions (OR = 2.27, $p < 0.05$) followed by limited financial status (OR = 1.335 $p < 0.05$) and poor access to care (OR = 1.299 $p < 0.01$). AA had more adverse oral health perceptions (83.72% vs. 69.81%, $p < 0.05$), higher incidence of dental decay (13.95% vs 7.54%, $p < 0.05$) and mixed disease (dental decay and periodontal disease) (88.37% vs. 60.37%, $p < 0.05$) compared to AS. There was no difference in oral health practices (brushing and flossing) between the two populations.

Conclusion: AA had more adverse oral health perceptions and higher incidence of dental disease than AS. Cultural influences have an impact on perceptions and behaviors that may affect oral health. Therefore, cultural awareness and competency among oral health professionals should be emphasized.

Keywords: Sociocultural factors, oral health perceptions, cultural competency, cultural awareness, race

This study supports the NDHRA priority area, **Health Promotion/Disease Prevention:** Investigate how environmental factors (culture, socioeconomic status-SES, education) influence oral health behaviors.

of the perceived benefits of preventive practices, with Caucasians “more likely to believe in the benefit of preventive practices.”¹⁰ Another study explored cultural influences on AA behavior and determined that a low emphasis is placed on seeking oral health care due to the perception of caries not being a health issue.² Cultural factors have also proven to impact AS use of oral health care. For example, a study showed that strong traditional beliefs concerning gingival swelling and bleeding are not deemed as a sign of disease and influenced Chinese immigrants’ attitudes toward not seeking dental care.¹¹ However there are few studies that have associated oral health beliefs with dental outcomes and how they relate to different races.

In 2005 a report of the Institute of Medicine provided evidence of cultural differences in health care between minorities and nonminorities. These differences were also related to disparities in access, health status, and health outcomes; increased risk of edentulism; higher incidence of systemic disease; reduced life expectancy; and lower quality of life. These are consequences that may result from poor access to oral health care. Unfortunately, individuals of various cultural groups may not fully comprehend the importance of preventive oral health care and/or may not trust current practices and oral health care professionals.² Oral health care professionals must be aware of these barriers so they can be overcome.¹²

Oral health care professionals must be culturally aware and acquire skills in self-awareness, respect for diversity, and sensitivity in communication.¹³ The intent is to educate diverse populations on the importance of conventional medicine as a benefit to their health care beliefs. The goal and responsibility of all oral health care professionals is to promote health, reduce the incidence of oral disease, and perform clinical and educational services while being aware of sociocultural differences in order to understand, effectively communicate with, educate, and treat patients from all cultural backgrounds. Cultural competency provides consistent behaviors, attitudes, and policies among oral health professionals to work effectively in cross-cultural situations.¹³

Patients are more likely to value the patient provider relationship if they believe their cultural needs are acknowledged and respected. Patient perceptions have become progressively accepted as significant and valid measures of health care quality.³

Currently, there is a shortage of diversity in the health care workforce and a lack of cultural com-

petence among oral health care professionals to care for diverse populations.¹² There is a great need based on existing demographic changes to take measures to ensure that the health care workforce is prepared to care for a more diverse population. Fourteen percent of presently licensed dentists are non-white, almost 7% are AS/Pacific Islander, 3.4% are Black/AA, 3.3% are Hispanic/Latino and 0.1% is Native American. A past report stated that minority patients in the U.S. have increased levels of satisfaction in health care settings of same race oral health care professionals, and concluded that greater racial and ethnic diversity among health professionals will improve access to and quality of health care for all Americans.^{12,14} A report of the American Dental Education Association (ADEA) emphasized the role of dental educational institutions in recruiting minorities and training all students in diversity.¹⁵ Research has shown that successful patient-provider communication is correlated with patient satisfaction, adherence to oral health instructions, and positive health outcomes.¹²

Brach and Fraser described nine categories of cultural competency activity that could lead to reducing health disparities for minorities.¹⁶ They concluded that training is imperative to improve problems stemming subculture and mutual understanding of each other’s health beliefs. There are few opportunities for continuing education in cultural competency aimed at oral health professionals, however there is growing realization of this need.¹⁵ From the above, it is evident that there are few studies that have investigated how oral health perceptions affect dental outcomes in different races and how these can be used to improve cultural competency of oral health professionals and improve patient care.

There are limited data regarding race, sociocultural factors and dental outcomes such as oral health perceptions. The purpose of this study was to recognize and determine whether sociocultural factors impede oral health practices, and how these relate to the perception of oral health care among AA and AS populations.

Methods and Materials

This cross-sectional study used quantitative data collection methods through the use of a researcher developed survey, similarly to prior studies to investigate the sociocultural influences on oral health care perceptions among AA and AS.^{16,17} Participation was voluntary, based on a purposive sampling technique among all new enrolling patients at New York University College of Dentistry (NYUCD) to

gather relevant data among both groups. The researcher reviewed the completed surveys and discarded those completed by individuals who indicated they were not of AS and or AA origin.

The Kentucky Oral Health Survey was used in Part 1 of the survey and included questions addressing demographics, dental insurance, general and oral health status, oral health practices, etc.¹⁷ It used a multiple-choice format, dichotomous answers and open-ended questions. Part 2 of the survey probed oral health perceptions, such as the importance of routine dental checkups and proper homecare.^{10,18,19}

The researcher conducted the study at NYUCD Admissions Clinic 1A, following Institutional Review Board approval. NYUCD was chosen because of its diverse and urban patient pool. Data were collected from participants from January 30, 2012, to March 7, 2012, by the researcher.

A questionnaire information sheet provided a written summary of the nature of the research study. Subjects were informed that participation would aid in educating oral health care professionals to understand the oral health care perceptions of patients, and to provide a step towards implementing culturally competent care. The researcher reviewed the completed surveys and discarded those completed by individuals who indicated they were not of AA and AS origin. To further ensure the privacy of the participants, a numerical coding system was utilized for the survey responses. The gathered data were stored and locked in a filing cabinet system.

Definition of Variables

The most important sociocultural factors were race, education, poor access to care, oral health awareness, poor financial status and strong cultural beliefs. Education was studied as a 3 level variable as listed: low education was defined as high school/GED or lower, medium as some college – Associates degree and high level of education as Bachelor's - Professional degree. The poor access to care variable was created based on patient's answers of dental or no visit at time of visit at NYUCD ("NYU today") as well as in the last year or last 5 years. The major reasons of no visit in the last year were cost, unawareness of prevention ("no reason to go") and fear. The main reasons disclosed for visit at any time point were pain/extraction and prevention. If any of the answers to the above questions had negative meaning regarding access to care (i.e. "no transportation") that patient was coded as having poor access to care. The

poor financial status variable was created based on patient's answers of cost being the main reason for not seeking dental treatment.

In order to help define the adverse oral health perception variable, the survey question responses were analyzed. The subject's answers were deemed as correct or adverse oral health perception based on professional oral health practices. The patients were asked the following questions that are considered as correct statements in oral health care:

1. Dental problems can cause other health problems
2. I place great value on dental health
3. I can keep my teeth by brushing, flossing, and going to the dentist regularly
4. It is important to keep my natural teeth

Another variable, "adverse periodontal disease perception," was created based on patient's responses regarding answering the question correctly based on accepted dental practice. The patients were asked the following questions that are considered correct in oral health care: flossing prevents gum disease, brushing prevents gum disease. If patients disagreed with the correct perception then that patient was coded as having an adverse perception of periodontal disease. The "periodontal disease" variable was created based on patient's responses on answering the questions that describe periodontal disease. Questions addressed were: bleeding gums, mobile teeth and periodontal disease as reason for dental visit in the past 5 years or time of visit at NYUCD. If any of the answers to the above questions indicated signs and or a history of periodontal disease (i.e. "I have mobile teeth or periodontal disease as reason for dental visit in the past 5 years") that patient was coded as having periodontal disease. Secondly, patients were asked the following questions that are considered as incorrect statements regarding oral health care: it's natural to lose teeth with age, dentures are less of a bother than natural teeth and state of teeth is decided at birth and not related to self-care. If patients agreed with the incorrect perception or disagreed with the correct perception then that patient was coded as having an adverse oral health perception. The "dental decay" variable was created based on patient's responses concerning the questions that describe dental decay based on presence and or history of carious lesions. Such questions addressed: root canal as reason for dental visit in the past 5 years or at time of NYUCD visit. If any of the answers to the above questions were positive that patient was coded as having dental decay. The "periodontal disease and dental decay" variable was created to describe patients

with mixed disease. This variable was based on patient's answers to the questions that describe periodontal disease and dental decay based on usual dental practice. The questions addressed: brushing, flossing, swollen gums, lost teeth due to periodontal disease/decay and different reasons for dental visit time of visit at NYUCD or past 5 years, such as pain/extraction, restorative work, crown/bridge and or dentures. If any of the answers to the above questions had negative meaning regarding periodontal disease and dental decay (i.e. "I do not brush or floss, I have bleeding gums, etc") that patient was coded as having mixed disease.

Data Analysis and Statistics

A p-value ≤ 0.05 was considered statistically significant. Continuous data are presented as mean and standard deviation, while categorical data are presented as a number (percent of patients). Comparisons between groups were made using a 2-sample t-test for continuous data. Chi-square test or Fisher's exact test for categorical data was used. After testing the assumptions, a bivariate analysis was performed between both population groups as well as the available covariates including patient characteristics such as age, gender, education, major sociocultural factors such as poor access to care, oral health awareness, poor financial status, adverse oral health perceptions, adverse perceptions of periodontal disease, and dental characteristics such as periodontal disease and dental decay.

Multiple logistic regression analysis was conducted using the available covariates to identify important predictors of outcomes such as adverse oral health perceptions, adverse periodontal disease perceptions, dental disease characteristics such as dental decay, and dental decay and periodontal disease. In the final multivariable model, important biological characteristics were entered as well as important predictors of outcomes in bivariate analysis at a p-value of 0.25. Outcomes such as adverse oral health perceptions, adverse periodontal disease perceptions, dental disease characteristics such as dental decay and periodontal disease were analysed as categorical variables.

Results

A total of 139 subjects participated and completed the researcher-developed questionnaire for the study. Among the participants, 86 (61.87%) were of AA origin, and 53 (38.13%) were of AS origin.

Descriptive characteristics of important demographic and sociocultural variables are presented

in Table I. The mean age of all patients was 45.50 ± 18.65 years. AS were older compared with AA (49.82 ± 21.42 vs. 41.36 ± 14.55 , $p=0.007$). There was no statistical significant difference of various levels of education between AA and AS, although AS seemed to have higher levels of education (43.39% vs. 22.09%, $p=0.073$). AA demonstrated poorer access to care compared with AS (58.14% vs. 43.40%, $p=0.005$). Cost was a major cause for lack of dental visits between AS and AA (41.86% vs. 26.41%, $p=0.008$). AS reported seeking preventive dental treatment more frequently than AA in the past 5 years (66.03% vs. 46.51%, $p=0.009$). AS also reported that prevention was also the reason for their present dental visit at NYUCD in comparison to AA (47.17% vs. 29.07%, $p=0.003$). There was no difference in oral health awareness and poor financial status between the 2 groups (Table I).

Table II describes important perceptions and differences of oral health among the 2 racial groups. Overall, 109 (78.41%) in the 2 comparison groups had adverse oral health perceptions. The AA sample group had more adverse oral health perceptions compared with AS (83.72% vs. 69.81%, $p=0.041$). There was no difference in perception of adverse periodontal disease between AA and AS (29.07% vs. 28.30%, $p=0.09$). Both races had similar perceptions that flossing and brushing can prevent periodontal disease.

Table III demonstrates important dental disease characteristics of AA and AS. The AA group did not have significantly more periodontal disease compared to the AS group (55.81% vs. 37.73%, $p=0.18$). More AA sought dental treatment in the past 5 years for periodontal disease than AS (16.27% vs. 7.54%, $p=0.015$). Dental decay was more prevalent among AA than AS (13.95% vs. 7.54%, $p=0.035$), along with more incidence of both periodontal disease and dental decay (88.37% vs. 60.37%, $p=0.038$), inflamed gingiva (34.88% vs. 20.75%, $p=0.024$), and higher rates of edentulism (24.48% vs. 15.09%, $p=0.004$). There was no difference between the 2 races regarding prevalence of gingival bleeding, tooth mobility, prevalence of brushing and or flossing, different reasons for dental visits such as root canal, restorative work, crown/bridge, and dentures.

Table IV depicts differences in perceptions between the 2 comparison groups concerning important oral health practices such as brushing and flossing. Despite the AS group reporting agreement with the statement "I can keep my teeth by brushing and flossing," (75.47% vs. 58.14%, $p=0.002$), they did not seem to brush (90.56% vs. 87.21%,

Table I: Patient Characteristics and Important Sociocultural Factors

Demographics	Overall	African Americans (AA)	Asian Americans (AS)	p-value
	139	86 (61.87%)	53 (38.13%)	
Age	45.50±18.65	41.36±14.55	49.82±21.42	p=0.007
Gender (males)	48 (34.53%)	30 (34.88%)	18 (33.96%)	p=0.85
Sociocultural factors:				
Education				
• Low (high school/GED or lower)	50 (35.97%)	35 (40.69%)	15 (28.30%)	p=0.211
• Medium(some college-Associates degree)	47 (33.81%)	30 (34.88%)	17 (32.07%)	p=0.718
• High(Bachelor-Professional degree)	42 (30.22%)	19 (22.09%)	23 (43.39%)	p=0.073
• Poor access to care	73 (52.52%)	50 (58.14%)	23 (43.40%)	p=0.005
Reasons for no dental visit in the past year				
• Cost	50 (35.97%)	36 (41.86%)	14 (26.41%)	p=0.008
• Unawareness of prevention (no reason to go)	19 (13.67%)	14 (16.28%)	5 (9.43%)	p=0.182
• Fear	23 (18.11%)	12 (13.95%)	11 (20.75%)	p=0.098
Reasons for visit in last five years				
• Pain/Extraction	19 (13.67%)	16 (18.60%)	3 (5.66%)	p<0.001
• Prevention	75 (55.56%)	40 (46.51%)	35 (66.03%)	p=0.009
Reasons for visit at NYUCD today				
• Pain/Extraction	18 (12.95%)	10 (11.63%)	8 (15.09%)	p=0.684
• Prevention	50 (35.97%)	25 (29.07%)	25 (47.17%)	p=0.003
• Oral Health awareness	112 (80.57%)	67 (77.90%)	45 (84.90%)	p=0.055
• Poor financial status	76 (54.68%)	46 (53.49%)	30 (56.60%)	p=0.68
• Insurance (yes or no)	63 (45.32%)	40 (46.51%)	23 (43.39%)	p=0.68
Type of insurance				
• None	76 (54.68%)	46 (53.49%)	30 (56.60%)	p=0.688
• Medicaid (average)	43 (30.94%)	29 (33.72%)	14 (26.41%)	p=0.277
• Private (Very good)	20 (14.34%)	12 (13.95%)	8 (15.09%)	p=0.388
• Strong cultural beliefs/traditions	98 (70.50%)	56 (65.11%)	42 (79.24%)	p=0.034

p=0.23) or floss (45.28% vs. 40.69%, p=0.35) significantly more than AA.

Table V demonstrates important demographic and sociocultural factors as predictors of adverse oral health perceptions (multivariable logistic regression analysis). Overall, in the unadjusted analysis, race was an important predictor of adverse oral health perceptions (OR 2.27, p=0.05). In the adjusted final model, race remained an important predictor of adverse oral health perceptions (OR 2.96, p=0.029). Generally, in the adjusted analysis, age was an important predictor of adverse oral health perceptions (OR 1.03, p=0.017). More specifically, age was a more significant predictor of adverse oral health perceptions (OR 1.510, p=0.001) in AA than in AS (OR 0.966, p=0.177). In the adjusted analysis, poor access to care was an important predictor of adverse oral health perceptions (OR 1.275, p=0.021). More specifically, poor access to care was a more vital predictor of adverse oral health perceptions (OR 1.457, p=0.035) in AA

than in AS (OR 1.054, p=0.129). Moreover, in the adjusted analysis, poor financial status was an important predictor of adverse oral health perceptions (OR 1.335, p=0.016). Poor financial status was also an important predictor of adverse oral health perceptions for both AA (OR 1.896, p=0.014) and AS (OR 1.252, p=0.043).

Using a similar model, demographic and sociocultural factors as predictors of periodontal disease perceptions were examined. Overall, race was an important predictor of periodontal disease perceptions both in the unadjusted (OR 1.053, p=0.034) and adjusted analysis (OR 1.040, p=0.046). Overall, in the adjusted analysis, age was an important predictor of periodontal disease perceptions (OR 1.028, p=0.044). More specifically, age was a more important predictor of periodontal disease perceptions (OR 1.029, p=0.046) in AS than in AA (OR 1.012, p=0.062). Education, poor access to care and poor financial status were not important predictors of periodontal disease perceptions.

Table II: Patient Characteristics and Important Perceptions of Oral Health

Perceptions of oral health	Overall	AA	AS	p-value
	139	86 (61.87%)	53 (38.13%)	
Adverse oral health perceptions :	109 (78.41%)	72 (83.72%)	37 (69.81%)	p=0.041
• Dental problems can cause health problems (correct perception)	121 (87.05%)	72 (83.72%)	49 (92.45%)	p=0.006
• Great value on dental health (correct perception)	92 (66.19%)	50 (58.14%)	42 (79.24%)	p<0.001
• It's natural to lose teeth with age (adverse perception)	104 (74.82%)	58 (67.44%)	46 (86.79%)	p<0.001
• I can keep my teeth for life by brushing, flossing, and going to the dentist regularly (correct perception)	90 (64.75%)	50 (58.14%)	40 (75.47%)	p=0.002
• Dentures will be less of a bother than natural teeth (adverse perception)	49 (35.25%)	40 (46.51%)	9 (16.98%)	p=0.018
• State of teeth is decided at birth and not related to self care (adverse perception)	46 (33.09%)	31 (36.04%)	15 (28.30%)	p=0.004
• It is important to keep my natural teeth (correct perception)	120 (86.33%)	73 (84.88%)	47 (88.68%)	p=0.024
Adverse Perception of Periodontal disease	40 (28.78%)	25 (29.07 %)	15 (28.30%)	p=0.09
• Flossing prevents gum disease (correct perception)	111 (79.86%)	71 (82.56%)	40 (75.47%)	p=0.078
• Brushing prevents gum disease (correct perception)	115 (82.73%)	73 (84.88%)	42 (79.24%)	p=0.069

Moreover we studied the above demographic and sociocultural factors as predictors of dental decay and mixed disease. Regarding dental decay overall, race was not a significant predictor of dental decay (OR 1.19, p=0.072). Similar results were noted for the other sociocultural factors. Regarding mixed disease (dental decay and periodontal disease), race was not a significant predictor of mixed disease (OR 1.419, p=0.068). Overall, in the adjusted analysis, age was an important predictor of mixed disease (OR 1.043, p=0.005 and was a more important predictor of mixed disease (OR 1.114, p=0.023) in AA than AS (OR 1.016, p=0.258). Poor access to care was also an important variable of mixed disease in the unadjusted analysis (OR 2.904, p=0.025) but not in the adjusted (OR 2.675, p=0.073). Education and poor financial status were not important predictors of mixed disease.

In summary we noted the following significant differences in sociocultural factors, oral health perceptions and predictors of dental disease between AA and AS: AA had worse access to care 58.14 vs. 43.40 (p=0.005), did not visit the dental office due to cost (41.86% vs 26.41%, p=0.008) , visited the dental office more often due to pain and tooth extraction (18.60% vs 5.66, p<0.001) , had worse

overall adverse oral health perceptions (83.72% vs 69.81%, p<0.05), had more often dental decay (13.95% vs 7.54% , p<0.05) and mixed disease (88.37% vs 60.37% , p<0.05). In AA age was a more important predictor of adverse oral health perceptions (OR 1.510, p=0.001) than AS (OR 0.966, p=0.177). Similar results for poor access to care (OR 1.457, p<0.05 for AA vs OR 1.054, p=0.129 for AS). Prevention was a more important reason for dental visits among AS (p<0.01). Also AS has stronger cultural beliefs (p<0.05) and more correct oral health perceptions (p<0.01) than AA.

Similarities between the 2 groups included level of education, oral health awareness, poor financial status, adverse perception of periodontal disease, prevalence of gingival bleeding and inflammation, prevalence of brushing or flossing, different reasons for dental visit such as root canal, restorative work, crown/bridge, and dentures. Poor financial status was an equally important predictor of adverse oral health perceptions.

Discussion

From the data obtained in the study, there was no difference in the majority of sociocultural factors between AA and AS such as oral health aware-

Table III: Dental Disease Characteristics of African Americans and Asian Americans

	Overall	AA	Asians	p-value
	139	86 (61.87%)	53 (38.13%)	
Periodontal disease	68 (53.54%)	48 (55.81%)	20 (37.73%)	0.18
<ul style="list-style-type: none"> Bleeding gingiva Teeth mobility Periodontal disease as a reason for dental visit in the past five years Periodontal disease as reason for dental visit time of visit at NYUCD 	46 (33.09%) 16 (11.51%) 18 (12.95%) 12 (8.63%)	34 (39.53%) 10 (11.62%) 14 (16.27%) 8 (9.30%)	12 (22.64%) 6 (11.32%) 4 (7.54%) 4 (7.54%)	0.23 0.42 0.015 0.32
Dental decay	16 (12.60%)	12 (13.95%)	4 (7.54%)	0.035
<ul style="list-style-type: none"> Root canal as reason for dental visit in the past five years Root canal as reason for dental visit time of visit at NYUCD 	12 (8.63%) 8 (5.76%)	8 (9.30%) 5 (5.81%)	4 (7.54%) 3 (5.66%)	0.06 0.74
Periodontal disease and dental decay	103 (81.10%)	76 (88.37%)	32 (60.37%)	0.038
<ul style="list-style-type: none"> Do you brush Do you floss Inflamed gingiva Pain/extraction as reason for dental visit passed five years Pain/extraction as reason for dental visit time of visit NYUCD Restorative work as reason for dental visit past five years Restorative work as reason for dental visit time of visit NYUCD visit Crown/Bridge as reason for dental visit past five years Crown/Bridge as reason for dental visit time of visit NYUCD Dentures as reason for dental visit past five years Dentures as reason for dental visit time of visit NYUCD Lost teeth due to Periodontal disease and or dental decay Lost teeth? Edentulous 	123 (88.49%) 59 (42.45%) 41 (29.50%) 19 (13.67%) 18 (12.95%) 34 (24.46%) 19 (13.67%) 8 (5.76%) 7 (5.03%) 23 (16.55%) 27 (19.42%) 80 (57.55%) 107 (76.98%) 29 (26.13%)	75 (87.21%) 35 (40.69%) 30 (34.88%) 13 (15.11%) 12 (13.95%) 22 (25.58%) 12 (13.95%) 6 (6.98%) 5 (5.81%) 16 (18.60%) 16 (18.60%) 52 (60.46%) 68 (79.07%) 21 (24.48%)	48 (90.56%) 24 (45.28%) 11 (20.75%) 6 (11.32%) 6 (11.32%) 12 (22.64%) 7 (13.20%) 2 (3.77%) 2 (3.77%) 7 (13.20%) 11 (20.75%) 28 (52.83%) 39 (73.58%) 8 (15.09%)	0.23 0.35 0.024 0.032 0.24 0.23 0.34 0.61 0.72 0.29 0.38 0.12 0.14 0.004

Table IV: Differences in Perceptions and Oral Health Practices between African Americans and Asian Americans

Oral Health Practices (brushing, flossing)	Overall	AA	AS	p-value
	139	86 (61.87%)	53 (38.13%)	
Brushing/Flossing				
<ul style="list-style-type: none"> Do you brush Do you floss 	123 (88.49%) 59 (42.45%)	75 (87.21%) 35 (40.69%)	48 (90.56%) 24 (45.28%)	0.23 0.35
Perceptions regarding brushing and flossing				
<ul style="list-style-type: none"> Flossing prevents Periodontal disease Brushing prevents Periodontal disease I can keep my teeth by brushing, flossing and going to the dentist regularly 	111 (79.86%) 115 (82.73%) 90 (64.75%)	71 (82.56%) 73 (84.88%) 50 (58.14%)	40 (75.47%) 42 (79.24%) 40 (75.47%)	p=0.078 p=0.069 p=0.002

Table V: Important Demographic and Sociocultural Factors in Adverse Oral Health Perceptions

Adverse oral health perceptions	Overall (OR, CI)	p-value	AA (OR, CI)	p-value	AS (OR, CI)	p-value
Demographics						
Race	2.27 (0.999 to 5.200)	0.05	-	-	-	-
Race Adjusted	2.96 (1.11 to 7.85)	0.029	-	-	-	-
Age	1.012 (0.990 to 1.035)	0.277	1.164 (1.045 to 1.297)	0.006	0.999 (0.975 to 1.024)	0.965
Age adjusted	1.03 (1.005 to 1.061)	0.017	1.510 (1.175 to 1.940)	0.001	0.966 (0.918 to 1.015)	0.177
Gender (males)	1.691 (0.691 to 4.135)	0.250	2.310 (0.901 to 4.102)	0.09	0.75 (0.255 to 2.202)	0.601
Sociocultural factors:						
Education						
Medium (some college-Associates degree)	1.539 (0.566 to 4.184)	0.39	1.055 (0.228 to 4.867)	0.91	2.00 (0.518 to 7.721)	0.315
High(Bachelor's Professional degree)	0.889 (0.345 to 2.291)	0.80	1.703 (0.337 to 8.600)	0.519	0.4 (0.111 to 1.435)	0.160
Poor Access to care	1.299 (1.123 to 1.729)	0.008	1.350 (1.211 to 2.205)	0.006	1.130 (1.086 to 1.258)	0.051
Adjusted poor access to care	1.275 (1.091 to 1.823)	0.021	1.457 (0.983 to 2.203)	0.035	1.054 (0.998 to 1.138)	0.129
Poor Financial status	1.335 (1.137 to 1.815)	0.016	1.698 (1.184 to 3.639)	0.006	1.178 (1.051 to 1.615)	0.046
Adjusted financial status	1.453 (1.157 to 2.305)	0.03	1.896 (1.376 to 3.816)	0.014	1.252 (1.003 to 1.456)	0.043

Note – Final model adjusted for age, gender, education, poor access to care, poor financial status, and oral health awareness

ness and poor financial status. AA overall had more adverse oral health perceptions than AS, along with higher incidence of dental decay and mixed disease. Yet, similarities were seen among the two groups as well. AS and AA had comparable perceptions that flossing and brushing can help prevent periodontal disease and did not report a difference in frequency of brushing and flossing.

Race was the most significant predictor of adverse oral health perceptions and periodontal disease perceptions but not a significant predictor of dental decay. Age was a chief predictor of adverse oral health perceptions and mixed disease and was a more significant variable among AA than AS. Age was also a chief predictor of periodontal disease perceptions in the adjusted analysis. These results are consistent with prior studies. Nakazono et al determined that age and race were major predictors of the perceived benefits of preventive practices, with Caucasians "more likely to believe in the benefit of preventive practices."¹⁰ Furthermore, the results also revealed that there was no statistical

significant difference regarding different level of education between the two population groups.

Moreover, AA had inferior access to care than AS with cost being a main barrier for the lack of dental visits. In addition, a higher percentage of AA stated that pain and or tooth extractions were a chief reason for their dental visits in the past 5 years. These results are reflective of previous studies such as the evidenced provided by the United States Department of Health and Human Services (USDHHS) report which disclosed that underprivileged individuals experience more oral disease and are more likely to have untreated teeth than those who are more economically stable.¹ The outcomes of the study regarding prevention are also consistent with previous studies. A study exploring cultural influences on AA behavior determined that a low emphasis is placed on seeking oral health care due to the perception of caries not being a health issue.²

AA had inferior access to care compared with AS

and cost was a major barrier and reason for lack of dental visits among AA. Prior surveys have also shown that low finances may serve as barriers to care for many racial groups, more so in AA.³

AS also showed to have more acceptable oral health perceptions than AA. This is consistent with prior studies that revealed that AA disclosed stronger negative perceptions of disrespect because of their race which has been shown to influence patients' compliance with treatment, which in turn can influence health outcomes.³ Furthermore, it has been shown that individuals from diverse cultures have different perceptions of oral health and symptoms.^{20,21}

More AA believed that dentures will be less of a bother than natural teeth and that state of teeth is decided at birth and is not related to self care. However, more AS had the adverse perception that it is natural to lose teeth with age. AS and AA generally have less confidence in their ability to control their oral health and also report to have less concern about the value of saving their natural teeth.^{10,11,16,21}

This study has important implications. It demonstrates that sociocultural factors such as race and poor access to care have an impact on perceptions and behaviors that condition perceptions, judgments, communication, and behaviors that may impinge on overall general and oral health. Oral

health care professionals can be more aware and understanding as to why certain population groups may not seek preventive treatment or consider oral health as equally important as general health, and specifically educate such patients in a manner which they will understand while being culturally sensitive to their beliefs.

Limitations of the study include its cross sectional nature, and small number of participants at a single center detracting from external validity. Finally, the methods used in this study serve only to describe statistical associations, which are not necessarily proof of causation. Future research studies conducted throughout the U.S. aimed at collecting data from all minority groups are warranted in order to improve the cultural competence of oral health professionals.

Conclusion

In conclusion, AA overall had more adverse oral health perceptions and higher incidence of dental disease than AS. Cultural influences have an impact on perceptions and behaviors that may affect oral health and therefore attaining of cultural competency of oral health professionals should be emphasized.

Nicole Kelesidis RDH, MS, is a clinical instructor at the New York University College of Dentistry, Dental Hygiene Programs.

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In Vitro Effect of Over-the-Counter Probiotics on the Ability of *Candida Albicans* to Form Biofilm on Denture Strips

Shweta Ujaoney, MDS; Jyotsna Chandra, PhD; Fady Faddoul, DDS, MSD; Maya Chane, DDS, MS; Jing Wang, DMD; Louay Taifour, BDS; Manju R. Mamtani, MD; Tushar P. Thakre, MD, PhD; Hemant Kulkarni, MD; Pranab Mukherjee, PhD; Mahmoud A. Ghannoum, PhD

Introduction

Candida albicans is a commensal saprophytic fungus that colonizes the oral cavity of humans. However, overgrowth of *C. albicans* can result in clinical presentation of candidiasis that includes a disturbance of the oral microbiome. Of interest, wearers of partial as well as complete dentures are at a significantly high risk of oral candidiasis.^{1,2} In an extensive review, Gendreau and Loewy report that 15 to 70% of denture wearers have dental stomatitis and that the oral hygiene related risk factors of this condition are significantly associated with morbidly increased colonization of *C. albicans*.³

Of the various virulence properties of *C. albicans*, formation of biofilms plays a critical role in maintenance of dental and oral hygiene.⁴ Biofilms represent unique niches for microbial growth, where microorganisms are encased in a self-produced extracellular matrix and are protected from the action of antimicrobial agents, saliva and immune host cells. It has been reported elsewhere that biofilm-associated *C. albicans* cells, compared with cells grown in planktonic form, are resistant to antifungals used to treat denture stomatitis.⁵ Thus, the ability of *C. albicans* to form biofilms on epithelial surfaces and prosthetic devices reduces its susceptibility to antifungal agents,^{6,7} as well as fosters accumulation of detrimental bacteria.

In this regard, probiotics have emerged as a fascinating potential intervention in the last 2 de-

Abstract

Purpose: There is a burgeoning recognition and interest in the potential of probiotics in the treatment and prevention of oral candidiasis associated with the use of dentures. Our aim was to investigate if commercially available over-the-counter probiotics can influence the ability of *Candida albicans* to form biofilms, which is considered a hallmark of the initiation and progression of oral candidiasis.

Methods: We conducted a 2x5 factorial in vitro study to culture *C. albicans* on denture strips and challenge with one of the following four commercially available probiotics in bacterial or cell-free supernatant form: Accuflora®, Align®, Culturelle® and Sustenex®. *C. albicans* biofilm formation was studied in triplicates in all factorial combinations of the study and assessed qualitatively with fluorescence microscopy and quantitatively with tetrazolium salt (XTT) reduction assay. Quality control measures included determination of coefficient of variation, Bland Altman plots and Pittman's test. Results were analyzed using two-way analysis of variance (ANOVA) with pairwise post-hoc Scheffe's tests.

Results: Our experimental conditions passed the quality control checks. Two-way ANOVA results indicated that cell-free supernatants provided a stronger and significant inhibitory effect on biofilm formation than their bacterial counterparts (2-way ANOVA $p=3.8 \times 10^{-6}$). Further, Lactobacillus-containing probiotic formulations (Accuflora® and Culturelle®) significantly reduced biofilm formation especially in supernatant form.

Conclusion: Commercially available probiotics that contain Lactobacilli species interfere with the in vitro ability of *C. albicans* to form biofilms on dentures. The mechanistic and clinical implications of our results need to be addressed by larger in vivo studies.

Keywords: candidiasis, dentures, probiotics, biofilm, experimental studies

This study supports the NDHRA priority area, **Health Promotion/Disease Prevention:** Validate and test assessment instruments/strategies/mechanisms that increase health promotion and disease prevention among diverse populations.

acades.⁸⁻¹¹ It is noteworthy that several probiotics are already available for use over-the-counter. Of interest, a recent clinical trial suggests that in the elderly population, the use of probiotics can reduce

the prevalence of oral candidiasis.¹² Mechanistically, however, it is unclear whether this reduction of the risk of candidiasis can be attributed to the potential influence of probiotics on the biofilms formed by *C. albicans*. While evidence from murine models is suggestive of this mechanism, direct evidence based on denture materials is currently lacking. In this study, we therefore evaluated the in vitro effect of various over-the-counter probiotics on the ability of *C. albicans* to form biofilms on denture strips.

Methods and Materials

Study Design

This study was conducted in the biosafety level-2 laboratory facility of the Center for Medical Mycology, Department of Dermatology, Case Western Reserve University. Four over-the-counter probiotic supplements were used in the study namely; Accuflora® [mixture of *Lactobacillus acidophilus*, *Lactobacillus rhamnosus*, *Bifidobacterium bifidum*, *Lactobacillus salivarius*, *Streptococcus thermophilus* 500 million colony forming units (CFU) per caplet], Align® (*Bifidobacterium infantis* 35624, 1 billion bacteria per capsule), Culturelle® (*Lactobacillus GG*, 10 billion bacteria per capsule) and Sustenex® (*Bacillus coagulans* BC30, 2 billion bacteria per capsule). We cultured the probiotic bacteria in Man-Rogosa-Sharpe (MRS) medium for 36 hours. *C. albicans* 10341 was used for the formation of biofilm on denture strips after culturing in YNB/Dextrose for 24 hours and adjusted to a concentration of 1×10^7 cells/mL using a hemocytometer. The probiotic bacterial density was calculated with nephelometry and aimed to obtain a probiotic:candida cell ratio of 1:1. For this, the turbidity of the bacterial broth culture was adjusted to obtain a turbidity-equivalent to 0.5 McFarland standard using nephelometer at 600 to 625 nm which yields an approximate cell density of 1.5×10^8 cells/ml. This was then diluted with PBS to obtain bacterial density of 1×10^7 cells/ml to obtain a probiotic:candida cell ratio of 1:1. Finally, cell-free solutions from bacterial cultures were obtained by centrifuging and filtering through a filter of 0.2 μ l pore size

A 2x5 factorial design was used, where the source of the probiotic material (bacteria or supernatant) and the probiotic used (none or 1 of the aforementioned 4 probiotics) constituted the study factors. The study was designed to detect the potential influence of these two study factors on the ability of *C. albicans* to form biofilms. This ability was studied qualitatively (using fluorescent microscopy) as well as quantitatively (using tetrazolium salt assay). All 10 combinations of the

2 factors were studied in triplicates. As additional quality control measures, a blank negative control was used (neither *C. albicans* nor probiotics added to the denture strip) and 2 sets of positive controls (that is only *C. albicans* without any probiotic intervention) – one using the MRS medium and another using the synthetic dextrose (SD) medium. This was done to examine if the influence of the probiotic bacteria on the biofilm-forming ability of *C. albicans* was confounded by the use of the MRS medium.

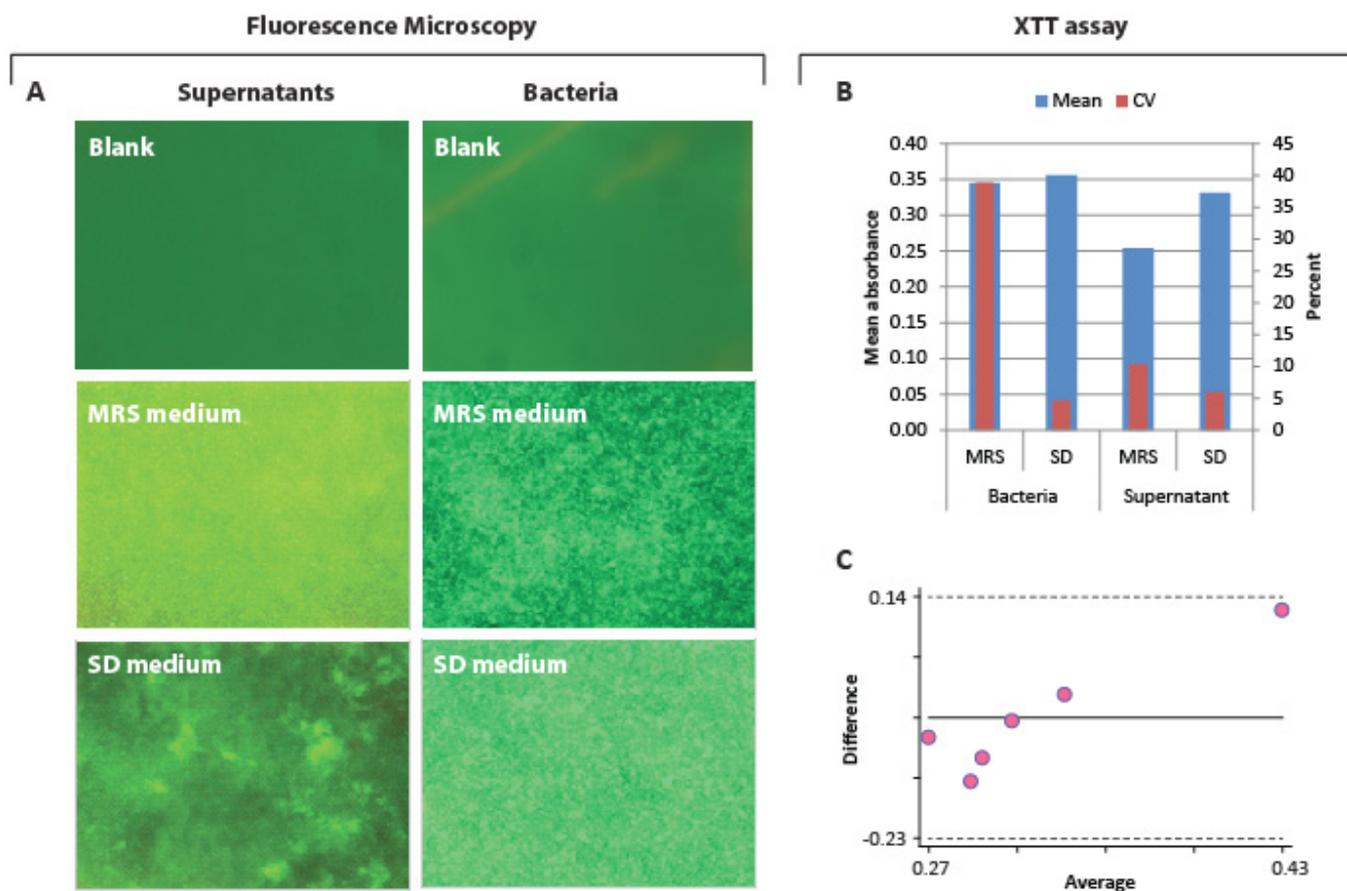
Experimental Protocols

The protocol described by Chandra et al to form biofilms on denture strips was utilized.¹³ The denture strips were first pre-coated with saliva (filter-sterilized through a 0.2 micron filter) and then subjected to formation of candida biofilms. This was achieved by application of an 80 μ L quantity of standardized *C. albicans* cell suspension to the surface of 1.5 cm² polymethylmethacrylate strips placed in a 12-well tissue culture plate. The cells were allowed to adhere to the strips for 90 minutes at 37°C. After washing away the non-adherent cells with PBS, the strips and the cells were incubated at 37°C to allow for biofilm formation. Following biofilm formation, the strips were transferred to either probiotic bacterial suspensions or to probiotic supernatants. Growth of the biofilms was quantified using the tetrazolium salt (XTT) reduction colorimetric assay.¹⁴⁻¹⁶ For this, the denture strips were transferred to a new 12-well plate containing 4 ml of PBS in each well. Then 50 μ l of XTT (1 mg/mL) and 4 μ l menadione (1 mM) solutions were added to each well. The plate was then incubated for 3 to 5 hours at 37°C. After incubation, the solution from each well was centrifuged and absorbance measured at 492 nm using spectrophotometry as described elsewhere.¹³ The morphology and architecture of the biofilm was examined using fluorescence microscopy (Zeiss, model Axio Imager Z1m; wavelength for Calcofluor white: excitation 440 nm and emission 500 to 520 nm).^{13,17} Briefly, the denture strips were transferred to glass microscope slides and a drop of Calcofluor white solution was added to the slides. The slides were then incubated at room temperature for 1 minute and then examined under a fluorescence microscope. XTT and fluorescence analyses were performed by different investigators who were blinded to the results of each other.

Statistical Analysis

Statistical methods for analysis included comparison of group means using 2-way analysis of

Figure 1: Quality Control of Experimental Conditions



- (A) Results from fluorescence microscopy suggest that the blank strips (top row) were clear with no biofilm or *C. albicans*; the MRS-grown *C. albicans* (middle row) showed uniform biofilm matrix while the SD-grown *C. albicans* (bottom row) showed a dense biofilm with yeast forms.
- (B) Mean (wider blue bars) and coefficient of variation (narrow pink bars) of the absorbance optical density from XTT-assay based on the medium (MRS or SD) used for culturing *C. albicans* and whether the control was used in later analyses for probiotic treatment using the bacteria or the supernatant.
- (C) Bland-Altman plot for agreement between the absorbance values obtained from the MRS-grown and SD-grown *C. albicans*. The limits of agreement (dashed horizontal lines) were at 0.139 and -0.227 and the mean difference was -0.044 indicating slightly lower estimates of OD from the MRS-grown *C. albicans*. Pittman's p for equal variation in two methods was 0.008.

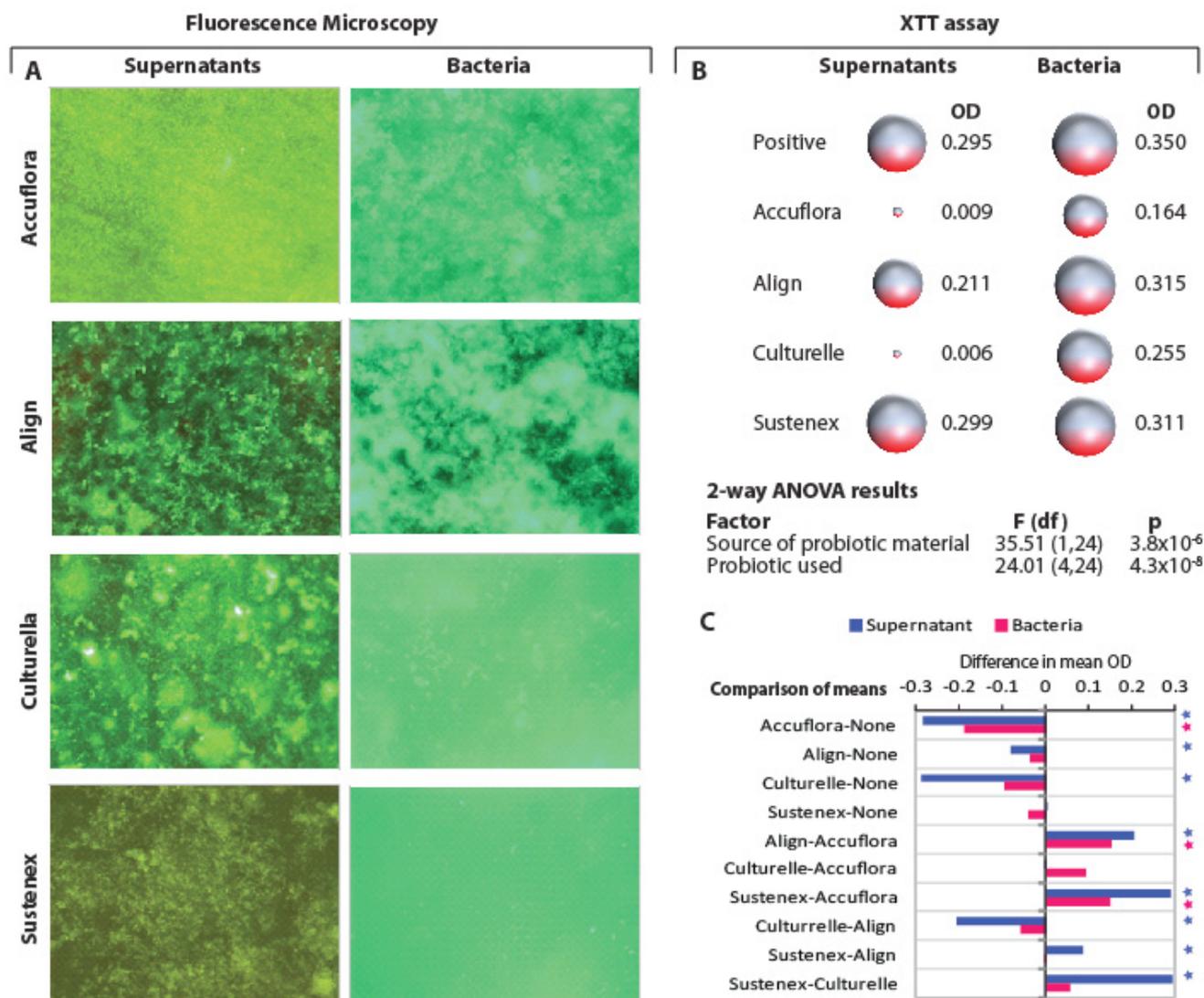
variance (ANOVA) and Bartlett's test for equal variances followed by post-hoc pairwise analyses using Scheffe's method. Quality control analyses included estimation of coefficient of variation (CV), Bland-Altman plots and Pittman's test for equal variances. Analyses were conducted using Stata 10.0 (Stata Corp, College Station, Texas) software and statistical significance was tested at a type I error rate of 0.05.

Results

A total of 50 dental strips were used in this study – for each source of the probiotic material (supernatant or bacteria), 1 negative control was used, 1 set of triplicates for *C. albicans* cultured on MRS medium, 1 set of triplicates for *C. albicans* cultured on SD medium, 1 set of triplicate each for each probi-

otic brand co-cultured with *C. albicans* and 6 dental strips for fluorescence microscopy. The experimental conditions were standardized by running quality control measures. Figure 1A shows that on fluorescence microscopy, the blank denture strips did not show any contamination, while *C. albicans* showed robust growth on both the MRS and the SD media. When the results were quantified using the XTT-reduction assay (Figure B), it was observed that, with the exception of the MRS-grown *C. albicans* which was used as a positive control in the experiments with bacteria, all other subgroups showed a CV<10%. The Bland-Altman plot (Figure 1C) indicated that while all observations on the MRS- and SD-grown *C. albicans* biofilm quantifications were within acceptable change, the MRS-grown *C. albicans* had slightly lower absorbance values. Pittman's test indicated that the variances of the MRS-

Figure 2: Effect of Probiotics on Biofilm Formation by *C. Albicans*



- (A) Qualitative results from fluorescence microscopy. Panels show that compared to the average unchallenged *C. albicans* (top row) Accuflora-supernatant-challenged and Culturelle-supernatant-challenged *C. albicans* formed thinner and patchy biofilms, respectively but the Align-supernatant-challenged and Sustenex-supernatant-challenged *C. albicans* biofilms were dense. On the other hand, all probiotic bacteria-challenged *C. albicans* showed visible and mostly dense or non-uniform biofilms.
- (B) Two-way analysis of variance of mean optical density estimated from the XTT reduction assay based on source (supernatant versus bacteria) and brand of probiotic used. The bubbles are proportional to the mean optical density shown alongside.
- (C) Post-hoc pairwise comparisons of mean optical density in the XTT reduction assay using Scheffe's correction for multiple comparisons. Differences are shown as horizontal color-coded bars (blue for supernatants and pink for bacteria) and statistically significant results are identified by a color-coded star on the right.

and SD-grown *C. albicans* biofilms were not equal ($p=0.008$). Considering these results and since we aimed at having a single positive control for the ensuing analyses, the average of absorbance from the MRS- and SD-grown XTT-assays as the positive control was measured.

When the *C. albicans* biofilms were metabolically quantified after co-culturing with the indicated probiotic, it was observed (Figure 2B) that the mean absorbance from the XTT indicated wide variations

across combinations of the study factors – source of probiotic and the brand of probiotic. Results of the 2-way ANOVA showed that both the factors contributed significantly to the inter-replicate variation in absorbance. Challenge with the supernatant was associated with a significantly lesser biofilm formation than challenge with the probiotic bacteria ($p=3.8 \times 10^{-6}$). Therefore, to find out which probiotic brand is associated with maximum beneficial reduction of the biofilm formation, a post-hoc pairwise comparisons (using Scheffe's correction) was

conducted separately for each source of probiotic material. When the analyses for supernatants were conducted (blue bars and stars in Figure 1C), it was found that the Accuflora and Culturelle-challenged *C. albicans* were associated with significantly reduced biofilms as compared to the non-challenged, Align-challenged or Sustenex-challenged *C. albicans* biofilms. In contrast, when the analyses were conducted for the bacterial challenge (pink bars and stars in Figure 2C), it was found that only Accuflora-challenged *C. albicans* was associated with a moderately reduced biofilm formation. On the other hand, *C. albicans* challenged with Culturelle bacteria showed mild inhibition that was not statistically significant. Results obtained from the quantitative XTT-reduction assay concurred qualitatively with those of fluorescent microscopy (Figure 2A).

Discussion

The results demonstrate that, in vitro, some commercially available probiotic formulations can reduce the biofilm-forming ability of *C. albicans*. Interestingly, only formulations that contained Lactobacillus species (Accuflora® and Culturelle®) appeared to have a statistically significant inhibitory effect on *C. albicans* suggesting that Lactobacillus species may be the sole organism responsible for the observed effect. Moreover, this effect was accentuated when the supernatants were used rather than the bacteria. To our knowledge this is the first study that demonstrates the inhibitory effect of over-the-counter probiotics on *C. albicans* biofilm production in vitro. Interestingly, these results are fully concordant with the series of observations in murine models of oral candidiasis.^{8-10,18} These results also afford indirect credence to the recent observations that probiotics can reduce the oral yeast counts in the elderly,¹² as well as the growing body of evidence showing the potential use of probiotics against localized candidiasis at other sites in the body that include urogenital and gastrointestinal colonization of *C. albicans*.¹⁹⁻²²

These results are important since oral candidiasis is a common condition in denture-wearers and accounts for a substantial proportion of morbidity.¹⁻³ From a hygienic perspective, our results raise the possibility that the oral microflora may be an important contributor to oral candidiasis in denture-wearers.

An evident limitation of the study is its in vitro disposition which constrains its ready generalizability. Indeed, Bilhan et al have recently shown that the counts of *C. albicans*, as well as Lactobacillus, are increased in aged patients with denture-related stomatitis.²³ Our findings somewhat agree with this

observation since we found that the culture supernatants rather than the bacteria proffer beneficial advantage against *C. albicans*. However, this question cannot be directly answered by the current study. Next, the fact that supernatants rather than bacteria were more effective in inhibiting biofilm formation somewhat limits the clinical enthusiasm for a direct use of over-the-counter probiotics since some biochemical processing (e.g. lyophilization²⁴) may be required before probiotics can be used for reduction of *C. albicans* biofilm. Another limitation of this study is that, by design, a commercially available probiotic formulation was used. Due to this design, however, it is not possible to estimate the relative efficacy of Lactobacillus species in inhibiting *C. albicans* biofilm formation. Although this places restrictions on the mechanistic interpretations from the results, it was deemed best to err on the side of clinical ease of use. In the absence of guidelines for choosing appropriate ratios of probiotics to fungal preparations, the ratio of 1:1 was chosen empirically. This is a potential limitation as it is unknown whether a different ratio might show even more significant effects of probiotics in inhibiting fungal biofilm formation. Further studies are warranted to explore the effects of different levels of probiotic to fungal load ratio.

Conclusion

Our results point towards 2 interesting directions for future research. First, simple and relatively inexpensive dietary interventions like yogurt consumption can be considered as a basis of treatment or prevention of oral candidiasis. A field trial for such intervention for diarrhea prevention has not shown encouraging results, but its value in candidiasis is unknown.²⁵ Second, it is possible that metabolic by-products of Lactobacilli might interfere with the binding properties or the metabolic activity of *C. albicans*.^{26,27} It is also possible that the fungal growth inhibition may be consequent to the depletion of nutrients in the culture media by overgrowth of the probiotic bacteria. Future studies need to dissect out these mechanistic possibilities.

Shweta Ujaoney, MDS is currently a dental student at Virginia Commonwealth University School of Dentistry. Jyotsna Chandra, PhD is a Senior Research Associate at the Center for Medical Mycology, Department of Dermatology, University Hospitals of Cleveland and Case Western Reserve University, Cleveland, OH. Fady Faddoul, DDS, MSD is Professor and Vice-Chairman of the Department of Comprehensive Care and Director of the AEGD and Faculty Practice programs at Case Western Reserve University School of Dental Medicine. Maya Chane, D.D.S, M.S. is a Senior Instructor in

the Department of AEGD, Case Western Reserve University School of Dental Medicine. Jing Wang, DMD was a Resident in AEGD at the Case Western Reserve University School of Dental Medicine when this study was conducted. Louay Taifour was a resident in AEGD at the Case Western Reserve University School of Dental Medicine when this study was conducted. Manju R. Mamtani, MD is a member of Lata Medical Research Foundation, Nagpur, India and Staff Scientist I at the Texas Biomedical Research Institute in San Antonio, TX. Tushar P. Thakre, MD, PhD is a member of Lata Medical Research Foundation, Nagpur, India and Assistant Professor at the East Carolina University Brody School of Medicine. Hemant Kulkarni, MD is the President of Lata Medical Research Foundation, Nagpur, India and Staff Scientist II at the Texas Biomedical Research Institute in San Antonio, TX. Pranab Mukherjee, PhD is an Assistant Professor in the Department of Dermatology at University Hos-

pitals of Cleveland and Case Western Reserve University, Cleveland, OH. Mahmoud A. Ghannoum, PhD is Professor in the Department of Dermatology at University Hospitals of Cleveland and Case Western Reserve University, Cleveland, OH. He is also the Director of the Center for Medical Mycology.

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