American Dental Hygienists' Association

Journal of Dental Hygiene

The American Dental Hygienists' Association

December 2016 • Volume 90 • Number 6

Journal of Dental Hygiene

Volume 90 • Number 6 • December 2016

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.

Subscriptions

The *Journal of Dental Hygiene* is published bi-monthly online by the American Dental Hygienists' Association, 444 N. Michigan Avenue, Chicago, IL 60611. Subscription rates for nonmembers are one year, $60.

Submissions

Please visit http://www.adha.org/authoring-guidelines for submission guidelines.

2016 to 2017 ADHA Officers

President
Betty Kabel, RDH, BS

President Elect
Tammy Filipiak, RDH, MS

Vice President
Michele Braerman, RDH, BSDH

Treasurer
Donnella Miller, RDH, BS, MPS

Immediate Past President
Jill Rethman, RDH, BA

ADHA/JDH Staff

Chief Executive Officer
Ann Battrell, MSDH
AnnB@adha.net

Chief Operating Officer
Bob Moore, MA, CAE
bobm@adha.net

Editor–In–Chief
Rebecca S. Wilder, RDH, BS, MS
RebeccaW@adha.net

Editor Emeritus
Mary Alice Gaston, RDH, MS

Director of Communications
Kimberly Campbell
KimberlyC@adha.net

Staff Editor
Thomas J. Campbell
thomasc@adha.net

Editorial Review Board

Inside

Journal of Dental Hygiene
Vol. 90 • No. 6 • December 2016

Features

Editorial

The Impact of Leadership and Research on Decision Making

Rebecca S. Wilder, RDH, BS, MS

During 2016 our theme for the *Journal of Dental Hygiene* editorials was "The Impact of Leadership and Research on Decision Making." During the year we published editorials from five of the nation's leading dental hygiene leaders on how leadership and research impact decision making on vital topics in our profession such as transformation of dental hygiene, the development of doctoral degrees in dental hygiene, forming collaborations and shared partnerships, leading through research . . . and, from the Chief Executive Officer of ADHA . . . the power of knowledge.

For this editorial, I would like to present some significant thoughts from the editorials—pieces of knowledge for you to take with you into the New Year. I challenge you to think about how leadership and research impacts your decision making!

May each of you have a wonderful holiday season and New Year!

Sincerely,
Rebecca S. Wilder, RDH, MS
Editor-in-Chief, *Journal of Dental Hygiene*

From Ann Battrell, MSDH; CEO, American Dental Hygienists' Association

The Power of Knowledge

- It is important that leaders create a vision of the person they want to be, and that they have the mentors to do so.
- In order to make sense of complex issues and to make decisions in the best interest of the organization, today's leaders (as well as future leaders) need to possess critical thinking skills that enable sound decision making.
- The underpinning of the decision making process is evidence and knowledge. Evidence and knowledge provides the answer to the fundamental question of "What do I know about . . ." Dental hygienists in a clinician role have the responsibility for using the dental hygiene process of care to ultimately determine a dental hygiene diagnosis and treatment plan, and evaluate the oral health outcomes for their patients. Scientific evidence, or knowledge, is the underpinning upon which oral health care providers should make their decisions.
- Simply asking ourselves the question "What do I know about . . ." is the starting point to searching for knowledge, information and scientific evidence for the critical thinking necessary for leaders in all of the professional roles of a dental hygienist.

From Tami Grzesikowski, RDH, MEd; Senior Director of Allied Dental Education, American Dental Education Association

Who Is Going to Lead the Transformation of Dental Hygiene?

- The Bureau of Labor Statistics reports that employment of dental hygienists will grow 19% in the next decade. In 2015, the American Dental Education Association recently reported 292 retirements for dental hygiene in the next 5 years representing approximately 2 faculty for each program.
- A decision regarding one's professional journey is important and it's imperative that one uses evidence to support the decision.
- It is crucial that we provide leadership and guidance to our new team members regardless of the setting.
- Eight dental hygiene leaders from the ADHA and ADEA are part of a collaboration titled the ADEA Curriculum Change and Innovation (ADEA CCI) workgroup with the ADHA. This group began working over two years ago with the goal to increase and enhance professional development and leadership opportunities for dental hygiene professionals for the future transformation of the dental profession. This workgroup collected data and information on voids in dental hygiene education. They established the priority of building a cadre of new leaders in dental hygiene education

that are prepared to assume responsibilities and lead the profession into the next century of dental hygiene.

- Each and every one of us has the opportunity to lead and it is our responsibility to be a mentor and leader to the new generation of dental hygienists.

From JoAnn Gurenlian, RDH, MS PhD; Professor and Graduate Program Director at Idaho State University

Doctoral Degrees in Dental Hygiene—A True Transformation for Dental Hygiene Education

- In 2005, the American Dental Hygienists' Association (ADHA) published a document entitled "Dental Hygiene: Focus on Advancing the Profession." Within this paper, the profession recognized that dental hygiene scholars were needed to lead the development of theory and knowledge unique to the discipline of dental hygiene and that there was a shortage of dental hygiene faculty that was expected to continue into the future. The leaders noted that doctoral preparation of dental hygienists is essential for building the dental hygiene knowledge base for advancing the professionalization process. Over the next decade, discussions occurred further supporting the need for doctoral education in dental hygiene, workshops were offered establishing interest in creating doctoral programs for dental hygiene, and research has been conducted about this topic.

- As this transformation of dental hygiene education occurs, the profession will change. Theory development will advance, research will broaden, new academicians will be prepared and a higher level of clinicians will be contributing to improving the oral health challenges of the nation. Equally exciting, these graduates will possess four years of education at the graduate level equivalent to other health care professionals.

From Deborah Lyle, RDH, BS, MS Director of Professional and Clinical Affairs for Water Pik, Inc.; Chair, Council on Research for ADHA

Leading through Research

The current revision of the NDHRA was designed to support the core ideology to lead the transformation of the dental hygiene profession, the vision that dental hygienists are integrated into the healthcare delivery system and the values of service, collaboration, quality, community, lifelong learning and ethics.

A research agenda helps:

- Balance internal and external influences to make good decisions
- Provides a capacity to influence clinical practice and public policy
- Provides the next generation of questions that will advance the science of dental hygiene
- Focus funding in research topics that will help make informed decision about initiatives for the future
- The idea to develop a conceptual research model was predicated on providing a document that could be utilized by educators who teach research concepts at all levels, graduate students and novice researchers. Experienced researchers may also use this when mentoring junior faculty and new researchers.

This revised research agenda is intended to guide researchers, educators, clinicians and students in advancing the profession though research by generating new knowledge within the discipline. It provides a visual framework for conceptualizing how individual research topic addresses ADHA priorities. Dental hygiene research and researchers are necessary, relevant and integral to our future.

From Ann Eshenaur Spolarich, RDH, PhD; Professor and Director of Research at Arizona School of Dentistry and Oral Health

Forming Collaborations and Shared Partnerships

- There is an old saying that "two heads are better than one." Certainly, there are many opportunities for healthcare providers to participate in collaborative work efforts, including for conducting original research.
- Studies have shown that even small differences in work effort by one or more individuals on a team lead to large differences in the degree of effectiveness.
- Collaboration is critical for growing the knowledge base that supports dental hygiene education and practice. Working together enables researchers to maximize the utilization of limited resources, capitalizes on existing skill sets of experienced

investigators, and allows for expansion of both the scope and depth of proposed projects. Collaborative efforts also may allow for enhanced efficiency in addressing prioritized topics identified through published research agendas.

- Dental hygiene educators and leaders within the profession must partner with the dental hygiene research community to disseminate knowledge gained through research. Knowledge changes very quickly, but translation and adoption of new knowledge are slow. Tremendous progress has been made with the acquisition of new knowledge gained through original research, as evidenced by the expansion of the number of issues of the *Journal of Dental Hygiene*, and the increase in the number of journals devoted to dental hygiene. However, getting dental hygienists to read journal articles is still a major challenge. Socialization to reading research papers must begin with dental hygiene students, with an emphasis placed on how that knowledge supports their decision-making. More effort is needed on the part of the leadership within the research community to encourage knowledge translation so that the adoption of this knowledge can be measured through changes in education and practice.

- Ongoing efforts are needed to further enhance the culture of research by keeping research efforts in front of the members of our dental hygiene professional organizations, by sharing research activities with leaders of dental hygiene organizations, by encouraging dental hygiene theory development, and by engaging key stakeholders in knowledge translation and adoption. Participation on interprofessional collaborative teams will also help to expand the reach of dental hygiene research projects through promotion of oral health within initiatives aimed towards improving general health.

Perceptions and Attitudes of Dental Hygiene Educators About the Establishment of Doctoral Education Programs in Dental Hygiene

Cheryl A. Davis, RDH, BS, MS, JD; Gwen Essex, RDH, MS, EdD; Dorothy J. Rowe, RDH, MS, PhD

Abstract

Purpose: To assess the perceptions and attitudes of dental hygiene (DH) educators at selected colleges and universities regarding the establishment of doctoral educational programs in DH in the United States.

Methods: An online survey of DH educators at the 58 U.S. schools offering baccalaureate or master's degree programs was used to assess participants' perceptions and attitudes regarding the following: need to establish doctoral programs in DH, interests in supporting their development, potential barriers and facilitators, and goals/motivators of potential enrollees. Percentages of respondents selecting each response were calculated for each survey item and responses of selected items analyzed for significant differences.

Results: Of 608 potential participants, 203 completed the survey for a 33% response rate. More than half the respondents strongly agreed and a quarter more agreed that a DH doctoral program was needed to relate equitably with doctoral graduates of other health-related disciplines and to expand the DH body of knowledge by conducting discipline-specific research. A majority indicated likely interest in supporting the development of both clinically oriented and research-based doctoral programs. Significantly ($p<0.01$) more respondents with doctorates were interested in developing doctoral programs than those with a master's degree as their terminal degree. Respondents identified shortages of qualified educators and interested enrollees as primary barriers. Facilitators included support from the American Dental Education Association and the American Dental Hygienists' Association. Becoming a better researcher and an institutional administrator were perceived as chief motivations.

Conclusion: The majority of DH educators perceived that doctoral educational programs in DH are needed to advance the DH profession.

Keywords: dental and dental hygiene workforce models, dental hygiene, educational concepts and theory, faculty development, professional development/team building, doctoral education in dental hygiene

This study supports the NDHRA priority area, **Professional Education and Development:** to investigate how other health professions have established the master's and doctoral levels of education.

Introduction

The profession of dental hygiene (DH), in contrast to other health professions and disciplines, has not established doctoral programs in the United States to prepare their graduates to engage in discipline-specific research, education, and practice.[1] DH education at the doctoral level, which would be parallel to that of other disciplines and professions, could increase the credibility of the DH profession.[2,3] Interprofessional collaboration is a driving force behind state-of-the-art health care delivery, and doctoral prepared dental hygienists could improve interprofessional patient care by bringing dental hygiene's unique perspective to the collaborative team.[1,4] Dental hygienists, prepared with skills and interdisciplinary experiences at the doctoral level, could contribute to solving many of the oral health care challenges facing our nation.[4,5] However, doctoral programs in DH necessary to prepare graduates for these roles do not exist.[4,5,6,7,8]

Preparing dental hygienists to conduct rigorous discipline-specific research would be another goal and purpose of doctoral programs in DH.[5] A critical mass of DH researchers and scholars could facilitate networking and sharing of common interests, contributing to an expansion of the unique body of knowledge needed for the growth of the profession.[2,5] Dental hygienists could pursue doctoral de-

Table I: Demographic Characteristics of Respondents, by Percentage and Number of Respondents

Gender, n=182	% (n)
Male	4 (7)
Female	96 (175)
Age, n=181	
26-30	2 (4)
31-35	9 (17)
36-40	9 (17)
41-45	7 (13)
46-50	10 (18)
51-55	10 (18)
56-60	23 (42)
61-65	22 (40)
66-70	6 (11)
71-75	1 (1)
Race/Ethnicity, n=185	
Afro-Caribbean or African American	2 (4)
East Asian or Asian American	2 (3)
Latino or Hispanic American	6 (10)
Middle Eastern or Arab American	1 (1)
Native American or Alaskan Native	2 (3)
Non-Hispanic White or Euro-American	88 (157)
South Asian or Indian American	1 (2)
Other heritage	3 (5)

grees in their own discipline, as in the case of other professionals.[5] Recently, it was reported that 77% of students from master of science programs in DH in the United States agreed that doctoral education in DH is needed, 89% agreed that doctoral programs are important for the profession, and 62% professed interest in applying to clinical doctoral programs.[1]

Because the perceptions and attitudes of DH educators regarding the establishment of doctoral programs in DH had not been identified, we created an online survey to answer the following research questions: What are the perceptions and attitudes of DH educators regarding the needs for establishing doctoral programs in DH? Are DH educators interested in initiating or supporting doctoral programs at their own or other institutions? Are DH educators interested in assisting with the development of models and curricula for doctoral programs at the national level? What barriers and facilitators do DH educators perceive may influence the development of such programs, and what goals do they perceive would motivate a dental hygienist to pursue a doctoral degree in DH?

Methods and Materials

The Institutional Review Board of the University of California, San Francisco approved the study. A 17-item online survey instrument was distributed to 608 DH educators and program administrators currently employed at the 58 universities and colleges throughout the United States that offer baccalaureate or master's degree programs in DH. These venues are more likely to support doctoral education programs, and responses of this particular group represent the perceptions of possible applicants to DH doctoral programs.

To assess the respondent's perceptions and attitudes regarding needs for establishing doctoral programs in DH, a 5-point Likert response scale was used, Strongly Agree to Strongly Disagree. To assess the participants' interests in developing and/or supporting the establishment of either research-based or clinically oriented doctoral programs, a 5-point Likert response scale was used, Very Unlikely to Very Likely, and merged Very Unlikely with Unlikely responses and Very Likely with Likely responses in the table. The participants' perceptions concerning barriers and facilitators that may influence the establishment of doctoral programs in DH, and which goals might provide significant motivation for dental hygienists to pursue a doctoral degree, were assessed by the respondents selecting the top 3 they considered to be key from a list of factors. Respondents were encouraged to comment on each of the topics. A convenience sample of DH educators (5 from a master of science in DH program, and 6 from an entry-level DH program) assessed the acceptability and feasibility of the survey. Modifications were made, based on their feedback.

A request to participate in the study was distributed electronically to DH educators using email addresses acquired from the institutions' websites. The invitation described the purpose of the study and provided instructions for giving informed consent and links to the survey instrument. Qualtrics,[9] a survey software program, tabulated responses of the participants and calculated frequencies (percentages) of responses to each survey item. The chi-square statistical analysis test was used to determine significant differences between the responses of participants with a doctorate and those with a master's degree as their terminal degree. The level of statistical significance was set at the alpha level of 0.05.

Results

Of the 608 potential respondents, 203 completed the online survey for a 33% response rate. The

majority of respondents were female, non-Hispanic White, and between the ages of 56 and 65 (Table I). Over half of the respondents had master's degrees, and approximately 20% held doctorate degrees. Most had been employed as DH educators for between 11 and 20 years and were members of the American Dental Hygienists' Association (ADHA) and the American Dental Education Association (ADEA) (Table II).

The vast majority (84%) of responding DH educators agreed or strongly agreed that the greatest need for establishing doctoral programs in DH was to relate equitably with doctoral graduates of other health-related disciplines (Table III). The highest percentage of respondents selected "strongly agree" to this need statement. Most respondents (80%) agreed the need to expand the body of knowledge for the DH profession by conducting discipline-specific research was important, again with the greatest percentage selecting "strongly agree." The fewest number of respondents agreed that the need to develop measures to improve the oral health of the country's varied populations, especially those underserved, constituted a need for establishing doctoral education programs in DH.

The majority of participants responded that they were more likely to support development of a doctoral program at an institution other than their own for both types of programs, research-based and clinically oriented (Table IV). The second-strongest response indicated the likelihood that they would assist with the development of models and curricula for doctoral programs in DH at the national level, again for both research-based and clinically oriented programs. The numbers of respondents likely to be interested in initiating a research-based doctoral program at their own institution ($p=0.002$), and assisting with models and curricula for such a program at the national level ($p=0.000$), were significantly higher for respondents with doctorates than for those with a master's degree as their terminal degree (Table V). Also, respondents with doctoral degrees were significantly ($p=0.022$) more likely than those with master's degrees to assist with models and curricula for clinically oriented programs (Table VI). Among the 38 respondents with doctorates, 25 reported interest in initiating research-based doctoral programs (68%), while only 21 were interested in initiating clinically oriented programs (55%). These values were significantly different ($p=0.006$).

Table VII lists the barriers that the respondents perceived would pose the 3 most meaningful challenges to establishing doctoral programs in DH. A substantial percentage of respondents selected a shortage of qualified educators (49%) and a shortage of interested enrollees (42%) as the greatest challenges. A number of respondents expressed other challenges and barriers; for example, concerns about career opportunities for the graduates of a doctoral program and about advantages provided by a doctoral education in DH, rather than in other disciplines.

The respondents chose "support from ADEA" as the greatest facilitator to support establishment of a doctoral program in DH, followed by "support by approval or advocacy from the ADHA" and "financial support from the ADHA" (Table VIII). The fewest respondents chose "interest from DH students" and

Table II: Professional Responsibilities and Educational Background of Study Participants, by Percentage and Number of Respondents

Position/Primary Duties in DH Program, n=182	% (n)
Administrative	19 (35)
Teaching/educational	81 (147)
Lecture-based/didactic	28 (50)
Clinical	15 (27)
Equally distributed	57 (103)
Educational Background*	
Baccalaureate degree	74 (135)
Master's degree in DH	33 (60)
Master's degree, non-DH discipline	54 (97)
Degree in Dental Science	3 (5)
EdD degree	10 (18)
PhD degree	11 (20)
Years as an Educator, n=181	
0-5	20 (37)
6-10	23 (42)
11-20	30 (54)
21-30	14 (25)
31-40	10 (18)
40+	3 (5)
Professional Organization Memberships*	
American Dental Hygienists' Association	90 (163)
American Dental Education Association	82 (148)
American Association of Public Health Dentistry	7 (12)
American Dental Association	1 (1)
Other organizations	20 (37)
No memberships in any organization	2 (4)

*Participants selected as many as applied

Table III: Perceptions of Respondents Regarding Needs for Establishing Doctoral Education Programs in Dental Hygiene, by Percentage and Number of Respondents

Perceived need for establishing doctoral education programs in dental hygiene	Strongly Agree % (n)	Agree % (n)	Neutral % (n)	Disagree % (n)	Strongly Disagree % (n)
Relate equitably with doctorates of other health-related disciplines, n=196	58 (113)	26 (51)	8 (16)	6 (12)	2 (4)
Expand the body of knowledge for DH profession by conducting discipline-specific research, n=196	51 (100)	29 (57)	8 (15)	9 (18)	3 (6)
Enhance ability to attract funding to support large-scale studies for oral health promotion and disease prevention, n=195	43 (83)	38 (74)	13 (25)	5 (10)	2 (3)
Increase appreciation for the expertise of the dental hygienist and value of DH profession in the minds of the public, n=195	42 (83)	29 (56)	12 (23)	12 (23)	5 (10)
Facilitate interprofessional collaboration among health care professions, n=195	39 (77)	32 (62)	16 (31)	9 (18)	4 (7)
Prepare dental hygienists with the knowledge and skills to conduct research at institutions of higher education, n=197	35 (79)	40 (79)	12 (23)	9 (17)	5 (9)
Investigate and address issues related to oral health care promotion and disease prevention, n=196	33 (65)	35 (68)	13 (25)	14 (27)	6 (11)
Develop measures to improve oral health of country's varied population, especially the underserved, n=196	32 (62)	36 (70)	14 (28)	14 (27)	5 (9)

"support from practicing clinical dental hygienists" as motivators or facilitators.

The desire to "become a better researcher" was perceived as one of the 3 most important goals or motivators for a dental hygienist to pursue a doctoral degree in DH (Table IX). "Becoming an institutional administrator" was selected as the second most important.

Discussion

Needs for Doctoral Education in Dental Hygiene

The need for doctoral education in DH has been a topic of serious discussion for more than 20 years.[2,10] In this study, the majority of respondents agreed that establishing doctoral education programs in DH is needed and for all of the 8 reasons proposed in the survey. The need to "relate equitably with doctorates of other health-related disciplines" was perceived as the most important by the greatest percentage of respondents.

For collaborative models to be effective, participating professionals should have equal levels of educational achievement.[4,7,10] A terminal degree at the master's level may be insufficient to enhance the DH practitioner's ability to work with other doctorates of the collaborative team,[3,11] or support consideration of dental hygienists for employment in many positions of leadership, research, and health care administration.[2]

Participants also perceived a related need, to "facilitate interprofessional collaboration among health care professions," as important. With increased focus on collaborative efforts among health care disciplines, dental hygienists have a distinct role as experts on maintaining oral health.[12] Interprofessional collaboration and education programs are possible antidotes to the persistent problems in health care delivery in this country.[11,12] However, many interprofessional education programs do not include dental hygienists,[11] perhaps due to their insufficient educational qualifications. If dental hygienists are to be working in interprofessional environments as leaders in administration and research, additional skill sets are required to formally bring DH beyond clinical expertise. Moreover, dental hygienists will need to master the arts of forecasting, evidence-based decisionmaking, critical thinking, and negotiation to be visionaries and credible members of the interprofessional team.[2,13] A doctoral education would provide these skills.

The second most predominant perceived need

Table IV: Respondents' Interests in Research-Based and Clinically Oriented Dental Hygiene Doctoral Programs, by Percentage and Number of Respondents

Doctoral program	Interest	Likely % (n)	Undecided % (n)	Unlikely % (n)
Research-based	Initiating/developing program at respondent's institution, n=199	40 (78)	25 (50)	36 (71)
	Supporting development at another institution, n=198	66 (132)	17 (34)	16 (32)
	Assisting with models and curricula for national level program, n=199	57 (113)	16 (31)	28 (55)
Clinically oriented	Initiating/developing program at respondent's institution, n=194	49 (96)	17 (34)	33 (64)
	Supporting development at another institution, n=193	69 (132)	14 (27)	17 (34)
	Assisting with models and curricula for national level program, n=191	58 (111)	16 (31)	27 (49)

for doctoral education was to "expand the body of knowledge for the DH profession by conducting discipline-specific research." The population in the United States is increasing, and so is the need for increasingly sophisticated methods, technology, theories, and delivery systems of health care to properly care for the growing number of people with health problems.[6,10,12] A research infrastructure is required to conceptualize DH in its current state of development by critical analysis of existing theories and methods, enabling discussion and dissemination of the results and findings to support systematic addition to our scientific base of knowledge.[8] An important component of an infrastructure is a substantial number of professionals trained and actively participating in discipline-specific research.[8]

In 1993, the ADHA Council on Research developed the first ADHA National Research Agenda and published a white paper to guide research efforts in the profession.[14] Other organizations interested in promoting research efforts in DH conducted studies, held research conferences, and created additional infrastructure improvements for research in the discipline. Unfortunately, despite the numerous improvements initiated in the 1990s, DH research

Table V: Respondents' Interests in Research-Based DH Doctoral Programs per Terminal Educational Degree Earned, by Percentage and Number of Respondents

Interest	Degree	Very Likely % (n)	Likely % (n)	Neutral % (n)	Unlikely % (n)	Very Unlikely % (n)	Total (n)
Initiating program at respondent's institution *	Doctorate	39 (15)	26 (10)	8 (3)	13 (5)	11 (4)	37
	Master's	14 (17)	21 (26)	24 (30)	22 (27)	19 (23)	123
Supporting development at another institution	Doctorate	47 (18)	29 (11)	13 (5)	3 (1)	5 (2)	38
	Master's	33 (41)	38 (48)	13 (17)	8 (10)	8 (10)	126
Assisting with models and curricula for a national level program **	Doctorate	63 (24)	13 (5)	8 (3)	5 (2)	8 (3)	38
	Master's	23 (28)	33 (40)	15 (18)	18 (22)	12 (15)	123

* Significantly more respondents with a doctorate than a master's as a terminal degree (p=0.003)
**Significantly more respondents with a doctorate than a master's as a terminal degree (p<0.001)

Table VI: Respondents' Interests in Clinically Oriented DH Doctoral Programs per Terminal Educational Degree Earned, by Percentage and Number of Respondents

Interest	Degree	Very Likely % (n)	Likely % (n)	Neutral % (n)	Unlikely % (n)	Very Unlikely % (n)	Total (n)
Initiating program at respondent's institution	Doctorate	34 (13)	21 (8)	24 (9)	11 (4)	11 (4)	38
	Master's	23 (29)	26 (32)	12 (15)	23 (29)	15 (19)	124
Supporting development at another institution	Doctorate	37 (14)	37 (14)	11 (4)	8 (3)	8 (3)	38
	Master's	31 (38)	40 (49)	12 (15)	8 (10)	8 (10)	122
Assisting with models and curricula for a national level program *	Doctorate	50 (19)	116 (6)	16 (6)	11 (4)	8 (3)	38
	Master's	28 (35)	31 (39)	15 (18)	16 (20)	10 (12)	124

* Significantly more respondents with a doctorate than a master's as a terminal degree (p=0.022)

did not advance to the level hoped, with much of the research confined to isolated pilot studies rather than theory-based research.[5] The first decade of the twenty-first century brought new research agendas, meetings, and conferences; however, the profession has yet to obtain full recognition of its potential to conduct valuable discipline-specific research, linking DH with the underlying foundation of health science.[6] One of the main stumbling blocks may have been the lack of doctoral educational programs in DH.[6]

Interestingly, fewer respondents (35%) strongly agreed with the need to "prepare dental hygienists with knowledge and skills to conduct research at institutions of higher education" than to "expand the body of knowledge by conducting discipline-specific research" (51%). Perhaps they perceived that the students in master of science degree programs in DH are already conducting research at the institutions at which they are enrolled or that the phrase "conduct research at institutions of higher education" unduly restricts DH research to a university setting.

The third-strongest response was the perceived need to "enhance the ability to attract funding to support large-scale studies for oral health promotion and disease prevention." Obtaining funding for multisite and large-scale studies requires having pilot data and establishing an area of expertise or a track record that is compatible with the research priorities of the funding agencies.[8] This takes time and requires enabling dental hygienists to build a research career path to be competitive.[6,8] As has occurred in the nursing profession, the DH profession should increase its efforts on valuing and building their research infrastructure, joining the mainstream scientific communities, and increasing its visibility in all aspects of professional activities, to establish priorities for funding and directives to target research projects.[8]

The need to "increase appreciation for the expertise of the dental hygienist and value of the dental hygiene profession in the eyes of the public" was the fourth-strongest need reported. DH is not considered a true profession by some, not meeting "the strict interpretation of a profession since it lacks autonomy and self-regulation."[15] Dental hygienists have a history of commitment to education, dental disease prevention, and oral health care.[6] However, their work has largely been restricted to the confines of private dental practice, limiting the appreciation for the expertise and value of the discipline by the public and other health care providers.[3]

The perceived need to "investigate and address issues related to oral health promotion and disease prevention" would require training leaders to examine and research evolving health care needs in the United States and assist with development of new public health care programs in those areas related to oral health. Oral health care policies and other issues affecting the DH profession should be determined by groups that include dental hygienists, but are currently determined by groups of professionals educated in other disciplines which may have different priorities.[10]

The fewest number of respondents agreed that doctoral education was needed to "develop measures

Table VII: Perceptions of Respondents Regarding the Top 3 Challenges or Barriers to Establishing Doctoral Programs in Dental Hygiene in the United States

Perceived Challenges and Barriers, n=183	% (n)
Shortage of qualified educators	49 (90)
Shortage of interested enrollees	42 (76)
Objections from the American Dental Association	38 (69)
Lack of support from institutional administrators	37 (67)
Objections from practicing dentists	31 (57)
Lack of federal and state grants	27 (49)
Lack of leaders, advocates, "movers and shakers"	27 (49)
Lack of support from dental school educators	26 (48)
Lack of support from professional organizations	15 (28)
Lack of support from the American Dental Education Association	15 (28)
Lack of support from DH educators	9 (16)
Objections from practicing clinical dental hygienists	7 (13)

Respondents selected their top 3 perceived challenges

Table VIII: Perceptions of Respondents Regarding the Top 3 Facilitators to Establishing Doctoral Programs in Dental Hygiene in the United States

Perceived Facilitator or Supporter, n=179	% (n)
Support from the American Dental Education Association	54 (96)
Support by approval or advocacy from the American Dental Hygienists' Association	47 (83)
Financial support from the American Dental Hygienists' Association	43 (76)
Support from public health programs and organizations	38 (67)
Support from dental hygiene educators	37 (66)
Support from educational institutions	33 (58)
Financial support from federal and state grants	25 (44)
Interest from dental hygiene students	16 (28)
Support from practicing clinical dental hygienists	11 (20)

Respondents selected their top 3 perceived facilitators

to improve oral health of the country's varied and underserved population." The reason for this lower perception of need may be due to a misunderstanding of the survey item. Dental hygienists are among those health care professionals frequently involved in community programs, school-based oral health care programs, health fairs, and volunteer work in socioeconomically disadvantaged and underserved areas.[16] It is conceivable that respondents interpreted this involvement as the "need" referred to in this question and, understandably, may have considered it sufficiently met. However, the intent was to ask whether doctoral education was needed to prepare dental hygienists to partner with other health care disciplines to develop measures to solve problems related to lack of access to health care in the United States for the underserved, rural, uninsured, and low-income populations. In 2003, the Surgeon General urged the public, health professionals, and policymakers to improve efforts to increase affordability and accessibility of oral health care to the underserved.[17] For this purpose, doctoral-prepared dental hygienists would be qualified and able to bring a unique and valuable perspective to the interdisciplinary table.[5,18]

Interests in Research-Based and Clinically Oriented Doctoral Programs in Dental Hygiene

The respondents expressed their interest in initiating and/or developing two different types of doctoral programs: research-based and clinically oriented. The majority responded that they would likely support development at another institution, rather than initiating either program at the respondent's institution. These respondents appear to be aware of the issues involved during an undertaking of this complexity, such as competing policies, organizational structure, environmental assessments, funding, and political climate, to name a few, and possibly perceive the numerous barriers and futility of such an endeavor at their own institution. The respondents may also fear that a doctoral program would compete with the institution's current program(s) for funding of expenses, such as facilities and personnel, or they may not want to assume a leadership role, because of time commitments to other interests. Their interest in doctoral education may be limited to the concept that the DH profession would benefit from such a program, and they would be supportive as long as it is at another institution.

By contrast, more than half of the respondents with doctorates were "Likely" or "Very Likely" interested

Table IX: Perceptions of Respondents Regarding the Top 3 Goals or Motivations for Dental Hygienists to Pursue a Doctoral Degree in Dental Hygiene

Perceived Goal or Motivator, n=182	% (n)
Become a better researcher	59 (108)
Become an institutional administrator	51 (93)
Become a better educator	41 (75)
Fulfill a personal dream	41 (74)
Increase salary	37 (67)
Become a DH program director	27 (49)
Become an executive in the oral health product industry	21 (38)
Expansion of clinical practice opportunities	20 (36)

Respondents selected their top 3 perceived goals or motivations

in initiating doctoral programs at their own institution, as well as supporting development of programs at another, and assisting with models and curricula for both types of programs. These results indicate that the respondents with doctorate degrees might be more interested in assuming leadership roles in establishing doctoral programs. These DH educators have personally experienced the doctoral education process and are familiar with the essential components of doctoral curricula—journal clubs, seminars, oral qualifying examinations, and most importantly, independent research. They also would possess a realistic assessment of the need for sufficient quantity and quality of faculty. In summary, these are the DH educators who would be critical to the establishment of doctoral programs. In this group of doctorates, there were a few who expressed less likelihood of involvement with developing programs. Perhaps the reluctance is due to their age: one third of the respondents in our study were over 60 years of age.

Our finding that doctoral-educated respondents were more likely interested in initiating a research-based educational program, rather than one clinically oriented, may have been due to their familiarity with this type of program and/or their opinion that research-based, doctoral-prepared dental hygienists would best assist the advancement of DH science.

Perceptions of Barriers

Of the top 3 barriers or challenges to establishing doctoral education programs, the "shortage of qualified educators" able to teach in these programs was the predominant choice of the respondents. Doctoral programs are faculty-intensive, with educators exceedingly involved in supervising research projects and editing dissertations, among other things. Ideally these educators would be dental hygienists with doctoral degrees, so that they could teach research skills and guide research in a direction related to dental hygiene. Currently, the number of these individuals is small. In this study, only 38 respondents (21%) had earned doctorate degrees (EdDs and PHDs). Increasing the number of this highly educated population is a great challenge, primarily because the majority of the current entry-level DH students graduate with an associate degree. Advancing from an associate degree to a doctoral degree might seem an insurmountable task to most dental hygienists. Raising the entry-level requirement for professional practice from an associate to a baccalaureate degree would be an important first step to developing a pipeline for any advanced degrees. More DH master's degree programs have been established in recent years, increasing the number of dental hygienists with master's degrees. This group would be the greatest source of doctoral program students and, ultimately, doctoral program faculty.

Financial concerns may have been a major reason for the respondents' perception that the "shortage of interested enrollees" would be a barrier. Obtaining a doctoral degree is a significant financial investment. Many dental hygienists would most likely continue to work while obtaining their degrees in order to meet their financial obligations. Online or hybrid programs could increase the feasibility of working simultaneously, and might prevent the students from having to relocate or disrupt their personal lives. Increased funding in terms of fellowships and scholarships could offset or partially reduce the cost of tuition. According to the study by Tumath and Walsh, the shortage of interested enrollees was not a barrier to enrollment in clinically oriented doctoral programs.[1] In that study, 62% of students enrolled in master of science DH programs professed interest in applying to clinical doctoral programs. Fewer students (38%) were interested in pursuing a research-based doctorate degree, which suggests less interest in conducting discipline-specific research. This is a concern because dental hygienists with research-based doctoral degrees would be needed as university professors to prepare more dental hygienists with doctoral degrees.

The third-ranked barrier, "objections from the American Dental Association," might be addressed by communication with the dental community concerning the value of doctorate-level dental hygienists as dental health professionals, emphasizing their ability to fulfill some of the needs discussed previously. Respondents from the Tumath and Walsh study indicated that practicing dentists may object less to the de-

velopment of a research-based doctoral degree than a clinically oriented degree.[1] Perhaps the possibility of competition is a factor in the perceived lack of support. Creation of clinically oriented doctoral degree dental hygienists, with the ability to utilize the research process and evidence-based decisionmaking to provide and/or manage comprehensive, individualized care to patients in a variety of settings, would have the potential to eliminate the need for supervision by dentists.[10] Introduction of this new member to the dental team could create a power paradigm shift within the dental profession and may make it necessary to advocate for changes in the dental practice acts in the states where the changes occur.[19] A review of the legislative process, and the example provided by the Minnesota Dental Hygienists' Association and its stakeholders, provides direction for states across the country who wish to advocate for increased access to oral health care for the underserved through more flexible licensure laws.[19]

The next-ranked barrier, "lack of support from institutional administrators," may be based on the respondents' knowledge of the politics or attitudes of the administration where they are employed, and a reason that fewer respondents were interested in initiating a doctoral program at their own institution than supporting development of a program at another. Perhaps they have worked with a leader plagued by the "Queen Bee Syndrome," a spectacle rooted in self-centered motivations.[20] Instead of being supportive of "subordinates" and DH goals, the Queen Bee is a nemesis and a barrier to the achievement and advancement of other women, especially if they are members of a group, such as dental hygienists, to which she initially belonged and perceives herself to have outgrown.[20]

Perceptions of Facilitators

More than half of our respondents selected the ADEA as the greatest support or facilitator for developing doctoral programs, whose mission is "to lead institutions and individuals in the dental educational community to address contemporary issues influencing education, research, and delivery of oral health care for the overall health and safety of the public."[21] Not surprisingly, support from the ADHA, financially and by approval and advocacy, was also among the top facilitators perceived to support doctoral education for the DH profession. The ADHA has continually supported advancement of the discipline through higher education with a vision that includes preparing dental hygienists for research, leadership, and interprofessional collaboration.[14,22]

Interestingly, a low percentage of respondents perceived that DH students and practicing clinical dental hygienists would provide support or encouragement in developing doctoral programs from which they might benefit. Practicing clinical dental hygienists were also perceived as not being a barrier or objector; it seems they are perceived to have no position regarding this issue. This perception may be because most of these dental hygienists graduated with an associate degree and may lack interest in advanced degrees. Extolling the value and benefits of advanced education to DH students during their entry-level programs may encourage them to continue their education.

Perceptions Regarding Goals

Of the top 3 goals or motivations for a dental hygienist to pursue a doctoral degree, the respondents' most prevalent choice was to "become a better researcher," which may relate to the perceived second-most important need for doctoral education: "expand the body of knowledge for the DH profession by conducting discipline-specific research." Research-intensive activities are necessary for mentoring and developing independent mastery of the skills necessary for methodical, innovative research, which would likely require more time than is available in educational programs other than those conferring a doctoral degree.

The next highly rated goal was to "become an institutional administrator." Dental hygienists with doctorates in other disciplines have often held administrative positions. However, institutional administrators with doctorates in DH may be more supportive of dental hygienists and assist in meeting the perceived strong need to "relate equitably with doctorates of other health-related disciplines." These leaders would be more inclined to support the goals of DH, while researching important questions central to the discipline and extending these inquiries across disciplinary lines. Institutional administrators with leadership styles that not only realize their own needs but, more importantly, also benefit the DH community are essential for the success of our discipline.

Demographic Characteristics

The majority of respondents in our study were 56-65 years old. This range was consistent with the findings of Collins and coworkers who studied full-time faculty in baccalaureate programs, revealing that 56% were aged 50 or more, with a mean of 50.2 ± 8.4.[23] The target population in our study and that of Collins' was limited to educators at programs offering baccalaureate and master's degrees. These positions would likely require clinical dental hygiene experience and advanced education, as indicated by our data that 21% had doctorates and 68% had a master's degree as their terminal degree. The age range may indicate that these respondents might have practiced clinical dental hygiene for many years

prior to entering DH education. Dental hygienists leave clinical practice to teach for many reasons such as limited scope of practice, repetitive work, lack of promotional opportunities, and subservient treatment. There may be younger dental hygiene educators at these institutions who did not respond to the survey because, as beginning educators, they may have been overwhelmed with their academic responsibilities.

Limitations

A limitation in our study was the fact that our study population consisted of DH educators, who often have a passionate interest in furthering education. Furthermore, we surveyed only educators from institutions offering baccalaureate and master's degrees in DH. DH educators from 2-year associate degree programs may have had different opinions. Another limitation was the lack of a clear definition of a clinically oriented doctoral degree, which may have created confusion for the respondents. Based on roles described in the literature, this clinically oriented doctoral degree dental hygienist may be a mid-level oral health practitioner who could provide care in a variety of settings under general supervision of physicians and dentists[1] or one educated to direct advanced clinical programs in a variety of health care delivery models or systems.[2] Our intent was to distinguish it from a doctoral program that focused on research and education, rather than the clinical aspects of the dental hygiene discipline.

Conclusion

The need for doctoral education in DH is supported by this study. The majority of responding DH educators from baccalaureate and master's degree doctoral programs in the United States agreed that the establishment of doctoral education in DH would fulfill a number of important discipline and societal needs. Although the respondents indicated the likelihood of supporting its development, they appeared realistic about the potential barriers and challenges that might hinder doctoral DH education. Regardless, these programs are needed to prepare dental hygienists to conduct discipline-specific research, generate new knowledge and theories important to the dental hygiene profession, and address the numerous concerns related to oral health care in our country. These exciting career paths should be available for dental hygienists who desire challenge in their personal and professional lives, as well as advancement in their chosen discipline. Many professions have advanced their educational models to include doctoral education, and it is widely recognized that the time has come for the dental hygiene profession to do the same.[2,7,10,12,15,22]

Cheryl A. Davis, RDH, BS, MS, JD, is a graduate of the Master of Science Program in Dental Hygiene at the University of California, San Francisco. Gwen Essex, RDH, MS, EdD, is HS Clinical Professor in the Department of Preventive and Restorative Dental Sciences at the University of California, San Francisco, and Co-Director of the Virtual Dental Home Clinics at the University of the Pacific Arthur A. Dugoni School of Dentistry. Dorothy J. Rowe, RDH, MS, PhD, is Associate Professor Emeritus in the Department of Preventive and Restorative Dental Sciences at the University of California, San Francisco.

Acknowledgments

We extend our sincere gratitude to the DH educators who participated in this survey. We also wish to thank Dr. Margaret Walsh for her initial inspiration for this research and her tireless efforts toward advancing higher education for the DH profession.

References

1. Tumath UG, Walsh M. Perceptions of dental hygiene master's degree learners about dental hygiene doctoral education. J Dent Hyg. 2015;89(4):210-218.

2. Gurenlian JR, Spolarich AE. Advancing the profession through doctoral education. J Dent Hyg. 2013;87(Supp l) 20-22.

3. Boyd LD, Henson HA, Guerlian JR. Vision for the dental hygiene doctoral curriculum. Access. 2008;22(5):16-19.

4. Fried J. Interprofessional collaboration: if not now, when? J Dent Hyg. 2013;87(Suppl):41-43.

5. Walsh MM, Ortega E. Developing a scholarly identity and building a community of scholars. J Dent Hyg. 2013;87(Suppl 1):15-19.

6. Bowen D. History of dental hygiene research. J Dent Hyg. 2013;87(Suppl 1):5-22.

7. Walsh MM. Raising the bar; making the case. Dimensions (Suppl). 2014;12(11):44-45.

8. Forrest JL, Spolarich AE. Building a research infrastructure. J Dent Hyg. 2010;84(1):11-13.

9. Qualtrics software, Version 60526, of Qualtrics Research Suite. Copyright © 2015. Provo, UT, USA. http://www.qualtrics.com.

10. Henson HA, Gurenlian JR, Boyd LD. The doctorate in dental hygiene: has its time come? Access. 2008;22(4):10-14.

11. Vanderbilt AA, Isringhausen KT, Bonwell PB. Interprofessional education: the inclusion of dental hygiene in health care within the United States—a call to action. Adv Med Educ Pract. 2013;4:227-229.

12. U.S. Department of Health and Human Services, Health Resources and Services Administration, Transforming Dental Hygiene Education, Proud Past, Unlimited Future: Proceedings of a Symposium. Rockville, Maryland: U.S. Department of Health and Human Services, 2014. [Cited 2015 May 31]. Available at: https://www.adha.org/resources-docs/AS2014-cehandouts/19CLL21-TH_PM_Transforming_Dental_Hygiene.pdf

13. Boyd LD, Bailey A. Dental hygienists' perceptions of barriers to graduate education. J Dent Hyg. 2011;75(8):1030-1037.

14. Spolarich AE, Davis C. Peterson-Mansfield S, et al. The ADHA National Research Agenda: White Paper by the ADHA 1993-94 Council on Research. J Dent Hyg. 1994;68(1):26-29.

15. Boyleston ES, Collins MA. Advancing our profession: are higher educational standards the answer? J Dent Hyg. 2012;86:168-178.

16. Conklin KV, Essex G, Rowe DJ. Factors influencing California dental hygienists' involvement in school-based oral health programs. J Dent Hyg. 2016;90(4):234-243.

17. US Department of Health and Human Services. Oral Health in America: A Report of the Surgeon General—Executive Summary. Rockville, MD: US Department of Health and Human Services, National Institute of Dental and Craniofacial Research, National Institutes of Health, 2000 [cited 2015 May 31]. Available from: http://www.nidcr.nih.gov/DataStatistics/SurgeonGeneral/Report/ExecutiveSummary.htm

18. American Dental Hygienists' Association. Dental Hygiene: Focus on Advancing the Profession [Internet]. 2005 June [cited 2015 Apr 6]. Available from: www.adha.org/resources-docs/7263_Focus_on_Advancing_Profession.pdf

19. Gadbury-Amyot CC, Brickle CM. Legislative initiatives of the developing advanced dental hygiene practitioner. J Dent Hyg. 2010;84(3):110-113.

20. Walsh MM, Ortega E, Heckman B. Dental hygiene's scholarly identity and roadblocks to achieving it. J Dent Hyg. 2015;89(Suppl 1):9-12.

21. American Dental Education Association: The Voice of Dental Education [Internet]. Home page mission statement [cited 2015 May 30]. Available from: http://www.adea.org/about_adea/Pages/default.aspx

22. American Dental Hygienists' Association: National Dental Hygiene Research Agenda [Internet]. Revised March 2007 [cited 2015 May 20]. Available from: https://www.adha.org/resources-docs/7111_National_Dental_Hygiene_Research_Agenda.pdf

23. Collins MA, Zinskie CD, Keskula DR, Thompson AL. Characteristics of full-time faculty in baccalaureate dental hygiene programs and their perceptions of the academic work environment. J Dent Educ. 2007;71(11):1385-1394.

Detection of Early-Stage Oral Cancer Lesions: A Survey of California Dental Hygienists

Dayna M. Hashimoto Barao, RDH, BS, MS; Gwen Essex, RDH, MS, EdD; Ann A. Lazar, PhD; Dorothy J. Rowe, RDH, MS, PhD

Abstract

Purpose: To assess dental hygienists' knowledge of early-stage oral cancer lesions and their practices, attitudes, barriers, and facilitators related to early detection.

Methods: A 20-item survey containing images of oral lesions and related multiple-choice questions was distributed electronically by the California Dental Hygienists' Association to all dental hygienists whose email addresses were in their database. Response frequencies were calculated per survey item. Logistic regression analysis was used to explore associations.

Results: Seven hundred fifty-one dental hygienists responded, yielding a 12% response rate. Respondents' correct identification of the six images of oral lesions varied from 40%-97%. Most respondents reported conducting oral cancer examinations (OCE) at every dental hygiene appointment and performing palpation during OCE. Regions of the mouth varied regarding the frequency of palpation. Lymph node palpation was considered the most commonly omitted step. Those who conducted palpations were 3.3 (95% CI: 1.4 to 7.9, p=0.006) times more likely to report that they knew someone with oral cancer and had detected oral cancer lesions than those who did not. Knowing a person with a history of oral cancer and previously detecting a cancerous lesion were also reported as factors encouraging respondents to bring suspicious lesions to the attention of the dentist. Discouraging factors were mostly related to the dentist' behavior, such as not referring a suspicious lesion for biopsy that the respondent identified.

Conclusion: Detection of early-stage oral cancer lesions by dental hygienists may be enhanced through more extensive education of visual appearances of lesions and the importance of palpation in a comprehensive OCE.

Keywords: clinical management, continuing education, dental hygiene education/curriculum, evidence based practice, health promotion, oral cancer

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

Introduction

Head and neck cancer is the sixth most common cancer worldwide,[1] with 630,000 newly diagnosed cases and 350,000 deaths per year.[1,2] Most cases of oral cancer are not diagnosed until they are in advanced stages (III or IV),[2,3] resulting in a 5-year survival rate less than 30%.[4,5] With early detection, prognosis can improve with 5-year survival rates increasing from 30% to over 80%.[6] However, early detection depends on thorough and frequent comprehensive oral cancer examinations.

Dental hygienists are educated to perform these potentially life-saving comprehensive oral cancer examinations. Curricula of entry-level dental hygiene educational programs provide fundamental knowledge about oral cancer lesions, as well as the theoretical background and clinical experience performing oral cancer examinations. The Commission on Dental Accreditation requires that dental hygiene graduates be competent in performing oral cancer examinations. A comprehensive oral cancer examination includes the steps outlined in Table I. Palpation of the head and neck lymph nodes and oral mucosa is integral to a comprehensive oral cancer examination.[5,7] In clinical practice dental hygienists have the opportunity to document and frequently monitor any abnormalities of the oral soft tissues noted at their patients' regular dental hygiene appointments. However, past research revealed 66% of surveyed dental hygienists reported conducting oral cancer examinations,[6] and 50% reported employing bimanual neck palpation in their assessment.[5]

While past studies have examined dental hygienists' oral cancer screening-related knowledge, atti-

tudes, and behaviors, factors influencing detection of early-stage lesions by dental hygienists are still unknown. Therefore, the purpose of this study was to assess the knowledge, practices, attitudes, barriers, and facilitators of early-stage oral cancer detection by California dental hygienists using an electronic survey approach.

Methods and Materials

This quantitative, cross-sectional study was approved by the Institutional Review Board of the University of California, San Francisco. The study population consisted of dental hygienists whose email addresses were in the California Dental Hygienists' Association (CDHA) database. The database included both members and nonmembers of CDHA. CDHA distributed an email message to potential participants, which included a recruitment cover letter, the study purpose, contact information, informed consent, and a link to the online survey.

The 20-item survey, which included conditional branching and multiple-choice questions, was developed by the authors based on previous related research. Questions from established surveys were examined for content and format and used when appropriate. The survey assessed the following: knowledge of visual appearance of lesions, oral cancer examination practices and attitudes, the barriers and facilitators of bringing a suspicious lesion to the attention of the dentist, and demographic information. The survey instrument was pilot tested by 15 dental hygienists for acceptability and feasibility, and modifications were made based on feedback received.

CDHA sent two follow-up email messages to all respondents 3 weeks and 6 weeks following the initial mailing, requesting nonresponders to complete the survey. Survey responses were recorded and compiled by Qualtrics online survey research suite.[8]

Descriptive statistics of the survey questions were calculated among the observed respondents and are presented as the frequency (percentage) for categorical variables and mean and standard deviation (SD) for variables measured on a continuous scale. A knowledge score of oral cancer was assessed for each respondent based on 6 images of oral lesions. Survey respondents were requested to view images of oral lesions and specify whether the lesions were suspicious or not. Each correct response to a knowledge question was awarded a single point with a maximum of 6 points. An average oral cancer knowledge score was calculated if at least half of the 6 questions relating to the knowledge assessment had responses; otherwise, the average cancer knowledge score was considered missing.

Logistic regression analysis was used to independently explore whether there was an association between respondents who reported conducting palpations of oral tissues (outcome) with respondents who knew someone with oral cancer (independent variable) or had previously detected a cancerous lesion (independent variable). Also explored was whether the combination of both knowing a person with oral cancer and previously detecting a cancerous lesion was associated with conducting palpations (outcome). Associations are reported as odds ratios (OR) with corresponding 95% confidence intervals (CI) among the observed data (n=685/751 or 91%). Statistical analyses used SAS version 9.4 (SAS Institute, Cary, NC). All statistical tests provided two-sided p-values, and p-values (p)<0.05 were considered statistically significant.

Table I: Steps in Conducting an Oral Cancer Examination[7]

1. Remove all appliances (dentures, partials, etc.)
2. Visually inspect face, neck, lips, mouth
3. Bimanually palpate lymph nodes (submandibular/submental, cervical, auricular, parotid, and occipital)
4. Palpate labial mucosa and buccal mucosa
5. Using gauze, extend tongue to visual inspect palpate: dorsum/ventral/lateral and base of tongue and floor of the mouth
6. Visually examine hard and soft palate and back of the throat

Results

Of the 6,248 dental hygienists whose email addresses were in the CDHA database, 751 responded to the online survey, yielding a response rate of 12%. Almost all (91%) of the respondents were currently practicing. Most respondents reported graduating from an associate degree program, practicing in a private dental office, and were either early in their career (0-3 years), or had been practicing for over 15 years (Table II).

The percentage of respondents correctly identifying the oral lesions presented as suspicious for oral cancer or not ranged from 40-97% (Figure 1). Ninety-one percent (n=684/751) responded to at least 3 of the 6 knowledge questions, and therefore an average knowledge score was calculated for those respondents with an average knowledge score of 77% (standard deviation = 16%). Image 2 depicted an early, less pronounced lesion, erythroplakia, and resulted in only 40% of the respondents correctly identifying it as suspicious for cancer.

Most respondents reported that they conducted an oral cancer examination at every treatment appointment (Table III). Only 1% of participants reported

Figure 1: Respondents' Knowledge of Cancerous Lesions, Based on Identification of Photographic Images. Lesion Description Followed by % (Number of Respondents Who Answered Correctly/Total Respondents)

Image 1: Leukoplakia. Most common precancerous lesion (89%: 618/695)[20]

Image 2: Erythroplakia. Highest potential for becoming malignant (40%: 272/684)[19]

Image 3: Leukoplakia. Precancer, smallest chance of developing into cancer (72%: 490/678)[19]

Image 4: Geographic Tongue. Benign migratory glossitis (89%: 600/676)[20]

Image 5: Erythroleukoplakia. Highest potential for becoming malignant (97%: 659/679)[19]

Image 6: Hypekeratinization. Benign (72%: 471/652)[20]

having never conducted an oral cancer examination. The most commonly reported factor associated with not conducting an oral cancer examination was that a supervising dentist conducted the OCE. A minority of respondents indicated that they never inform their patients that they are conducting an oral cancer examination. The inclusion of palpation during the OCE was reported by most participants.

The frequency of palpation varied by region of the mouth and head/neck (Table IV). The labial mucosa was always palpated by 87% of the respondents. While 32% reported that they never palpate occipital lymph nodes, 97% of the respondents indicated palpation was important. The areas reported to be less important to palpate included the occipital lymph nodes and tongue. Respondents who conducted palpations were more likely to report knowing a person with oral cancer (OR=1.3, 95% CI: 0.9 to 1.9, p=0.24) and previously detecting an oral cancer lesion (OR=1.2, 95% CI: 0.8 to 1.8, p=0.3) than those who did not. Those who reported both knowing someone with oral cancer and previously detecting an oral cancer lesion were 3.3 (95% CI: 1.4 to 7.9, p=0.006) times more likely to conduct palpations than those who did not.

Table V describes the self-reported frequency of visual examination. The majority of the respondents reported "always" as the frequency of examination of the oral regions included in OCE. For example, 98% indicated that they always examine the buccal mucosa. On the other hand, facial symmetry was never examined by 10% of the respondents.

Factors that discouraged respondents from bringing suspicious lesions to the attention of the dentist were primarily related to the dentists' behavior: for example, not referring a lesion for biopsy that the dental hygienist felt was suspicious (Table VI). Few respondents experienced patients becoming upset. The facilitating factors, ones that encouraged respondents to bring a suspicious lesion to the attention of a dentist, were the personal experiences of the respondents. More than half the respondents knew a patient with a history of oral cancer or had detected a cancerous lesion in the past.

Discussion

Detection of early-stage oral cancer is dependent upon the clinician's knowledge of the visual appearance and tactile characteristics of the oral lesions and the features that differentiate malignant lesions from benign. Dental hygienists play a key role in the detection of precancerous and cancerous lesions.[9] Do dental hygienists possess sufficient knowledge to detect early-stage oral cancer lesions? In our study we assessed this knowledge by asking survey respondents to view images of oral lesions and specify whether the lesions were suspicious or not. The respondents' correct identification of the six images ranged from 40-97%. However, nearly 10% of the respondents did not respond to at least 3 of the 6 knowledge questions, and it is unclear if this was due to a lack of oral cancer knowledge.

Image two was challenging for the respondents, with only 40% of the respondents correctly identifying the depicted lesion as erythroplakia, which has a high likelihood of malignant transformation. The other lesions may have been more obviously suspicious or benign. These data suggest that dental hygienists have the knowledge to detect obvious, or more advanced, lesions. However, due to the variety

Table II: Demographic Characteristics of Respondents

	%	(n)
Currently Practicing (n=584)*		
Private Practice	86	(503)
Community Clinic	7	(40)
Educational Institution	16	(91)
Other	7	(38)
Entry-level Degree (n=640)		
Bachelor Degree	32	(206)
Associate Degree	68	(434)
CDHA Members (n=641)	79	(508)
Years in Practice (n=577)		
0-<3	29	(166)
3-< 5	7	(43)
5-< 10	11	(63)
10-<15	9	(50)
15->15	44	(255)

*Respondents selected all that applied

Table III: Respondents' Report of Oral Cancer Examination (OCE) Practices

	%	(n)
Frequency of OCE (n=676)*		
With each new patient	26	(178)
Annually with each patient	18	(125)
At every treatment appointment (i.e., prophylaxis, periodontal maintenance appointments)	80	(538)
Never	1	(7)
Other	9	(60)
Palpation performed during OCE (n=665)	83	(552)
Patient informed of conducting OCE (n=644)		
Always	64	(413)
Sometimes	33	(212)
Never	3	(19)

*Respondents selected all that applied

Table IV: Respondents' Report of Frequency of Palpation

	Always % (n)	Sometimes % (n)	Never % (n)	Total Responses
Buccal Mucosa	83 (439)	15 (79)	2 (9)	527
Lymph Nodes				
Auricular	57 (292)	24 (124)	18 (92)	508
Cervical	66 (341)	22 (113)	12 (60)	514
Occipital	39 (192)	28 (140)	33 (160)	492
Submandibular	79 (415)	16 (85)	5 (24)	524
Submental	72 (369)	21 (106)	8 (41)	516
Floor of Mouth	84 (446)	14 (74)	1 (7)	527
Labial Mucosa	87 (456)	12 (62)	1 (6)	524
Lips	82 (432)	16 (82)	2 (10)	524
Tongue	76 (393)	18 (92)	7 (34)	519

Table V: Respondents' Report of Frequency of Visual Examination

	Always % (n)	Sometimes % (n)	Never % (n)	Total Responses
Back of Throat	85 (544)	14 (86)	1 (9)	639
Buccal Mucosa	98 (625)	2 (12)	0 (1)	638
Facial Symmetry	63 (398)	28 (176)	10 (62)	636
Hard Palate	96 (615)	4 (23)	0 (1)	639
Labial Mucosa	97 (615)	3 (20)	0 (1)	636
Lips	97 (618)	3 (17)	1 (4)	639
Maxillary Tuberosities	78 (497)	17 (111)	4 (28)	636
Retromolar Pads	88 (560)	10 (62)	3 (17)	639
Soft Palate	95 (605)	5 (30)	0 (2)	637

of benign lesions, such as bite trauma, or hyperkeratinization, less-obvious lesions may be difficult to distinguish as suspicious for oral cancer. Also, the difficulty in correctly identifying Image 2 may have been due to the photographic image itself. It may have been ambiguous in its clinical presentation to some respondents.

Using images to test knowledge addresses the potential limitation present when knowledge is measured by self-report. Previous studies assessed other health care professionals' oral cancer knowledge using various methods, usually multiple choice survey questions and self-report. For example, the survey reported by Applebaum et al. included risks of oral cancer, signs symptoms, and characteristics of lesions.[10] Questions on the impact of early detection on patient survival and the characteristics of lesions associated with smokeless tobacco were included in the knowledge score by LeHew et al.[11] Because the surveys asked different questions, it is difficult to compare the results of the level of knowledge across the studies. Generally, survey respondents performed in the average range. In addition to assessing general oral cancer knowledge, investigators used a diagnostic ability scale to measure the correct identification of suspicious oral lesions.[11] At least two previously published surveys addressed dental hygienists' knowledge. Forrest et al. found that 67% of the respondents correctly answered oral cancer questions relating to risk factors.[6] Similarly, another study reported that the majority of respondents performed poorly on the knowledge portion of the survey (53% correct).[9] The findings of these studies underline that there is no standardized, obvious visual sign of oral cancer, and that the variety in appearance of oral lesions makes early detection challenging.

Oral cancer lesions are usually detected in the Oral Cancer Examination (OCE); Cotter et al. found a significant positive correlation between the identification of a suspicious lesion and the performance of oral cancer screening.[12] Visual examination and lymph node palpation are reported to be valued components of the OCE, yet are not always performed. The majority of our respondents reported conducting some type of palpation, with the lymph nodes and tongue reported to be the least commonly examined by palpation. According to Kujan et al., many dental

hygienists are seriously misinformed of what constitutes a thorough examination.[2]

In the study by LeHew and colleagues, dentists were surveyed for their thoroughness conducting the OCE, an assessment of both skill and frequency of procedures.[11] These factors were also incorporated into the early detection practice scale, reported by Hassona.[13] Based on this scale, participating medical and dental professionals reported average early detection practice, and only 18% reported that they routinely performed OCE in their practices.[10] On the other hand, in a study of dental hygienists, Cotter et al. reported that 46% of their respondents "always" performed OCE, 24% performed OCE at the initial appointment, and 47% at the recall appointment.[10] These percentages are lower than the values that our respondents reported: 80% conducting OCE at every treatment appointment and 82% performing palpation. The current results are also higher than the Forrest et al. study in which 25% of the respondents reported routinely palpating lymph nodes of their patients 100% of the time, while 51% reported not doing it at all.[6] The inconsistency in the data may be explained by the lack of one standardized, explicit method for comprehensive OCE. Without a consistent method, integral steps of the OCE are being skipped. There is a striking need to establish a global consortium on oral cancer screening that will oversee research and provide recommendations for health professionals at regular intervals.[2]

Previous experience in detecting an oral cancer lesion or knowing a patient having a history of oral cancer were reported as facilitators, experiences that encouraged dental hygienists to bring a suspicious lesion to the attention of a dentist. Both of these factors may motivate a dental hygienist to continue to conduct thorough, comprehensive OCE. In fact, the current findings demonstrated that the respondents who conducted palpations were more likely to have known a person with a history of oral cancer and had previously detected a cancerous lesion. Making a personal connection enhances one's understanding of the value of OCE in early-stage lesion detection.

The respondents of the current study reported these barriers or factors that influenced their decision not to bring a suspicious lesion to the attention of the dentist: personal experience in detecting a lesion that came back with a negative biopsy, the dentist not referring the dental hygienist's recommendations, as well as the supervising dentists conducting OCE themselves. Twenty-nine percent of our respondents reported that their supervising dentists wanted to conduct the OCE themselves. Similarly, Bigelow et al. reported that the patient does not perceive urgency without the support from a dentist.[9] While not asked in the current study as a survey question, lack of public and dentists' awareness of dental hygienists' competence with OCE appears to be a barrier to early diagnosis. Postponement of oral cancer diagnosis is often caused by delays from both patients and health professionals, partially due to poor awareness regarding oral cancer among the public and health care professionals alike.

Table VI: Factors That Discouraged and Encouraged Respondents Bringing a Suspicious Lesion to the Attention of a Dentist

	% (n)
Discouraging Factors or Barriers: (n=465)*	
Dentist conducts all oral cancer exams	28 (131)
Dentist requests that you do not conduct an oral cancer exam	2 (10)
Dentist did not refer a lesion for biopsy that you felt was suspicious	26 (122)
Patient was upset after oral cancer exam	7 (32)
Patient returned with negative biopsy	25 (116)
Encouraging Factors or Facilitators: (n=465)*	
You have detected a cancerous lesion previously	55 (257)
You know a patient with history of oral cancer	65 (302)

*Respondents selected all that applied

The delay in detection and diagnosis of lesions is often attributed to the asymptomatic nature and the difficulty in differentiating premalignant and malignant lesions from benign conditions.[6] For example, the majority of respondents incorrectly identified image 2 as not suspicious for oral cancer, indicating the difficulty in differentiation and suggesting the need for more extensive education of visually ambiguous malignant lesions. Education in identifying the visual appearance of early lesions may improve the early detection ability of professionals and increase the awareness needed to reduce delays in treatment.[10] Also, the lack of a standardized method for OCE examination may contribute to the low detection rate. Professionals may be using their experience and clinical judgment to decide which structures to examine and palpate rather than an examination based on evidence. Steps in one standardized method are illustrated in the sequential photographs in the dental hygiene textbook, Darby and Walsh.[14] Having knowledge of the necessary steps in performing a thorough exam[6] and implementing one consistent method with clear and realistic steps may be a positive step toward increasing the detection of oral cancer lesions at an early stage.

The focus of this article was OCEs for all patients. Factors encouraging OCEs were based on the dental hygienists' experiences with lesions and relation-

ships, not on patients being high or low risk. It is unknown whether dental hygienists may not routinely do an OCE, but do at least conduct one when the patient is at high risk. In Table II, 9% of the respondents selected "other" as frequency of OCE. Perhaps it can be speculated that the "other" was selected based on the respondents conducting OCEs only on high-risk patients. An ongoing study is assessing whether dental hygienists are more diligent in performing OCE when potentially treating high-risk patients. The danger of that philosophy is that early-stage lesions may be missed on patients without any risk factors, so OCE for all patients is recommended.

This study and many other studies of OCE conclude that there is a need for continued or mandatory continuing education on oral cancer knowledge and practices to make a difference in prevention and early detection of oral cancer in our patient population.[4,6,9-13,15,16,17,18] Specifically, continuing education courses that include hands-on technique workshops were found to positively change attitudes and behaviors of OCE.[4] These workshops should focus on palpation technique for specific areas to comprise a comprehensive OCE.[9] The results from the current study suggest that continuing education courses, as well as entry-level education, should focus on the visual appearance of early-stage oral cancer lesions and one standardized method of OCE to ensure all valuable steps are performed thoroughly.

Limitations of this study include selection bias: respondents who completed the survey may have greater interest in the topic due to personal experience with oral cancer or oral cancer detection. Also, the low response rate (12%) yielded a response bias, which would affect the ability to generalize the results to all dental hygienists in California. The study population was limited to California dental hygienists whose email addresses were in the CDHA database. Although this database included both members and nonmembers, it is presumed that more members than nonmembers were in their database, as our data (Table I) indicates that 79% of the respondents were CDHA members. That value would not be representative of the California dental hygienists. However, the remainder of the demographic characteristics does appear similar to the California dental hygiene population. Another limitation was that OCE practices were based on self-report, which often results in a social desirability bias.

Conclusion

This study indicates that dental hygienists have the knowledge to conduct OCE effectively. The majority of respondents reported conducting comprehensive OCE, although some omitted palpation of the lymph nodes and tongue. The lack of one clear, standardized method of OCE by health care professionals may be related to the low rate of early oral cancer detection. Establishing a standardized method for OCE could provide the knowledge health care professionals need to perform every integral step of a comprehensive OCE. Conventional oral examination still constitutes the gold standard screening method to identify potentially malignant oral lesions. The detection of early-stage oral cancer lesions by dental hygienists may be enhanced through more extensive education of visual appearances of lesions and the importance of palpation in a comprehensive OCE during both entry-level and continuing education programs.

Further research is indicated to improve the knowledge and practice of OCE, which may in turn increase the rate of early detection and decrease the life-altering and life-threatening experience of oral cancer in our patients.

Dayna M. Hashimoto Barao, RDH, BS, MS, is a graduate of the Master of Science Program in Dental Hygiene at the University of California, San Francisco. Gwen Essex, RDH, MS, EdD, is a Clinical Professor in the Department of Preventive and Restorative Dental Sciences at the University of California, San Francisco and Co-Director of the Virtual Dental Home Clinics at the University of the Pacific Arthur A. Dugoni School of Dentistry. Ann A. Lazar, PhD, is an Assistant Professor and Dorothy J. Rowe, RDH, MS, PhD, is an Associate Professor Emeritus in the Department of Preventive and Restorative Dental Sciences at the University of California, San Francisco.

Acknowledgments

The authors express their appreciation to the California Dental Hygienists' Association for their support of this study and distribution of the survey.

References

1. Nadarajah V, Williams MD. Epidemiologic trends in head and neck cancer and aids in diagnosis. Oral Maxillofac Surg Clin North Am. 2014;26(2):123-141.

2. Kujan O, Sloan P. Dilemmas of oral cancer screening: an update. Asian Pac J Cancer Prev. 2013;14(5): 3369-3373.

3. Paulis M. The influence of patient education by the dental hygienist: acceptance of the fluorescence oral cancer exam. J Dent Hyg. 2009;83(3):134-40.

4. Walsh MM, Rankin K, Silverman S. Influence of continuing education on dental hygienists' knowledge and behavior related to oral cancer screening and tobacco cessation. J Dent Hyg.

2013;87(2):95-105.

5. Regezi JA, Sciubba JJ, Jordan RCK. Oral Pathology: Clinical Pathologic Correlations. Saunders Elsevier, St. Louis, MO. 2008, p. 66-68.

6. Forrest J, Horowitz A, Shmuely Y. Dental hygienists' knowledge, opinions, and practices related to oral pharyngeal cancer risk assessment. J Dent Hyg. 2001;75(4):271-281.

7. National Institute of Dental and Craniofacial Research. The oral cancer exam: NIH Publication. Bethesda, MD [Internet]. 2013 [cited 2014 Aug 27]. Available from: http://www.nidcr.nih.gov/OralHealth/Topics/OralCancer/TheOralCancerExam.htm

8. Qualtrics software, Version 60526, of Qualtrics Research Suite. Copyright © 2015. Provo, UT, USA. http://www.qualtrics.com.

9. Bigelow C, Patton L, Strauss R, et al. North Carolina dental hygienists' view on oral cancer control. J Dent Hyg. 2007;81(4):1-14.

10. Applebalm E, Ruhlen TN, Kronenberg FR, et al. Oral cancer knowledge, attitudes and practices: a survey of dentists and primary care physicians in Massachusetts. J Am Dent Assoc. 2009;140(4):461-467.

11. LeHew C, Epstein J, Kaste L, et al. Assessing oral cancer early detection: clarifying dentists' practices. J Pub Health Dent 2010;(70):93-100.

12. Cotter J, McCann A, Schneiderman E, et al. Factors affecting the performance of oral cancer screenings by Texas dental hygienists. J Dent Hyg. 2011;85(4):326-334.

13. Hassona Y, Scully C, Shahin A, et al. Factors influencing early detection of oral cancer by primary health-care professionals. J Cancer Educ. Jun 2016;31(2):285-291.

14. Fehrenbach MJ. Extraoral and intraoral clinical assessment. In: Darby ML, Walsh MM, ed. Dental Hygiene: Theory and Practice. 4th ed. St. Louis, MO. Saunders/Elsevier Publishing. 2015. p. 221-225 and p. 228-231.

15. van der Waal I, de Bree R, Brakenhoff R, et al. Early diagnosis in primary oral cancer: is it possible? Med Oral Patol Oral Cir Bucal. 2011; 12 (3):e300-305.

16. Silverman S, Kerr A, Epstein J. Oral and pharyngeal cancer control and early detection. J Canc Educ 2010;(25):279-281.

17. Maybury C, Horowitz A, Goodman H. Outcomes of oral cancer early detection and prevention statewide model in Maryland. J Publ Health Dent 2012;(72):S34-38.

18. Gajendra S, Cruz G, Kumar J. Oral cancer prevention and early detection: knowledge, practices, and opinions of oral health care providers in New York State. J Cancer Educ 2006;(3):157-162.

19. New York University Oral Cancer Center. Erythroplakia [Internet]. [Cited 2014 Nov 15]. Available from: http://www.nyuoralcancer.org/oral_cancer/oral_precancer.html

20. Crutchfield Dermatology. Case of the month from Crutchfield dermatology [Internet]. [Cited 2014 November 15]. Available from: http://www.crutchfielddermatology.com/caseofthemonth/studies/2010/m_2010_006.asp

Distribution of Bacteria in Dental Offices and the Impact of Hydrogen Peroxide Disinfecting Wipes

Charles P. Gerba, PhD; Gerardo U. Lopez, PhD; Luisa A. Ikner, PhD

Abstract

Purpose: The purpose of this study was to characterize the occurrence of heterotrophic plate count bacteria (HPCs), fecal bacterial indicators, and methicillin-resistant Staphylococcus aureus (MRSA) on hard, nonporous surfaces (fomites) commonly found in dental offices, and to assess the impact of a hygienic disinfection intervention on the reduction of these bacteria in the office setting.

Methods: Samples of various fomites were collected from dental offices located in Arizona (6) and Illinois (4) and assayed for HPCs, total coliforms, Escherichia coli, and MRSA in order to establish baseline bacterial levels. Dental office personnel were then provided with disposable disinfectant wipes containing hydrogen peroxide to use in the office, and the surfaces were subsequently resampled to assess their impact on the specified bacterial populations.

Results: The greatest numbers of HPCs were found on the patients' arm rest and office phones, with dental tool handles and the dentist examination lights yielding the lowest levels. Coliform bacteria and E. coli were also detected on those surfaces demonstrating the highest HPCs, and were cultured from other fomites as well. MRSA was also isolated from 5% of the fomites tested. The use of disinfectant wipes significantly reduced the numbers of HPC bacteria detected on fomites ($p=0.002$). No total coliforms, E. coli, or MRSA were cultured from disinfected fomites following the hygienic intervention.

Conclusion: The use of hydrogen peroxide-impregnated towelettes reduced total bacterial numbers on fomites commonly located in dental offices. Total coliforms, E. coli, and MRSA were reduced to levels below detection.

Keywords: bacteria, coliforms, fomites, dental office, disinfection, hydrogen peroxide

This study supports the NDHRA priority area, **Occupational Health and Safety:** Evaluation of a hygienic disinfection intervention to reduce microbiological ergonomic hazards for dental hygienists (aerosols, chemicals, latex, nitrous oxide, noise and infectious diseases).

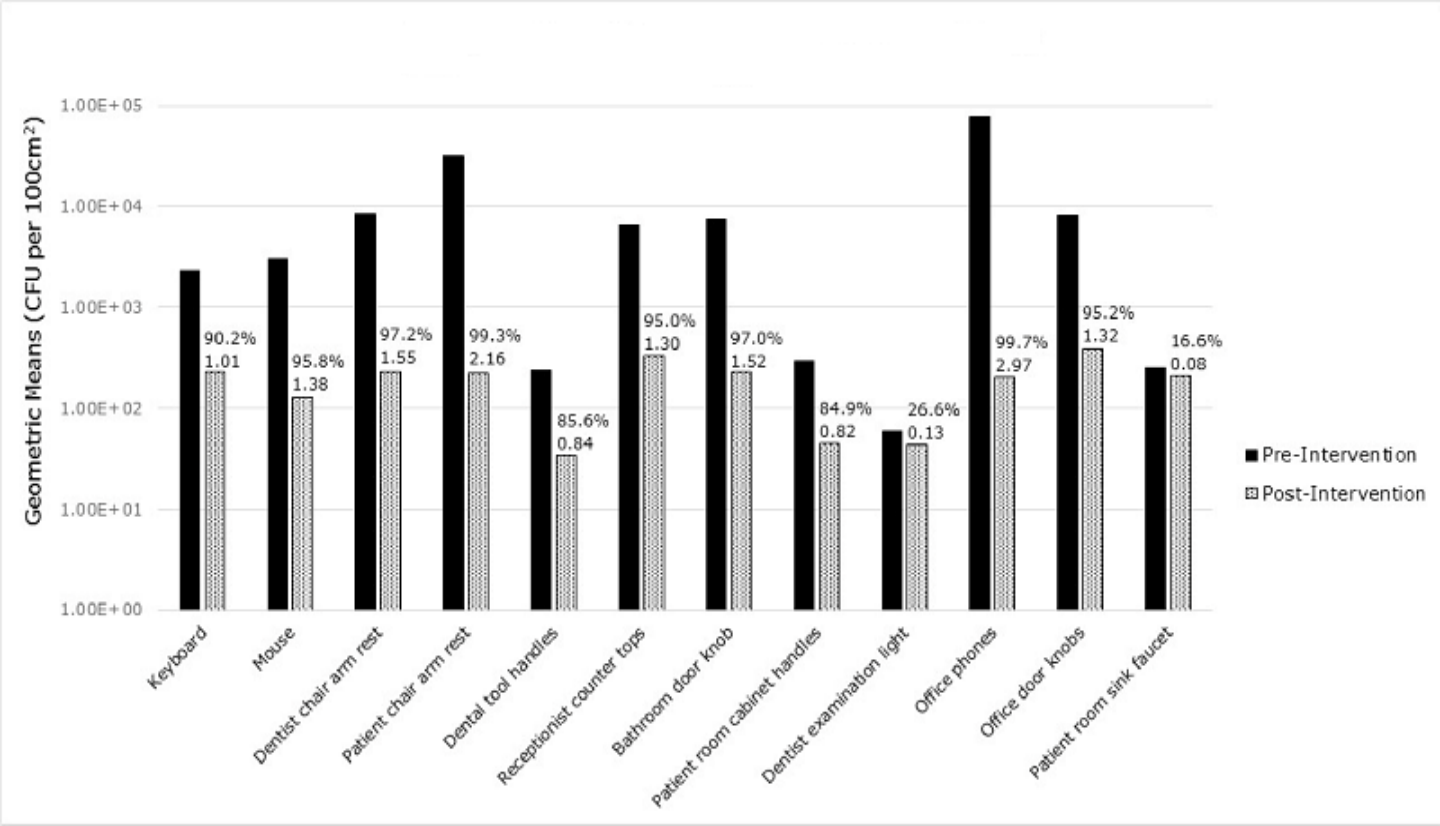
Introduction

In the dental clinic setting, the potential for pathogen transmission from staff to patients (as well as from patients to staff) is of chief concern. Sources of infectious microorganisms include contaminated bodily fluids (e.g. saliva and blood), improperly sterilized equipment/instruments, and airborne transmission. The invasive nature of the procedures performed on behalf of patients by both dentists and dental hygienists, coupled with the high degree of potential exposure within the oral cavity, underscores the need for pathogen elimination from all potential sources. Dental hygienists in particular may serve as a vital link in the potential transmission of microbes in a dentistry, as they are in contact with all incoming patients, including those seeking only routine services (e.g. cleanings and X-rays) and those who require more complex procedures.

In addition to the aforementioned sources of pathogens in the dental setting, inanimate objects (fomites) may also function as reservoirs for such microorganisms within the indoor environment. In the clinical setting, fomite contamination occurs by touch via infected patients or staff, and from the settling of aerosols (e.g. from sneezing) expelled from infected persons. The subsequent touching of contaminated fomites by individuals may then result in the transfer of infectious microorganisms to the hands.[1,2] Self-inoculation may then occur when contaminated fingers make contact with the mouth, nose, or eyes,[3] with direct transmission and colonization of skin also a possibility for some pathogens such as methicillin-resistant *Staphylococcus aureus* (MRSA).[4] Studies assessing bacterial occurrence in the dental setting have focused primarily on clinical patient-care areas.[4,5,6] However, data with regards to bacterial levels on surfaces commonly found in dental offices not associated with corresponding schools or clinics is largely nonexistent.

The implementation of disinfection-based hygienic interventions in the hospital setting has resulted in lower levels of nosocomial pathogens such as MRSA on surfaces, with corresponding decreases subse-

Figure 1: Mean Pre- and Postintervention HPC Values on Tested Fomites with Log_{10} and % Reduction Values



quently observed in incident cases among patients.[7] MRSA is also a bacterial pathogen of great concern in dental clinics, and has been investigated extensively with regards to aerosol transmission,[8] surface contamination,[4,9] and prevalence among dental students and patients.[10,11] Determination of the numbers and types of bacteria [including heterotrophic plate count bacteria (HPCs) and fecal indicators such as total coliforms and *Escherichia coli*] that occur on the variety of surface types present in the dental setting will provide useful information as to the general areas that might also serve as reservoirs for pathogenic microorganisms.[12] Knowledge of the fomites commonly found in dental offices that are characterized by the highest levels of microbial contamination, coupled with the potential risks of pathogen transmission, can facilitate the development of a strategic surface-treatment hygienic intervention strategy employing the use of disinfectants.

Hydrogen peroxide (chemical formula: H_2O_2) is a naturally occurring oxidizing agent that produces short-lived free radical ions (HO- and HOO-). These ions can damage bacterial cell walls, thereby compromising cell wall integrity and resulting in an increased vulnerability to other disruptive agents (e.g. detergents). The goal of this study was to determine the levels of HPCs, total coliforms, *E. coli*, and MRSA on various fomites in private practice dental offices, and to assess the impact of a hygienic intervention on the reduction of these bacteria following fomite disinfection using hydrogen peroxide-impregnated disposable wipes.

Table I: Fomites Evaluated in the Study (Quantity of Samples Collected)*

Keyboards in operatories and offices (33)
Computer mouse in operatories and offices (24)
Dentist chair arm (39)
Patient chair arm (36)
Dental tool handles (29)
Receptionist countertops (36)
Bathroom door knob (21)
Operatory cabinet handles (19)
Dentist light (14)
Office phones (12)
Office door knobs (6)
Operatory sink faucet (16)

*No. of dental offices: Arizona (6); Illinois (4); No. of operatories sampled per dental office (2) = 20 total

Table II: Geometric Means and Range Values of Heterotrophic Plate Count (HPC) Bacteria Prior to and After the Hygienic Intervention

Fomite Type	Preintervention (CFU/100 cm^2)			
	n	GeoMean	Log_{10}±SD	Range Values
Keyboard	16	2.33E3	3.37±0.84	6.00E1—7.20E4
Mouse*	11	3.06E3	3.49±0.99	7.50E1—8.55E4
Dentist chair arm rest*	22	<8.33E3	<3.92±0.93	<3.00E1—2.07E5
Patient chair arm rest*	20	3.19E4	4.50±0.95	3.90E2—8.25E5
Dental tool handles	16	<2.35E2	<2.37±0.97	<3.00E1—3.33E4
Receptionist countertops*	18	6.62E3	3.82±1.00	3.00E1—2.07E5
Bathroom door knob*	12	7.55E3	3.88±0.87	1.20E2—9.38E4
Patient room cabinet handles	11	<2.98E2	<2.47±1.26	<3.00E1—2.12E5
Dentist examination light	9	<5.90E1	<1.77±0.40	<3.00E1—3.75E2
Office phones	7	7.64E4	4.88±0.93	1.70E3—1.30E6
Office door knobs	3	8.28E3	3.93±1.24	3.30E2—7.20E4
Patient room sink faucet	8	<2.49E2	<2.40±1.11	<3.00E1—1.07E5
All Fomite Types#	153	<2.91E3	<3.46±1.26	<3.00E1—1.30E6
	Postintervention (CFU/100 cm^2)			
Keyboard	17	2.27E2	2.36±0.42	3.00E1—8.55E2
Mouse*	13	1.27E2	2.10±0.44	6.00E1—8.70E2
Dentist chair arm rest*	17	<2.33E2	<2.37±0.45	<3.00E1—8.70E2
Patient chair arm rest*	16	<2.21E2	<2.34±0.51	<3.00E1—1.97E3
Dental tool handles	13	<3.37E1	<1.53±0.18	<3.00E1—1.35E2
Receptionist countertops*	18	3.28E2	2.52±0.56	3.00E1—8.40E3
Bathroom door knob*	9	<2.27E2	<2.36±0.75	<3.00E1—3.89E3
Patient room cabinet handles	8	<4.51E1	<1.65±0.29	<3.00E1—1.95E2
Dentist examination light	5	<4.33E1	<1.64±0.22	<3.00E1—7.50E1
Office phones	5	<2.03E2	<2.31±0.53	<3.00E1—7.95E2
Office door knobs	3	3.93E2	2.59±0.33	1.65E2—6.15E2
Patient room sink faucet	8	<2.08E2	<2.32±0.54	<3.00E1—2.10E3
All Fomite Types#	132	<1.60E2	<2.20±0.56	<3.00E1—8.40E3

*Heterotrophic plate counts (HPCs) measured post-disinfection were significantly reduced on the indicated fomites relative to predisinfection levels [Student's t test ($p<0.05$)].
#Overall total culturable heterotrophic bacteria counts were significantly different ($p=0.0002$) on the combined number of fomite types prior to disinfection relative to those measured post-intervention. Surface Disinfectant Wipe Treatment

Materials and Methods

The 10 private practice dental offices selected for the study were located in Arizona (6) and Illinois (4). Each dentistry contained a minimum of two operatories, and two currently in use at the time of the study were selected for the sampling. A combined total of 285 fomite (surface) samples were collected prior to and following the surface disinfection wipe treatment between the hours of 12 p.m. to 3 p.m. on randomly selected patient care days (Monday through Thursday) over a 3-month period. A list of the surfaces evaluated and the number of samples collected per surface type appears in Table I. In order to determine baseline prehygienic intervention enumeration data for HPCs, total coliforms, *E. coli*, and MRSA, approximately 4 square inches (41 cm^2) of each fomite type were swabbed using a sterile Sponge-Stick infused with 10 mL of Letheen Neutralizing Broth by the manufacturer (3M, St. Paul, MN). For the surface disinfection intervention, an area measuring the same dimensions (41 cm^2) and directly adjacent to the preintervention swab area was then disinfected according to manufacturer's instructions using Hydrogen Peroxide Cleaner Disinfectant Wipes (The Clorox Company, Oakland, CA), and held for the recommended one-minute contact time. One disinfectant towelette was used per study fomite, and then disposed of promptly. Upon closure of the contact period, the disinfected area was swabbed to

Table III: Total Coliform Range Values Prior to and Following the Hygienic Intervention Surface Disinfectant Wipe Treatment

Fomite Type (n)	Preintervention (CFU/100 cm^2)*	Postintervention (CFU/100 cm^2)#	% of Positive Samples
Keyboard (33)	1.00E2—>2.42E3	*	52
Mouse (24)	1.00E2—>2.42E3	*	53
Dentist chair arm (39)	1.00E2—>2.42E3	*	76
Patient chair arm (36)	1.00E2—>2.42E3	*	70
Dental tool handles (29)	<3.00E0	*	0
Receptionist countertops (36)	1.00E2—>2.42E3	*	63
Bathroom door knob (21)	3.10E2—>2.42E3	*	50
Patient room cabinet handle (19)	1.00E2—>2.42E3	*	22
Dentist examination light (14)	<3.00E0	*	0
Office phones (12)	1.10E2—>2.42E3	*	64
Office door knobs (6)	1.00E2—>2.42E3	*	67
Patient room sink faucet handle (16)	1.31E3—>2.42E3	*	18

*Range values indicated for samples testing positive; Maximum detectable level (>): 2.42E3 CFU/100cm
* = None detected: values below limit of detection, <3.00E0 CFU/100cm

obtain a postdisinfection sample using a fresh, sterile Sponge-Stick infused with 10 mL of Letheen Neutralizing Broth.

For fomites measuring less than 8 in^2 in surface area, half of the visible surface area was swabbed to obtain baseline bacterial levels. The remaining nonsampled half portion of the fomite was then disinfected by wiping as previously described. Following the one-minute contact time, the disinfected area was swabbed to obtain the posttreatment sample using a fresh, sterile Sponge-Stick infused with 10 mL of Letheen Neutralizing Broth. After sample collection, the Letheen Broth from all control and test swabs was expressed and collected into sterile tubes (average collected volume = 3 mL). Serial dilutions (1:10) of the expressed liquid were performed using physiological saline (0.85% NaCl), and heterotrophic plate count assays were conducted by dilution (10^{-1} thru 10^{-4}) and plating in duplicate onto R2A agarose medium (Difco, Sparks, MD) using the spread plate method. The agar plates were incubated at 30°C for 5 days. Bacterial colonies were enumerated to determine the number of colony-forming units (CFU), and values were mathematically normalized to report CFU per 100 $cm.^2$

Total coliforms and *E. coli* were concurrently assayed using the Colilert-Quantitray system (IDEXX, Westbrook, ME). The Colilert reagent was rehydrated using 99 mL of sterile water, followed by the addition of 1 mL of sample extract from the swabs. Upon thorough mixing and pouring of the contents into Quantitrays, each sample tray was sealed and incubated at 35ºC for 24 hours. The trays were scored by visualizing and counting the large and small wells that demonstrated the positive color-change signal indicating the presence of total coliforms. *E. coli* was detected by exposing each tray to UV light. The large and small wells exhibiting both the positive color-change signal and fluorescence were scored as positive for the bacterium. The number of positive-score wells each for both total coliforms and *E. coli* were then converted to units of Most Probable Number (MPN) using a software calculator provided by IDEXX. Randomly selected samples that tested positive for *E. coli* were confirmed using the API 20E Identification System (BioMerieux, Marcy l'Etoile, France).

Methicillin-resistant *Staphylococcus aureus* (MRSA) was assayed for using the spread plate technique on Tryptic Soy Agar (TSA) amended with 5% sheep blood, 10 mg/L colistin, and 15 mg/L naladixic acid. The agar plates were then incubated at 35°C for 24-48 hours. Colonies demonstrating β-hemolysis (i.e. complete lysing of red blood cells in the zone surrounding the colony) were transferred onto standard unamended TSA plates using the streak isolation method, and incubated at 35°C for 24-48 hours. Successfully isolated β-hemolytic colonies were subjected to a series of tests to confirm traits characteristic of MRSA including Gram staining for G(+) cocci cluster morphology, positive assay results for catalase and coagulase production (both tube and slide for the latter), and antibiotic resistance in the presence of polymixin B. Those colonies presumed as MRSA were then struck onto Methicillin-Resistant *Staphylococcus aureus* (MRSA)-specific CHROMagar (Becton Dickinson, Sparks, MD), a selective and differential medium, for confirmation.

Table IV: *E. coli* Range Values Prior to and Following the Hygienic Intervention Surface Disinfectant Wipe Treatment

Fomite Type (n)	Preintervention (CFU/100 cm^2)*	Postintervention (CFU/100 cm^2)#	% of Positive Samples
Keyboard (33)	<3.00E0—1.20E3	*	4
Mouse (24)	<3.00E0—1.00E2	*	7
Dentist chair arm (39)	3.10E1—>2.42E3	*	76
Patient chair arm (36)	4.00E1—>2.42E3	*	70
Dental tool handles (29)	*	*	0
Receptionist countertops (36)	1.00E2—1.10E3	*	25
Bathroom door knob (21)	2.10E2—>2.42E3	*	25
Patient room cabinet handle (19)	*	*	0
Dentist examination light (14)	*	*	0
Office phones (12)	*	*	0
Office door knobs (6)	*	*	0
Patient room sink faucet handle (16)	*	*	0

*Range values indicated for samples testing positive; Maximum detectable level (>): 2.42E3 CFU/100cm
* = None detected: below limit of detection, <3.00E0 CFU/100cm

Results

The geometric means and range values of HPCs for each fomite type sampled both pre- and posthygienic intervention are shown in Table II. The average number of HPCs per 100 cm^2 ranged from <3.00E1 (i.e. 30) to 1.30E6. The greatest numbers were found on the office phones and the patient chair arm rests. The lowest levels were recovered from the dentist examination light. The geometric average of HPCs recovered from all sites sampled was <2.91E3, as several fomites including the dentist chair arm rests, dental tool handles, cabinet handles, dentist examination lights, and patient room sink faucets yielded HPC bacterial levels below detection during the prehygienic intervention swabbing phase. Following treatment of the fomites with the disinfecting wipe, heterotrophic plate count bacteria levels were reduced by the disinfectant wipes overall to a geometric average of <1.60E2, with a more extensive list of fomites yielding bacterial levels below the limit of detection (30 CFU). The HPC levels measured prior to the intervention were statistically different ($p=0.0002$) compared to the counts observed postdisinfection as determined by the Student's t-test ($p<0.05$). The patient chair arm rests and the office phones, which exhibited the highest preintervention HPC levels observed in the study, also saw reductions of >99% when calculated on a per-fomite-type basis (Figure 1).

In Table III, the ranges of total coliform counts that were measured prior to and following the disinfectant wipe intervention are listed according to the various fomites sampled in the dental offices. The preintervention occurrence of total coliform bacteria ranged from none detected (<3 CFU per 100cm^2) on the dental tool handles and dentist examination light, to greater than the maximum detectable level of 2.42E3 on the arm rests of both the patient and dentist chairs. No coliforms were detected on any of the fomites tested subsequent to the disinfectant wipe intervention. Similar to the coliforms, *E. coli* was most frequently detected on the patient chair arm rests (70%) and dentist chair arm rests (76%) as shown in Table IV. It was also detected on 25% of all bathroom door knob and receptionist countertop samples, as well as on the computer mouse (7%) and computer keyboards (4%). Dental tool handles, patient room cabinet handles, dentist examination lights, office phones, office door knobs and patient room sink faucets yielded no detectable *E. coli* either before or after use of the hydrogen peroxide disinfectant wipes. Overall, and for all surface types evaluated, both total coliforms and *E. coli* were reduced by the disinfectant wipes > 99%. Methicillin-resistant *Staphylococcus aureus* (MRSA) was isolated from one office located in Illinois and from one in Arizona on a total of eight fomites prior to disinfection: one each of a dentist chair arm rest, door knob, keyboard, office phone, in addition to two computer mouse devices and two receptionist counters. No MRSA was isolated following the hygienic intervention disinfectant wipe treatment of these surfaces.

Discussion

Bacteria were found in large numbers on fomites located throughout most of the common areas shared by patients and staff in dental offices. These findings

reflect a lack of (or inadequate) disinfection in these high traffic areas. Cleaning alone is merely designed to remove dirt and grime from surfaces, and can actually facilitate the spread of bacteria and viruses throughout a facility; therefore, the use of disinfectants is key in preventing exposure to pathogens. Guidelines have been suggested for suitable levels of total bacterial numbers in the health care setting,[13] with levels ranging from 250 to 500 CFU per 100 square-cm.[14] These values were exceeded at least once on all fomite types sampled during the current study, with the exception of the dental tool handles and the dentist examination light. These guidelines do not reflect risk of infection, but serve as baseline recommendations to assess the effectiveness of disinfection and cleaning practices. Relative to pre-intervention bacterial levels, the use of disinfecting wipes decreased heterotrophic plate count bacterial numbers significantly ($p=0.0002$). Following the hydrogen peroxide disinfectant wipe hygienic intervention, none of the geometric mean levels calculated for the study fomites tested exceeded 500 CFU cm^2, although two surface types demonstrated mean values greater than 250 CFU cm^2 (receptionist countertops and office doorknobs). Total coliform bacteria were found most frequently on the arm rests of both the dentists' and the patients' chairs (Table III). Although coliforms are commonly found in feces, they may originate from other environmental sources such as certain foods. While their survival time is limited on dry surfaces, they can multiply on cleaning materials such as cotton cloths and sponges, thereby contaminating surfaces during the course of their use.[15]

The *E. coli* findings for the study were similar to those observed for total coliforms in that levels of the former were greatest on the high-frequency hand contact areas of the dentist and patient armchairs. Patients often grip the handles of the armchair during examinations, likely leading to the increased numbers detected on this type of fomite. The presence of *E. coli* indicates the presence of feces, although they may also grow in cleaning materials (e.g. sponges) and be transferred during the wiping of surfaces.[15] *E. coli* also tends to become inactivated on dry surfaces fairly rapidly; therefore, their ability to be readily cultured from fomites likely indicates recent contamination events.

Hands can be inoculated with coliform and *E. coli* bacteria by touching surfaces previously contaminated by other individuals, and then remain contaminated following improper washing during restroom use. In addition, cross-contamination of surfaces may occur when the sponges and cloth towels used to wash areas soiled with these bacteria are then subsequently employed to clean other materials. In a previous study, our research group demonstrated that the proper use of disinfectant cleaners in the home significantly reduces the occurrence of enteric bacteria.[16] More recently, we reported even greater antimicrobial efficacy using disposable disinfecting wipes.[17] The enhanced levels of microbial inactivation using disinfectant towelettes may be attributed to several factors, including the excess liquid that tends to be released by the saturated wipes when used, the willingness of individual users to allow this liquid to dry upon the treated surfaces after wiping (thereby increasing the antimicrobial contact time), and the wiping action itself, which also serves as a mechanism of removal (although the reductions due to wiping alone were not conducted in the current study). As a disinfectant active, hydrogen peroxide is highly oxidative and able to inactivate a broad spectrum of microorganisms including environmentally resistant bacterial spores such as *Clostridium difficile*, as well as enveloped and nonenveloped viruses.[18] This study has demonstrated that the use of disposable hydrogen peroxide towelettes was effective in reducing HPC levels by > 90% for most of the fomites evaluated (Figure 1), while total coliforms, *E. coli*, and MRSA were reduced to undetectable levels.

Although bacteria were found in high numbers prior to the disinfectant wipe hygienic intervention, these levels were likely due to the inadequate disinfection of fomites located throughout the common areas shared by patients and staff. The dental offices sampled in the current study reported adherence to the Centers for Disease Control (CDC) dental health care settings guidelines,[19] which require sterilization procedures for patient care items including instruments and devices depending on their categorization as "critical, semicritical, or non-critical." The CDC also recommends the use of an EPA-registered hospital disinfectant for use on clinical contact surfaces (e.g. light handles, faucet handles, and countertops) and housekeeping surfaces (e.g. floors, walls, and sinks) when contamination is apparent. The dental offices participating in the study specified the use of quaternary ammonium compound-based disinfectant products (QACs) as recommended for the operatories and bathrooms, and a specialized QAC-alcohol formulation for oral patient-care cleaning tools. While many commercially available QACs are designated as broad-spectrum antibacterial agents, their efficacy depends largely on the directions for use indicated by the manufacturer with regard to maintenance of a wetted surface over the course a specified contact time. Nonadherence by dentistry or cleaning personnel to the label directions may have resulted in low levels of microbial reduction on office and operatory fomites. In addition, none of the dental offices surveyed reported regular wiping/cleaning of high-touch fomites including door handles and computer keyboards, with such cleanings conducted on an "as-needed" basis. Use of the same towels for cleaning a variety of surfaces throughout different areas of the dentistry, even when conducted incon-

sistently, may also facilitate cross-contamination via the spread of bacteria and other microorganisms. Therefore, the proper use of disinfectants and cleaning procedures is key in preventing the potential exposure of individuals to pathogens.

Fomites commonly located in the dental office and operatory settings may serve as reservoirs for a variety of bacteria including HPCs, total coliforms, *E. coli*, and pathogens such as MRSA. These bacteria may be transferred from fomite to fomite by human touch, and during cleaning procedures when sponges or rags are used to treat multiple surface types. In order to ensure a hygienic environment that is safe for patients, operatory staff, and office personnel, levels of bacteria and other microorganisms on surfaces should be minimized by effective cleaning and disinfection practices. The use of a broad-spectrum antimicrobial disinfectant towelette, when used according to the manufacturer's instructions, can effectively reduce levels of common environmental bacteria and pathogens present on inanimate surfaces in the dental environment.

Conclusion

The present study examined the effects of a hygienic intervention employing disposable hydrogen peroxide infused towelettes for the disinfection of fomites commonly found in dental offices. The results reveal a statistically significant reduction in HPC levels, as well as a decrease in fecal-associated bacteria and MRSA to levels below the limit of detection on the evaluated fomite surfaces following the disinfectant wipe treatment. It is uncertain what percentage of the reduction was attributed to the mechanical action of wiping alone compared to the bactericidal action of the hydrogen peroxide active ingredient. Therefore, additional research may be warranted in order to further delineate the sources of efficacy demonstrated by broad-spectrum antimicrobial wipes that may be used by dental office personnel for fomite decontamination.

Charles P. Gerba, PhD, is a Professor at the Department of Soil, Water and Environmental Science at The University of Arizona. Gerardo U. Lopez, PhD, is an Assistant Professor at the School of Animal and Comparative Biomedical Sciences at The University of Arizona. Luisa A. Ikner, PhD, is a Postdoctoral Research Associate in the Department of Soil, Water and Environmental Science at The University of Arizona.

Disclaimers/Disclosures: This study was supported in part by a grant to The University of Arizona from The Clorox Company.

Funding Sources for the Project: The Clorox Company.

Acknowledgments

We wish to thank Ms. Sherri Carlino and Mr. Raj Lodhia for assistance in the conduct of this project.

References

1. Gerba CP, Pepper IL. Domestic and indoor microbiology. In: Environmental Microbiology. 3rd ed. New York, NY. John Wiley Publishing. 2015. p. 665-675.

2. Lopez GU, Gerba CP, Tamimi AH, et al. Transfer efficiency of bacteria and viruses from porous and nonporous fomites to fingers under different relative humidity conditions. Appl Environ Microbiol. 2013;79:5728-5734.

3. Rusin P, Maxwell S, Gerba CP. Comparative surface-to-hand and fingertip-to-mouth transfer efficiency of gram-positive bacteria, gram-negative bacteria, and phage. J Appl Microbiol. 2002;93(4):582-592.

4. Kurita H, Kurashina A, Honda T. Nosocomical transmission of methicillin-resistant Staphylococcus aureus via the surfaces of the dental operatory. Brit Dental J. 2006;201(5):297-300.

5. Bernardo WL, Boriollo MF, Goncalves RB et al. 2005. Staphylococcus aureus ampicillin-resistant from the odontological clinic environment. Rev Inst Med Trop Sao Paolo. 2005;47(1):19-24.

6. Williams HN, Sigh R, Romberg E. Surface contamination in the dental operatory: a comparison over two decades. J Am Dent Assoc. 2003;134(3):325-330.

7. Boyce JM. Environmental contamination makes an important contribution to hospital infection. J Hosp Infect. 2007;65(S2):50-54.

8. Leggat PA and Kedjarune U. Bacterial aerosols in the dental clinic: a review. Intl Dent J. 2001;51:39-44.

9. Lopes Motta RH, Groppo FC, Cassia Bergamaschi C, et al. Isolation and antimicrobial resistance of Staphylococcus aureus isolates in a dental clinical environment. Infect Cont Hosp Epidem. 2007;28(2):185-190.

10. Cássia Negrini T, Duque C, Mascarenhas de Oliveira AC, et al. Staphylococcus aureus contamination in a pediatric dental clinic. J Clin Ped Dent. 2009;34(1):13-18.

11. Zimmerli M, Widmer AF, Dangel M, et al. Methicillin-resistant Staphylococcus aureus (MRSA)

among dental patients: a problem for infection control in dentistry? Clin Oral Inves. 2009;13(4):369-373.

12. Reynolds KA, Watt PM, Boone SA, et al. Occurrence of bacteria and biochemical markers on public surfaces public surfaces. Intl J Environ Hlth. Res. 2005;15(3):225-234.

13. Lewis T, Griffth C, Gallo M, et al. A modified ATP benchmark for evaluating the cleaning of some hospital environmental surfaces. J Hospital Infect. 2008;69(2):156-163.

14. Dancer, SJ. How do we assess hospital cleaning? A proposal for microbiological standards for surface hygiene in hospitals. J Hospital Infect. 2004;56(1):10-15.

15. Enriquez C, Enriquez-Gordillo ER, Kennedy DI, et al. Bacteriologic survey of used cellulose sponges and cotton dishcloths from domestic kitchens. Dairy, Food Environ Sanitation. 1997;17:20-24.

16. Rusin P, Orosz-Coughlin P, Gerba CP. Reduction of faecal coliform, coliform and heterotrophic plate count bacteria in the household kitchen and bathroom by disinfection with hypochlorite cleaners. J Appl Microbiol. 1998;85(5):819-828.

17. Gerba, CP, Maxwell S, Sifuentes LY et al. Impact of a disinfecting wipe on bacterial contamination in households. Household Person Care. 2013;8(3):24-26.

18. Linley E, Denyer SP, McDonnell G et al. Use of hydrogen peroxide as a biocide: new considerations of its mechanisms of biocidal action. J Antimicrob Chemother. 2012;67(7):1589-1596.

19. Kohn WG, Collins A, Cleveland JL et al. Guidelines for infection control in dental healthcare settings. Morbidity and mortality weekly report: MMWR. 2003; 52(RR17):1-61. Center for Disease Control.

Program Evaluation of a Distance Master's Degree Dental Hygiene Program: A Program Effectiveness Study

Cynthia F. Sensabaugh, RDH, MS; Tanya Villalpando Mitchell, RDH, MS; Pamela R. Overman, MS, EdD; Christopher J. Van Ness, PhD; Cynthia C. Gadbury-Amyot, MSDH, EdD

Abstract

Purpose: The purpose of this study was to conduct a program evaluation of the University of Missouri-Kansas City Master of Science in Dental Hygiene Education Program (MSDH). This evaluation examined long-term outcomes in the context of stakeholders (the profession, the student, and the degree-granting institution).

Methods: A mixed-methods approach was used to gather data from the 28 graduates from the MSDH program. An electronic questionnaire included both open- and closed-ended questions including demographic and practice data, and data related to alumni preparedness to reach their career goals. Virtual focus groups provided valuable insight into whether the program has achieved its goals, and prepared the graduates to meet their program competencies and future goals.

Results: Out of a total of 28 individuals who have successfully completed the distance program (2001-2011), 19 participated in an online survey (67.8%). The majority of the participants (73.7%) participated in one of 3 focus groups. Sixty-three percent of the graduates are currently employed in dental hygiene education. Eighty-four percent of the respondents have published their research conducted while in the program, thereby contributing to the dental hygiene body of knowledge. Sixty-eight percent indicated that had the distance option not existed, they would not have been able to obtain their advanced degree in dental hygiene. Twenty-one percent of the respondents report either being currently enrolled in a doctoral program, or having completed a doctoral degree.

Conclusion: These results suggest that the University of Missouri-Kansas City Master of Science in Dental Hygiene Education Program is meeting its goals from the perspective of all stakeholders and providing its graduates with access to education and educational resources to meet the program competencies and ultimately achieve their career goals.

Keywords: access to care, alternative practice, dental hygiene education/curriculum, e-learning technology, faculty development, qualitative research

This study supports the NDHRA priority research area, **Professional Education and Development,** in the discovery phase of research.

Introduction

Status of Dental Hygiene Education

A master's degree in dental hygiene education seeks to prepare dental hygienists for careers in education as well as alternative career paths. In the late 1990s there were 260 entry-level dental hygiene programs.[1] Currently there are 335 entry-level dental hygiene programs. With this growth in the number of programs, there is an increased need for dental hygiene educators. According to the 2014 American Dental Hygienists' Association (ADHA) Dental Hygiene Education Program Directors Survey,[2] the number of master's degree programs in dental hygiene, dental hygiene education, or a related field grew from 11 programs in the early 2000s to 21 programs in 2014; a 91% increase in MS programs versus a decade ago, with 16 of the programs (76%) offering all or some of their curriculums in a distance format. Of the 335 entry-level dental hygiene programs in 2014, 288 offered an associate's degree, the most commonly attained level of education, which prepares graduates for the clinical practice of dental hygiene. Building on this existing framework for dental hygiene education, distance education is appropriate for degree completion and graduate programs.

In addition to preparing dental hygienists for faculty positions, advanced education also serves to prepare clinicians for mid-level clinical positions, ad-

ministrative roles in education, corporate positions, and careers in research. Although there were a fair number of graduate programs that were geographically dispersed, barriers still existed. Cost, time, and family commitments preventing potential students from moving to the program location were some of the reported major barriers to dental hygienists seeking to advance their education.[3]

Dental Hygiene Faculty Shortage Predicament

The issue of faculty shortage remains a critical issue in dental hygiene. In 2003, the American Dental Education Association (ADEA) Board of Directors created a task force to investigate the current status of allied health faculty. They surveyed all dental hygiene program directors and found their concerns were related to a greater future shortage for the dental hygiene discipline due to the imminent retirement of current faculty members.[4] Of those responding, 47% reported that they require a master's degree for a full-time faculty appointment.

Following publication of the 2004 ADEA survey report, several articles also supported that a shortage of dental and allied dental educators exists.[5,6,7,8,9] To address the dental hygiene educator shortage, a recurring recommendation has been to increase the number of baccalaureate and graduate programs in dental hygiene.[6]

The 2006 Dental Hygiene Education Program Director Survey found that program directors of master's degree programs reported more than three quarters of their current graduate students were interested in teaching dental hygiene upon completion of their graduate education. Future dental hygiene faculty comes, in large part, from the graduate programs. Therefore, distance graduate programs can be a viable option to address the faculty shortage issue, as they overcome some of the barriers to advanced education by providing access to any dental hygienist pursuing further education in preparation for alternative careers.

The University of Missouri-Kansas City Master of Science in Dental Hygiene Education Program started in 2001, was the first program in the country to offer an online master's degree curriculum.[10,11] At the initiation of the online program, University of Missouri-Kansas City Master of Science in Dental Hygiene Education Program had a 30-year history of offering a traditional, or face-to-face (F2F), graduate program. In determining the model of distance education that would be adopted to replace the traditional F2F program, the goal was to provide students with the same educational experience in terms of quality that the F2F students had experienced through the years. Hence, an innovative delivery system utilizing a hybrid (blended) model was adopted, with online courses and F2F delivery/on-campus experiences. The coursework is accomplished using both asynchronous and synchronous technology. The F2F components involve students coming to campus to participate in an initial orientation as they begin their studies, as well as potential additional onsite visits if needed to bring their research projects to completion. A full description of the model used for the delivery of the MSDH program is found in Gadbury-Amyot et al. 2007.[11] Since the inception of the program, all courses delivered through the MSDH program are taught online by full-time tenured faculty.[10] The program has always required its students to conduct an original research project as part of the students' graduation requirements, and this requirement has not changed with the conversion to a distance program. It is of note that the online graduate program was created without additional resources, including no release time or additional compensation to faculty who develop and implement the online courses.[12]

Addressing the Faculty Shortage Predicament

Although there are plenty of studies to demonstrate positive student learning outcomes in distance education, program effectiveness, and equivalence to traditional educational methods, there are few studies to demonstrate that programs are addressing the issues they were designed to address. For instance, many of the distance education programs in dental hygiene were established to provide access to advanced education in response to demand for dental hygiene faculty members, to address the oral health needs of the nation, and to meet the needs for expanded dental hygiene research.[13] In addition to access, Kansas City Dental Hygiene Education distance programs (degree completion and graduate) were initiated to increase enrollment, to increase student convenience, and to increase service to adult learners.[10]

The distance education program was designed to be of equivalent quality to the traditional program, and the goal was to educate dental hygiene educators, researchers, and dental hygienists prepared to assume alternative careers. Converting to a distance program made that education more accessible to many dental hygienists seeking an advanced degree from a highly regarded dental hygiene program.

University of Missouri-Kansas City Master of Science in Dental Hygiene Education Program Effectiveness

This study was designed to explore program effectiveness of the first distance graduate dental hygiene program in the United States via program evalua-

tion using a mixed-methods design. Program evaluation has been defined by Chen[14] as the application of evaluation approaches, techniques, and knowledge to systematically assess and improve the planning, implementation, and effectiveness of programs. In the end, program evaluation should produce useful information that can be used to improve the program.

According to Chen[14] there are 4 stages of a program's growth, and each stage has different program evaluation requirements. The stages are as follows: 1) Program Planning Stage, 2) Initial Implementation Stage, 3) Mature Implementation Stage, and 4) Outcome Stage. In its 14th year of delivering the program via a distance education hybrid model, the MSDH program lies in the Outcome Stage. Following a period of program maturity, stakeholders both inside and outside the program want to know whether or not the program is achieving its goals. Chen notes that evaluation at this point can serve any of the five primary evaluation needs: 1) stakeholders may want to know if the program is ready for outcomes evaluation, 2) stakeholders may want to monitor progress, 3) stakeholders may ask for information on what the program would be achieving if it existed in the ideal environment, 4) stakeholders may seek to know in detail the program's effects in its real-world setting, or 5) stakeholders may want an evaluation that serves both accountability and program improvement needs. It is the fifth purpose that this study will be focused on, and, in accordance with Chen, the conceptual framework for this study is effectiveness program evaluation. Chen states that at the very least effectiveness evaluation must involve collection of data about intervention and outcomes.

Purpose

With more than 10 years of historical data, a retrospective look at the program was utilized to determine if this program is achieving its goals, which may be found at http://dentistry.umkc.edu/Future_Students/DHMasterScience.shtml#mission. An effectiveness evaluation was conducted to help determine how this program is performing and if it is providing educational access to dental hygienists looking to advance their education. The research questions guiding this program evaluation include:

- Is the MSDH program achieving its goals in the following areas?
- Addressing faculty shortage
- Preparing students for alternative careers, research, and lifelong learning
- Did this program increase access for students to earn advanced degrees in dental hygiene to meet their career goals?
- Did the program provide appropriate resources for students to reach established program competencies to meet their goals?
- Based on feedback from various stakeholders, what are the recommendations for the future for the MSDH program?

Methods and Materials

This study design included a combination of quantitative and qualitative research methods as suggested by Chen with the intent that using mixed-methods would enhance the validity of the study and provide deeper insights into program effectiveness.[14] Further, this is in line with Chen's recommendation that program evaluation follow scientific principles in order to lend credibility to the findings.[14] The program evaluation research project was approved by the AHSIRB at the University of Missouri-Kansas City (#13891).

Sample

Since the conversion from a traditional F2F to a distance program, the MSDH program accepted 45 students between 2001 and 2011. At the time of the start of this study, 28 have completed their degrees. The U.S. Department of Education's Integrated Postsecondary Education Data System (IPEDS) reports graduation rates based on full-time students who are first-time college attendees. While this is the most recognized measure of the graduation rate in use today, these criteria are not inclusive of adult learners who are returning to education. To address this shortcoming, Transparency by Design (TBD) has created student cohorts that include "full-time and part-time degree-seeking students entering the institution or the degree level for the first time" and "do not exclude students who are part-time or have transferred into the institution."[15] The Transparency by Design initiative is a "collaborative collection of regionally-accredited, adult-serving, distance education institutions with a mission to help adult learners become informed consumers of distance education."[15]

Like many of the TBD institutions, the student population in the MSDH program does not reflect the undergraduate student population captured in the U.S. Department of Education's IPEDS reports. Because of the MSDH program's purposeful design, students enrolled are, in most instances, part-time students wishing to take courses in the evening while they continue to work full-time during the day. The methodology used to determine the study population for this study is based on the Transparency by De-

Table I: Learner Completion Metrics

Enrolled (2001-2011)	Completed Degree	Noncompleters (learners returning to institution from their first year of enrollment to second year of enrollment)*	Noncompleters (students withdrawing from the institution within the first year of the program)*
45	28	6	5

* Based on Learner Progress Methodology: Transparency by Design. Available at http://wcet.wiche.edu/advance/transparency-by-design [Accessed 10 Apr 2015].

sign Learner Progress Methodology[15] metrics, which consist of Learner Retention and Learner Completion. Learner Retention is the percentage of students who remain enrolled or completed a degree after one year in the program. There are two categories of noncompleters: 1) those who drop out before the end of the first year in the program and 2) those who return to the institution from their first year of enrollment to second year of enrollment and drop out after that time.

Out of the 45 students accepted and enrolled in the MSDH program, 5 noncompleters dropped out before the end of the first year in the program. Following the methodology set forth by TBD, these 5 students are excluded from the total count of students enrolled. There were 6 students who progressed into the second year but did not earn their degree, resulting in an overall dropout rate of 15% (6/40). According to the U.S. Department of Education, of the students who had enrolled in a graduate degree program between 1993 and 2003, 60% earned their master's degree.[16] Using the TBD methodology as described above, the MSDH program completion rates (85%) far exceed those reported by the U.S. Department of Education.

Of the remaining 34 students, 28 have graduated from the program (Table I). Six students from the 34 were enrolled at the time the research proposal was submitted to the IRB and therefore were not included in the study. The remaining 28 graduates were contacted via email, utilizing the most recent email addresses from the Division of Dental Hygiene. Of the 28 graduates' email addresses, 26 were valid email addresses. Attempts were made to locate the 2 graduates for which no valid email address were available, without success.

Instrument/Data Collection—Quantitative

The quantitative data collection instrument was an electronic questionnaire (SurveyMonkey) utilized to capture demographic data, practice data, and data related to competencies and preparedness to reach career goals, which are directly related to the research questions. Additionally, the questionnaire incorporated questions aimed at seeking participants' opinions on goals and strategies for the program moving forward. Effective program evaluation is most useful when stakeholders understand what is working and what is not working well. The questionnaire was designed to capture the graduate's opinions to be able to address problems and improve the program. Content validity was established through the combined efforts of the coauthors, who collectively have more than 75 years of experience in dental hygiene education, and who have extensive involvement with the online MSDH program and the senior author who conceptualized and developed the online MSDH program. The questionnaire was pilot tested using 10 graduates of the program prior to 2001, and revisions were made based on feedback for the purpose of providing better clarity.

Along with the invitation to participate in the program evaluation research, a cover letter and an informed statement for participation were included. Graduates willing to participate agreed to the terms stated in the Informed Statement. After agreement to participate was attained, a link to the questionnaire was sent in an email to study participants. The questionnaire was accessible between July 1 and July 31, 2014. In the cover letter, the graduates were informed that participation in program evaluation was voluntary and that overall research project consisted of two elements of data collection: electronic questionnaire and focus groups using an online secure meeting room. Participants who agreed to participate in the electronic questionnaire were also asked to participate in the focus groups. To minimize bias in responses, participants were not compensated for their participation in either element of data collection.

Instrument/Data Collection—Qualitative

For the qualitative element of data collection 3 focus group interview sessions were conducted between August 11 and September 12, 2014. Focus groups help to provide a deeper understanding of the topic and give insights into how people think, while allowing for group interaction. According to Barnett[17] focus groups are used for program evaluation because focus group interviews can provide valuable insight into whether a program has achieved its goals. The focus group addressed how the program has achieved its goals, building on the questionnaire results addressing whether it achieved them. This holistic approach[14] helps in understanding the rel-

Table II: Demographic Data

	Total Respondents	Number	Valid Percent
Age	n=19		
31-40		4	21.1%
41-50		2	10.5%
Over 50		13	68.4%
Gender	n=19		
Female		19	100%
Ethnicity	n=19		
Caucasian		16	84.2%
Black/African-American		1	5.3%
Hispanic		1	5.3%
Native American/Alaska Native		1	5.3%
Practice Setting Prior to Enrollment*	n=19		
Private Practice Dental Hygienist		14	46.7%
Dental Hygiene Educator in the Clinic		5	16.7%
Dental Hygiene Educator in Clinic and Classroom		4	13.3%
Community/Public Health Clinical Practice		1	3.3%
Administrator in a Dental Hygiene Program		1	3.3%
Researcher		1	3.3%
Other		4	13.3%
Change in Practice Setting Since Graduation	n=19		
Yes		11	57.9%
No		8	42.1%
Had the University of Missouri-Kansas City Master of Science in Dental Hygiene Education Program Distance Option Not Existed Would You Have Been Able to Complete Your Degree?	n=19		
No		13	68.4%
Yes		5	26.3%
No response	(not sure)	1	5.3%
Characteristics for Selecting University of Missouri-Kansas City Master of Science in Dental Hygiene Education Program+	n=19		
No Need to Relocate		18	94.7%
Could Maintain Current Work Position		16	84.2%
Online Curriculum Provider		15	78.9%
National Reputation		13	68.4%
In-State Tuition		13	68.4%
Faculty Reputation		12	63.2%
Synchronous Delivery		8	42.1%
Alumni Recommendation		4	21.1%
Research Requirement		4	21.1%
If Dental Hygiene Education Was a Goal of Yours Following Your Graduation, Have You Been Able to Realize That Goal?	19		
Yes		12	63.2%
No		4	21%
DH Education Was Not a Goal		3	15.8%

*Total >19 due to multiple responses

evance of the program.

Three focus group sessions were conducted with 4-8 participants per group. Graduates of the distance program, already familiar with virtual meetings as the method of synchronous learning, were invited to participate in one of the focus group sessions using Blackboard Collaborate Classroom. Each participant could choose from one of the 3 offered sessions choosing the one that best fit their schedules. The 3 sessions were recorded and archived. Recordings were transcribed for analysis.

Each focus group session was structured around predetermined open-ended questions to encourage discussion. The focus group questions consisted of 3 distinct types: *engagement questions* to make participants comfortable discussing their opinions, *exploration questions* to help get to the core of discussion, and *exit questions* to check to make sure that nothing was missed in the discussion.[18]

Statistical Analysis

Data analysis utilized descriptive statistics including frequency distributions, central tendency, measures of variability, and association. The results were entered in SPSS version 22. Analysis of focus group transcripts followed principles of thematic analysis.[19,20] Thematic analysis is conventionally used in qualitative research to search through data to identify recurrent themes.

Results

Quantitative

Of the 28 graduates of the MSDH program, 19 completed the questionnaire, yielding a 67% response rate. Demographic data are provided in Table II, along with data regarding practice setting, goals, and reasons for selecting the MSDH program. Participants were exclusively female, a majority Caucasian (84%), and over the age of 50 years old (68%). The most dominant practice setting prior to enrollment was private practice (47%), followed by dental hygiene clinical instructor. Approximately 58% reported a change in practice setting following graduation from the MSDH program. When asked if they could have obtained their master's degree without the MSDH distance option, 68% said no. When asked to identify reasons for selecting the MSDH program, several of the choices centered around advantages to online education: did not require relocation (95%), they could maintain their current work position (84%), and a preference for the synchronous delivery model (42%). Other characteristics identified were related to the reputation of the program: national reputation (68%), and faculty reputation (63%). Alumni recommendation and the fact that there was a research requirement were identified by 21%, respectively.

To address the first research question, whether the MSDH program is achieving its goals of addressing faculty shortages and preparing students for alternative careers, the questionnaire captured practice settings before and following graduation. A majority of respondents (16/19 or 84%) shared a goal of becoming a dental hygiene educator as a reason for furthering their education. When asked if they have been able to realize that goal, 12 (63%) indicated their graduation helped them to realize that goal. Four respondents (21%) indicated that their graduation did not help them realize their goal, but did not comment as to why it did not.

When asked if graduation from the MSDH program was instrumental in the attainment of their current position, 12/19 (63%) responded affirmatively, 6/19 (32%) indicated it was not, and 1/19 (5%) did not answer but noted she moved from manager to director while attending University of Missouri-Kansas City Master of Science in Dental Hygiene Education Program. Four have transitioned from clinical practice or a combination of clinical practice and part-time education positions to full-time employment as dental hygiene educators. Three have moved to full-time education administrations positions. In addition to dental hygiene education, the program also prepares graduates for alternative careers. The sample included 3 dental hygienists with positions in corporate, public health, and professional association management. Given the above results, it would appear that the program is addressing faculty shortages in dental hygiene education, in addition to preparing dental hygienists for alternative career settings beyond traditional clinical dental hygiene.

Research question two addressed the issue of whether online delivery of the graduate program increased access for students to earn advanced degrees in dental hygiene to meet their career goals. The majority of respondents (13/19 or 68%) indicated that had the University of Missouri-Kansas City Master of Science in Dental Hygiene Education Program distance option not existed, they would not have been able to complete their degree. Therefore, the data support the conclusion that the program is meeting its goal to provide access to students to earn an advanced degree in dental hygiene to meet their career goals through the online hybrid delivery model.

Research question three addressed whether or not participants perceived that the program provided appropriate resources for students to achieve the program competencies. Fourteen respondents (73.7%) indicated that the program had provided them with the necessary resources and educational experiences to achieve the 6 program competencies. In those instances, of the remaining 3 respondents, they indicated that they believed they came into the program already possessing some of the program competencies. Communicating was the one competency that all felt the program helped them achieve. These results indicate that the MSDH program is providing the curricular and educational experiences that assist students in meeting required program competencies.

One of the overarching, capstone goals of the MSDH program is the conduct of original research and preparation of a manuscript for submission to a refereed journal. Sixteen (84%) of the respondents have published their research, and two have submitted and are waiting notification.

Pursuing higher education is an aspect of lifelong learning, one of the goals of the MSDH program. To date 4/19 (21%) of the respondents are either currently enrolled in, or have completed, a doctoral program. Eleven reported that they have considered en-

rolling with barriers such as cost and time identified.

The fourth research question sought recommendations from the program evaluation participants for the future for the MSDH program. Some of the strengths identified include: 1) quality of the faculty, 2) quality of the distance platform and distance education model, 3) flexibility, 4) strong curriculum, and 5) opportunities for financial assistance. Areas identified by the respondents as needing further consideration by the program include: 1) the length of the program (time to complete degree), 2) not all courses available as distance courses through University of Missouri-Kansas City Master of Science in Dental Hygiene Education Program (viewed as a disadvantage, as other courses were not consistently strong or of the level students expected given their experiences with the MSDH program course work), and 3) challenges of student teaching at other institutions in order to meet program requirements.

A major theme for weakness was also considered a strength: the research component. The research process, while valuable, was lengthy. Completing the thesis was frustrating, and there were delays due to waiting for feedback and processes (survey distribution). Two respondents commented that the faculty had too much responsibility.

Two graduates commented, under the weakness question, that they thought it would be better to be closer, to have more face-to-face time with faculty and to be more exposed to the University of Missouri-Kansas City Master of Science in Dental Hygiene Education Program environment. Interestingly, both students indicated a distance program made it possible to get their MSDH degree.

Qualitative

Using thematic analysis, four key themes emerged: career advancement, distance education vital to advancing education, support from faculty, and unique characteristics of the MSDH program. The first theme of career advancement is best captured by the following comments:

"Almost as soon as I got my diploma I had a full time job teaching in the program."

"I'm doing the thing that I had hoped I would be able to do, which is to teach full time."

A second theme that emerged was regarding how distance delivery of education made advancing one's education possible. The following comments illustrate this point:

"I would have a master's in education but not in dental hygiene which has been truly a better fit for what I'm doing. So it's really made a difference in allowing me to do what I'm doing today."

"…had it not been there, I would not have had the opportunity to have pursued that degree in that field without moving and changing my whole life."

A third theme emerged around appreciation for the faculty mentorship in the program. Mentorship and support provided by the faculty was, largely, a positive impression for the graduates.

"...the faculty, the professors were role models. They were phenomenal."

"I just always felt like they (the faculty) had my back. They were willing to make the program work for what I need…I'm very thankful for their support."

The fourth and final theme that emerged was related to characteristics unique to this particular graduate dental hygiene program. Participants noted that not all graduate dental hygiene programs are as flexible and also require students to conduct original research.

"It was really unique to meet your needs and to help you grow to get to your maximum capacity."

"In my opinion, I think it kind of surpasses the other programs. And let me justify my answer. I think it's because of the research requirements and the different resources you have available."

"One of the things that I really thought was an unbelievable experience was the portfolio…making me more of a reflective type of individual, an educator as well. And I hope I bring that to my students as well."

Table III provides additional insight into the 4 themes gleaned from the qualitative data.

Discussion

Current issues facing the dental hygiene profession are the lack of qualified faculty to teach in dental hygiene programs and preparedness of dental hygienists to take on alternative careers, such as researchers and mid-level providers. To address these issues the University of Missouri-Kansas City Master of Science in Dental Hygiene Education Program was the first MSDH program to move to an online format in 2001, chiefly to provide access for dental hygienists seeking advanced degrees to teach in dental hygiene programs or take on other alternative roles within the profession.

This program evaluation was conducted to determine if program outcomes are consistent with the goals of the program and to produce useful infor-

mation to improve the program.[14] The investigation provides evidence that the MSDH program in the outcomes stage is achieving its goals, specifically for three distinct stakeholder groups: the profession, the graduates, and the university.

Stakeholder: The Profession

A shortage of dental hygiene faculty has been well documented since 2004[5-9] with the recommendation to increase the number of baccalaureate and graduate programs in dental hygiene as one solution.[6] The majority of students entering the MSDH program have a career goal of dental hygiene education. The results of this study provide evidence that the program is preparing students for those roles, and, as a result, is helping to address the faculty shortage.

A theoretical body of knowledge is a commonly accepted characteristic of any discipline.[21] Although the research component of the program is one of the more difficult aspects according to graduates, it is still considered a strength of the program. The process of conducting original research and writing and submitting a scholarly manuscript for publication not only prepares graduates for education positions, but the publication requirement also serves to build the body of knowledge by contributing published research related to the field of dental hygiene.

Stakeholder: The Students/Graduates

The MSDH program evaluation resulted in positive outcomes when it comes to the students/graduates as stakeholders. First, the distance option provided access for students to attain their graduate degree in dental hygiene. Had it not been for MSDH program, students would have continued their studies in other areas such as public health or education at either local or other institutions with distance options. The program offered the majority of graduates in the study access to the degree most appropriate for their career goals. Additionally, the flexibility of the program worked well considering that all the students were nontraditional and employed during the course of their studies. Satisfaction with the distance program compared to that in published literature, including positive comments on the learning environment, interaction with peers, and interaction with faculty.[22]

The experience of conducting original research is extremely valuable and is a characteristic highly sought after in education, including a requirement for tenure. Anecdotally, the program has been told that it was because of the rigor of the research process that graduates felt confident in their ability to advance their education. Program evaluation outcomes provide us with hard data that 21% of the respondents reported being enrolled or having completed a doctoral degree, with 58% indicating that they have considered advancing their degrees.

Challenges with distance programs are consistent with published data in that identifying sites for clinical experience/teaching may be difficult.[22] While the length of the program, or the pipeline from entry to graduation, was noted by students as an area for further study and consideration, it must be acknowledged that the vast majority of students enrolling in the program continue to work full-time jobs while attending school part-time. This is naturally going to extend that pipeline, and program data show that to be the case with the average time from entry to completion being 4.52 years with a standard deviation of 1.67.

Stakeholder: The University

The issue of student retention in higher education has been examined extensively. The U.S. Department of Education data show graduation rates of 60%.[16] Outcomes from this program evaluation show an 85% retention rate, critical outcomes to be able to show in the current higher education environment. However, even with these types of retention data, the program remains under a microscope due to a low number of graduates. In 2011 the Missouri Department of Higher Education staff accepted the justifications provided by University of Missouri-Kansas City Master of Science in Dental Hygiene Education Program graduate studies for continuing including student demand, shared courses/faculty, and unique need.

Recommendations for Improvement and Strategies for Addressing Identified Areas of Need

The student participants identified that although the required research component was a strength of the program, additional resources are needed to assist students. During the conduct of this study, the University of Missouri-Kansas City's School of Graduate Studies launched a Writing Resources for Graduate Students website (http://sgs.X.edu/current-students/graduate-writing-resources/). This online resource is available 24/7, providing the foundation for graduate writing resources and development opportunities. Additionally, University of Missouri-Kansas City Online has contracted with a 24/7 tutoring service called Net Tutor that can help provide writing assistance for students.

Another issue identified by graduates is that not all required classes are available at the University of Missouri-Kansas City in an online format, requiring the director and students to seek out courses from other institutions. Students reported that in many instances courses taken at other institutions are not

at the quality of the coursework offered through the University of Missouri-Kansas City Dental Hygiene program. The university has recognized this and has been working to bring additional courses online. In 2013, an Associate Vice-Provost of Online Education was hired. This demonstrates that the university has identified this as an opportunity and is investing in resources to improve its online course offerings. Additionally, the University of Missouri-Kansas City has created an online website, http://info.X.edu/online/, to highlight distance education options and resources.

Limitations and Future Research Suggestions

Limitations to this study include the fact that it was restricted to one graduate dental hygiene program in one dental school and therefore the results may not be generalized. However, because this was the first MSDH Education program to deliver an online curriculum, longitudinal data (2001-2011) were available for this type of analysis. So while this study is not generalizable, the authors believe it can be instructive for other graduate dental hygiene programs in conducting program evaluations, regardless of the delivery modality.

Future research could include examination of external stakeholders, such as dental hygiene program directors and other employers, to determine if the program is meeting their needs by providing well-qualified dental hygiene graduates for the workforce. Another area for future research as suggested by Chen for programs that have had time to mature, is to examine what the program would be achieving if it existed in an ideal environment. As noted earlier, the transition of the graduate program from F2F to online was accomplished in the absence of any additional resources, including additional faculty.

In 2012 the MSDH program modified the competencies to align with the recommendations for graduate dental hygiene (DH) program competencies published by ADEA, working in collaboration with the ADHA. The development of the core competencies reflects current trends in the profession and the educational and health care system needs of the future. Further research could investigate whether the change to the competencies have addressed ADEA's intent.[23]

Conclusion

Through the use of theory, and following the concepts suggested in the literature for program evaluation, this study might serve as an example of how to design and conduct a comprehensive program evaluation for educational programs in the outcomes stage.

Based on the results of this program effectiveness study, the outcomes support that the MSDH program is meeting its goals. The suggestions for strengthening the program provide valuable insight to the educational institution and should be utilized for continuous improvement.

Cynthia Sensabaugh, RDH, MS, is the Senior Manager of Professional Education and Academic Relations for Philips Oral Healthcare. Tanya Villalpando Mitchell, RDH, MS, is an Associate Professor and Director of Graduate Studies at the University of Missouri-Kansas City School of Dentistry, Division of Dental Hygiene. Pamela Overman, MS, EdD., is the Associate Dean for Academic Affairs at the University of Missouri-Kansas City School of Dentistry. Christopher J. Van Ness, PhD, is a Research Assistant Professor and Director of Assessment at the University of Missouri-Kansas City School of Dentistry. Cynthia C. Gadbury-Amyot, MSDH, EdD, is Associate Dean and Professor of Instructional Technology and Faculty Development at the University of Missouri-Kansas City School of Dentistry.

Acknowledgments

The authors would like to thank Nancy Keselyak, RDH, MA for her contributions to this research and the University of Missouri-Kansas City Research Support Committee for their generous financial support to this research.

References

1. American Dental Association. Survey of Allied Dental Education, 1997-98. Chicago: American Dental Association; 1998.

2. American Dental Hygienists Association (ADHA) 2012 Dental Hygiene Education Program Director Survey, 2014, ADHA (unofficial) [Internet]. [cited 2015 January 15]. Available at: http://www.adha.org/resourcesdocs/72611_Dental_Hygiene_Education_Fact_Sheet.pdf

3. Newell K, Stoltenberg J, Osborn J, Peterson M. Dental hygiene student interest in advanced education. J Dent Hyg. 1989;63(6):276-82.

4. Nunn et al. The current status of allied dental faculty: a survey report. J Dent Educ. 2004;68(3):329-344.

5. Coplen A, Klausner C, Taichman L. Status of current dental hygiene faculty and perceptions of important qualifications for future faculty. J Dent Hyg. 2011;85(1):57-66.

6. Collins MA, Zinskie CD, Keskula DR, Thompson AL. Characteristics of full-time faculty in bacca-

laureate dental hygiene programs and their perceptions of the academic work environment. J Dent Educ. 2007;71(11):1385-1402.

7. Carr E. Ennis R. Baus L. The dental_hygiene faculty shortage: causes, solutions and recruitment tactics. [Review]. J Dent Hyg. [Internet] 2010;84(4):165-9. [cited 2012 Jul 19]. Available at: http://search.proquest.com/docview/866443006?accountid=14589.

8. Gadbury-Amyot C, Singh A, Overman P. Teaching with technology: learning outcomes for a combined dental and dental hygiene online hybrid oral histology course. J Dent Educ. 2013;77:732-743.

9. Mitchell TL, Lavigne SE. A survey of Canadian dental hygiene faculty needs and credentials. J Dent Educ. 2005;69(8):879-889.

10. Mitchell T, Gadbury-Amyot C, Simmer-Beck M. Advanced degree seeking Students' satisfaction with online courses at UMKC – an early investigation. J Dent Hyg. 2007;81(3)e1-e8.

11. Gadbury-Amyot C, Fried JL, Ernest Syme SL. Technology in teaching and online (distance) learning: two model programs. Access. 2007;21(7):10-17.

12. Bray K, Gadbury-Amyot C, Mitchell T. Providing advanced degrees in dental hygiene via computer mediated distance learning: a model program. J Contemp Dent Pract. [Internet]. 2006 [cited 2012 Jul 2]: 7(5):e1-e10. Available from: http://www.jaypeejournals.com/eJournals/ShowText.aspx?ID=1730&Type=FREE&TYP=TOP&IN=_eJournals/images/JPL OGO.gif&IID=149&Value=24&isPDF=YES

13. Gwozdek A, Springfield E, Peet M, Kerschbaum W. Using online program development to foster curricular change and innovation. J Dent Educ. 2011;75(3):339-350.

14. Chen, H. T. (2005a). Practical program evaluation: Assessing and improving planning, implementation, and effectiveness. Thousand Oaks, CA: SAGE.

15. Learner Progress Methodology: Transparency by Design. [cited 2013 Dec 14] Available from http://wcet.wiche.edu/advance/transparency-by-design

16. Nevill S, Chen X. U.S. Department of Education, Institute of Education Sciences NCES 2007-162 [Internet]. 2007 Feb. [cited 2014 Jan 12]. Available from: http://nces.ed.gov/pubs2007/2007162.pdf

17. Barnett, J. M. Focus groups tips for beginners: TCALL occasional research paper no. 1. [Internet] 2002. [cited 2013 Sep 7] Available from: http://www-tcall.tamu.edu/orp/orp1.htm

18. Duke University. Guidelines for conducting a focus group. [Internet] 2005. [cited 2013 Sep 6]. Available from: http://assessment.aas.duke.edu/documents/How_to_Conduct_a_Focus_Group.pdf

19. Creswell, J. (1994). Research design: Qualitative and quantitative approaches. London: SAGE.

20. Patton, M. (2002) Qualitative Research and Evaluation Methods (3rd ed.). London: SAGE.

21. Bowen, D. History of dental hygiene research. J Dent Hyg. (Special Commemorative Issue) (2013), p. 5-22.

22. Ali N, Hodson-Carlton K, Ryan M. Students' perceptions of online learning: implications for teaching. Nurse Educ. 2004;29(3):111-115.

23. ADEA http://www.adea.org/uploadedFiles/ADEA/Content_Conversion_Final/about_adea/governance/ADEA_Core_Competencies_for_Graduate_Dental_Hygiene_Education.pdf

Dental Hygienists' Attitudes Toward the Obese Population

Gwen Essex, RDH, MS, EdD; Keiko Miyahara, RDH, BA, MS; Dorothy J. Rowe, RDH, MS, PhD

Abstract

Purpose: To explore dental hygienists' attitudes toward the obese population and to determine whether there are differences in attitudes among those with different self-reported body images.

Methods: The study population was dental hygienists whose email addresses were in the database of the California Dental Hygienists' Association (CDHA). CDHA distributed the electronic message containing study information, informed consent, and a link to the survey. The survey consisted of 14 items from the Fat Phobia Scale, 13 items from the Anti-fat Attitudes Questionnaire (AFAQ), 3 demographic questions, and 1 question on body image. Frequencies of responses for each survey item were calculated, and Likert-like scale responses from the AFAQ were analyzed to determine significant differences among self-reported body images.

Results: Of the 6,248 email addresses in the CDHA database, 518 hygienists or 8% responded. Mild fat phobia was indicated by 57% of the word pair scores on the Fat Phobia Scale being higher than 2.50. On the AFAQ, 84% agreed to the statement, "People who weigh too much could lose at least some part of their weight through a little exercise." Significantly ($p<0.05$) more respondents who self-reported as overweight than underweight agreed to "I feel disgusted with myself when I gain weight" and "I worry about becoming fat," while more in the overweight than underweight category significantly ($p<0.05$) disagreed with "Fat people make me somewhat uncomfortable."

Conclusion: Dental hygienists exhibited mildly negative attitudes toward the obese population. Curricula specific to the role of the dental hygienist in addressing the health effects of obesity are recommended.

Keywords: continuing education, dental hygiene education/curriculum, health promotion, oral health prevention, special needs patients, survey research

The study supports the NDHRA priority area, **Health Promotion/Disease Prevention:** Assess strategies for effective communication between the dental hygienist and client.

Introduction

The World Health Organization considers obesity to be a global epidemic.[1] Data from the National Health and Nutrition Examination Survey (NHNES) from 2003-2004 indicate that in the United States 17% of children and adolescents are overweight, and 32% of adults are obese.[2] These data also show that the overweight and obese populations are on the increase when compared to previous NHNES data from 1999-2000.[2] There is a serious problem even among the very young, with 5% of 6 to 11 year-olds estimated to be severely obese.[3]

Obesity is a growing public health concern; obesity increases the risk of diabetes, heart disease, stroke, arthritis, and some types of cancer.[4] Over the past 10 years in the United States the prevalence of obesity has increased, and weight discrimination also increased by 66%.[5] Physicians and medical students have expressed less desire to help obese patients, and have labeled these patients as lazy, undisciplined, and unmotivated.[5,6,7] Obese patients seeking health care who encounter negative attitudes and poor treatment from the health care providers have been shown to subsequently avoid preventive care,[5] which in turn may adversely affect their health status.

Magliocca and colleagues employed a modified version of a questionnaire, used to measure medical student bias,[8] to study both dental and dental hygiene students' attitudes toward obesity.[9] They found that both dental and dental hygiene students indicated negative attitudes toward obese patients.[9] Approximately 30% of student respondents report-

ed that obese patients were lazy, and 26% reported perceiving obese people as unmotivated and lacking will power. Also, 14% of the students reported feeling uncomfortable examining obese patients, and 17% lacked empathy toward obese patients.[9]

Additional data indicate that obesity bias is also present among those who study obesity and/or work with obese patients.[10] Schwartz and colleagues surveyed attendees at an international obesity conference and found there to be a significant obesity bias, particularly among the women participating, regardless of the assumption that this population would be well-informed on the topic of obesity. This finding underscores the importance of evaluating for, and addressing bias within, the health professions including dental hygiene.

Biases are known to influence patient care in the medical setting,[5-7] but it is unknown whether dental hygienists harbor or display biases toward obese patients. The research questions guiding this study are as follows: Do dental hygienists have biases toward obese patients? Are there differences in attitudes toward obesity among those with different self-reported body images? The purpose of this study is to explore dental hygienists' attitudes toward the obese population and to determine whether there are differences in attitudes among those with different self-reported body images.

Table I: Demographic Characteristics of Respondents

Age 20-39 40-59 60 or older	% (n) 37 (157) 40 (168) 21 (90)
Decline to answer	1 (4)
Race/Ethnicity American Indian or other Native American	1 (5)
Asian, Asian American	8 (34)
Black or African American	1 (6)
Mexican or Mexican American	7 (28)
Other Hispanic or Latino	3 (13)
Pacific Islander	1 (5)
Puerto Rican	0 (1)
White (non-Hispanic)	67 (277)
Multiracial	4 (15)
Other	2 (10)
Decline to answer	5 (21)
Gender Male	3 (13)
Female	97 (404)
Transgender	0 (1)

The total number of respondents per question varied due to respondents not answering all the questions.

Methods

The study population was dental hygienists whose email addresses were in the database of the California Dental Hygienists' Association (CDHA). Inclusion criteria included both members and nonmembers of CDHA. Potential participants received an email invitation to participate containing basic information on the purpose of the study, informed consent declaration, and a link to the online survey. Two follow-up emails were distributed after the initial invitation to participate was distributed; the first follow-up message was sent on the third week, and the second follow-up was sent on week eight.

The online survey consisted of two previously validated instruments adapted for use with dental hygienists. The first instrument was the Fat Phobia Scale, which consisted of 14 pairs of adjectives sometimes used to describe obese people.[11] For each of the 14 pairs of adjectives, respondents selected a number (1 through 5) closest to the adjective that they felt best described their feelings and beliefs. The total score was added and divided by 14 to obtain a scoring range from 1 to 5. Scores below 2.5 indicate a neutral attitude about obese patients, scores between 2.5 and 4.3 indicate a mild bias, and scores of 4.4 or higher indicate a high level of obesity bias.

The second instrument that was used was the Anti-fat Attitudes Questionnaire (AFAQ), which evaluated respondents' attitudes and behaviors related to obesity.[12] Respondents selected one of 9 Likert-like responses, ranging from very strongly agree to very strongly disagree. When frequencies (percentages) were calculated, 4 responses were merged for convenience in reporting, resulting in 6 categories of responses: very strongly and strongly agree, moderately and somewhat agree, moderately and somewhat disagree, and very strongly and strongly disagree.

The survey also included 3 items on demographic information and one item on body image, which asked respondents to self-identify as underweight, normal or average weight or overweight.

Qualtrics (Qualtrics, Provost, UT) survey and research suite was used to calculate frequencies (percentages) of responses to each survey item and to conduct cross tabulations among variables. The percentages of responses for each level of agreement with statements from the AFAQ were analyzed, using a variation of the chi-square test, for significant differences among self-reported body images. A p-value equal to or less than $p<0.05$ was considered

Table II: Self-reported Body Images of the Respondents

Body image	% (n)
Underweight	3 (12)
Normal/Average weight	71 (296)
Overweight	26 (110)

The total number of respondents per question varied due to respondents not answering all the questions.

statistically significant.

Results

The Institutional Review Board at the University of California, San Francisco approved this cross-sectional study. Of the 6,248 email addresses in the CDHA database, 518 dental hygienists opened the online survey, yielding a response rate of 8%. However, 90 of these respondents neglected to answer any questions, and the number of respondents per question varied greatly. Table I indicates that the majority of respondents were female, non-Hispanic White, and between 40 to 59 years of age.

Respondents self-reported their body image in terms of three categories: underweight, normal or average weight, and overweight. (Table II) Most of the respondents reported normal or average weight.

The respondents' assessments of their attitudes toward the obese population, based on responses to word pairs, are shown in Table III. More than half (57%) of the Fat Phobia Scale word pair scores were higher than 2.50, which indicated a slight fat phobia. The mean of all word pair scores for the Fat Phobia Scale was 2.61. The "Likes food: Dislikes food" word pair had the lowest score or the least "fat Phobia" and the "Weak: Strong" word pair had the higher score or mild "fat phobia."

Table III: Respondents' Assessments of Their Attitudes of the Obese Population, Based on Responses to Word Pairs from the Fat Phobia Scale[11]

Word Pairs	Mean of All Responses	Total Responses
Likes food: Dislikes food	2.05	406
Overeats: Undereats	2.20	403
Fast: Slow	2.44	404
Inactive: Active	2.47	406
Low self-esteem: High self-esteem	2.47	406
Insecure: Secure	2.50	406
Having no endurance: Having endurance	2.52	402
Poor self-control: Good self-control	2.61	406
Self -indulgent: Self-sacrificing	2.76	405
Unattractive: Attractive	2.76	407
No will Power: Has will power	2.85	408
Lazy: Industrious	2.93	408
Shapeless: Shapely	2.93	406
Weak: Strong	2.98	406

Score of 2.50 (thick black horizontal line) indicates a neutral attitude. Scores higher than 2.5 indicate a level of obesity bias. The total number of respondents per question varied due to respondents not answering all the questions.

Table IV indicates the respondents' levels of agreement with various statements from the AFAQ. The highest percentage (84%) of respondents' agreement, which includes those responding "strongly to very strongly agree," "somewhat to moderately agree," and "agree," was to the statement "People who weigh too much could lose at least some part of their weight through a little exercise."

Three statements had significantly ($p \leq 0.05$) different levels of agreement based on self-reported body image. Two of the statements were concerned with the respondent's personal belief of one's own body image, "I feel disgusted with myself when I gain weight" and "I worry about becoming fat." Significantly more respondents of the overweight population agreed to these statements than those who reported themselves as underweight. The third statement demonstrating significance was regarding a respondent's relationship with obese persons, "Fat people make me somewhat uncomfortable." This statement displayed a strong disagreement from the respondents of the self-identified overweight population compared to those identifying as underweight.

Most of the respondents (93%) reported that they had not completed a continuing education course related to obesity. The few that had taken courses indicated that the course was offered at dental scientific sessions or through scientific journals.

Discussion

In our study we assessed the attitudes of dental hygienists toward the obese population using two es-

Table IV: Respondents' Levels of Agreement With Statements From the Anti-fat Attitudes Questionnaire[12]

Statements	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)
	Strongly to Very Strongly Agree	Somewhat to Moderately Agree	Agree	Disagree	Somewhat to Moderately Disagree	Strongly to Very Strongly Disagree
*I feel disgusted with myself when I gain weight.	15.9 (69)	22.6 (96)	22.7 (96)	15 (64)	11.6 (51)	11(47)
*I worry about becoming fat.	15.5 (66)	24.9 (105)	24.7 (104)	14 (59)	8.2 (35)	12 (52)
**Fat people make me somewhat uncomfortable.	0.9 (4)	1.4 (42)	6 (25)	13.6 (57)	20.4 (44)	58.9 (247)
I really don't like fat people much	1.9 (8)	5.1 (22)	2 (9)	21 (89)	10.9 (46)	58.7 (247)
I don't have many friends that are fat.	4.9 (21)	10.1 (43)	14 (59)	18.7 (79)	22.5 (95)	29.4 (124)
I tend to think that people who are overweight are a little untrustworthy.	0.8 (4)	2.0 (9)	1.2 (5)	15.3 (65)	4.4 (19)	75.7 (321)
Although some fat people are surely smart, in general, I think they tend not to be quite as bright as normal weight people.	1.3 (6)	3.5(15)	2.3 (10)	14.9 (63)	6.1 (26)	71.6 (302)
I have a hard time taking fat people too seriously.	0.91 (4)	2.77 (12)	1.9 (8)	15.8 (67)	6.8 (29)	70.6 (302)
If I were an employer looking to hire, I might avoid hiring a fat person.	2 (9)	14.2 (60)	10.6 (45)	14.4 (61)	19.3 (82)	39 (165)
One of the worst things that could happen to me would be if I gained 25 pounds.	24.9 (106)	18.3 (78)	16.7 (71)	13.7 (58)	7.2 (31)	18.5 (79)
People who weigh too much could lose at least some part of their weight through a little exercise.	28.4 (120)	20.8 (88)	35 (148)	3.8 (16)	5.5 (23)	6.1 (26)
Some people are fat because they have no willpower.	7.5 (32)	25.1 (106)	25.6 (108)	13.5 (57)	13.4 (36)	19.4 (82)
Fat people tend to be fat pretty much through their own fault.	4.5 (20)	21 (89)	12.8 (54)	(19) 80	17.7 (75)	24.6 (104)

*Significantly greater agreement in overweight than in underweight respondents ($p \leq 0.05$). **Significantly greater disagreement in overweight than in underweight respondents ($p < 0.05$).
Thick black vertical line separates agree from disagree.
The total number of respondents per question varied due to respondents not answering all the questions.

tablished survey instruments: The Fat Phobia Scale[11] and the Anti-fat Attitude Questionnaire.[12] Participating dental hygienists were shown to report mildly negative attitudes or bias toward the obese population when the two implemented measures were considered in total. More than half of the scores on the Fat Phobia Scale were higher than 2.5, indicating a slight fat phobia. However, compared to the Fat Phobia Scale score of 3.4[13] reported for the study involving registered dieticians, registered dental hygienists were found to report more positive attitudes toward the obese population.

The results of the Anti-fat Attitude Questionnaire suggest that the majority of the respondents presented a positive attitude toward the obese population. However, the levels of agreement with three of the statements on the Fat Phobia Scale, "I feel disgusted with myself when I gain weight," "I worry about becoming fat," and "Fat people make me somewhat uncomfortable," demonstrated statistically significant differences of reported attitudes between those who self-reported as overweight, normal/average weight, or underweight.

When the respondents were asked to indicate their levels of agreement with various statements designed to detect the "presence of bias and negative attitude" on the Anti-fat Attitude Questionnaire, the majority of the respondents did not present a negative attitude toward the obese population. In a study by Magliocca et al., when the dental and dental hygiene students were asked to respond to the statement, "Overweight people tend to be lazier than normal weight people," 30% of both dental and dental hygiene students agreed with the statement, and 40% disagreed and 30% were neutral.[9] Compared to the respondents in the current study, in which 24% agreed that overweight people are lazy, 16% disagreed and 60% felt neutral. It was further reported that 14% of the dental and dental hygiene students felt uncomfortable when examining an obese patient;[9] however, only 2.3% of the respondents in our study reported feeling uncomfortable with the obese population.

In a study by Walter and colleagues, the Anti-fat Attitudes questionnaire[12] was used to survey undergraduate and graduate students enrolled in a religiously affiliated university.[14] The participants indicated that 10% felt uncomfortable interacting with an obese person.[14] Over 50% of the participants' responses to statements, self-reflective of one's own weight gain or weight concern, ranked between 7-9 on the Anti-fat Attitudes scale indicating a negative attitude.[14] Participants were generally more critical about their own personal weight gain, and less critical about others who gain weight.[14]

There is a similarity in findings from the Walter et al. study and the current study. In both studies, participants who ranked highest for the statement, "People who weigh too much could lose at least some part of their weight through a little exercise," were found to have the highest indication of negative bias towards the obese population.[14] The bias reported may indicate either adherence to a stereotype or lack of knowledge about the obese population. Many people may make the assumption that what an overweight person might need to do to lose weight is to exercise rather than investigating further into the etiology of a patient's weight gain through their health history, cultural background, nutrition or other variables.

Obesity bias in dental hygienists should be explored in future studies. Raising awareness of negative attitudes toward obesity population for both dental hygiene students and dental hygienists in practice is needed so that all patients receive the best comprehensive care available. It is necessary to address the unconscious bias that one can hold in addition to meeting educational needs in order to prepare dental hygienists to meet the needs of obese patients. One suggestion is to encourage dental hygienists to investigate their own unconscious biases through resources such as Project Implicit, a research and education project on implicit bias ongoing in collaboration with several U.S. universities. In addition to examining personal bias dental hygienists can also participate in general diversity training, particularly those that include persons of size as a diversity marker.

More extensive education relating to the additional health concerns that present with obesity and the role of the dental hygienists in addressing these concerns is recommended. Research done by Kading and colleagues supports this recommendation;[15] North Carolina dental hygienists reported that they lacked the training on how to address specific topics, which may improve the overall health of their obese patients. Integrating obesity health concerns into current curricula is one means of addressing this need. There are content areas already taught that should be evaluated for possible refinement and inclusion of obesity content; for example, when addressing diabetes and other metabolic disorders. Professional training must follow population changes. It is clear that the trend toward obesity is still rising and will necessitate greater expertise among dental hygienists in managing the oral health and supporting the total health of obese patients. On the other hand, dental hygienists need to be aware of their limited education in addressing the complications of obesity that require the expertise of a nutritionist. Determining dental hygienists' needs and practices of referrals to a nutritionist would be an interesting study.

Being obese increases the likelihood of a patient

having associated medical and oral health problems. Recent studies have suggested obesity as a risk factor for periodontal disease.[16] One study found that body mass index was positively and significantly associated with severity of periodontal attachment loss.[17] This relationship may result from the fat cells in the abdominal adipose tissue secreting inflammatory factors, such as the cytokine tumor necrosis factor-alpha (TNF-α), into the plasma. The circulating inflammatory factors would increase systemic inflammation and, thus, promote the risk for periodontal inflammation. To maintain the obese individual's periodontal health, the dental hygienist has an important role in emphasizing preventive oral care.

Another health message for the patient-centered interaction would be a discussion of the patient's consumption of high sugar foods and drinks that increase the risk of dental caries, as well as contribute to obesity. Discussion of dietary versus nutritional counseling may be an important change to consider within the profession. Dental hygienists are commonly educated in dietary counseling as related to oral health and caries prevention. Enriching and expanding that curricular content may be a means of addressing the needs of obese patients. For example, providing greater content of evidence-based nutrition information related to obesity and introducing a clinical requirement of counseling obese patients may enhance the student's confidence and ability to be proactive at addressing the obese patient's oral health.

Offering obesity content in both dental hygiene clinical programs and in continuing education courses that meet the current need for information is necessary to ensure that both entering dental hygiene clinicians as well as currently practicing dental hygienists are reached with this information. Respondents in our study overwhelming reported that they have not taken any continuing education courses on obesity. Creating continuing education courses on obesity is strongly recommended. This will ensure that all dental hygienists will receive new and useful information on the topic of obesity that they can incorporate into their dental hygiene care. Core curriculum in entry-level dental hygiene programs and continuing education courses specific to obesity education ought to address the currently identified need. Courses should include topics such as etiology, risk factors, nutrition, psychology, patient management, and specific dental hygiene interventions focused on helping the obese patient.

A limitation of this study was response bias. The response rate was only 8%, based on the number of email addresses in the CDHA database. However, the relationship between email addresses and individuals is uncertain. Another limitation may have been that the body image category was self-reported. The Body Mass Index would have provided a more accurate system to categorize the individuals into underweight, normal or average weight, and overweight categories. However, in this study, we were interested in the influence of respondents' perception of their body image, rather than their actual weight. The third potential limitation may be due to the sensitivity of the study; respondents may have answered in a way that they think was the correct choice instead of choosing what they truly felt.

Conclusion

Dental hygienists in this study exhibited mildly negative attitudes toward the obese population. Most attitudes were similar among self-reported body images. It is recommended that dental hygienists be made aware of any negative attitudes toward the obese population and that content specifically addressing obesity and the role of the dental hygienist in addressing the health effects of obesity be incorporated into current curricula and continuing education courses. With these recommendations, dental hygienists could offer care that would enhance the oral and systemic health of their obese patients.

Gwen Essex, RDH, MS, EdD, is HS Clinical Professor in the Department of Preventive and Restorative Dental Sciences at the University of California, San Francisco, and Co-Director of the Virtual Dental Home Clinics at the University of the Pacific Arthur A. Dugoni School of Dentistry. Keiko Miyahara, RDH, BA, MS, is a graduate of the Master of Science Program in Dental Hygiene and Dorothy J. Rowe, RDH, MS, PhD, is Associate Professor Emeritus in the Department of Preventive and Restorative Dental Sciences at the University of California, San Francisco.

Acknowledgment

The authors appreciate the support of the California Dental Hygienists' Association for assisting with the distribution of the survey.

References

1. World Health Organization. Obesity: Preventing and managing the global epidemic. Report of a WHO consultation. World Health Organ Tech Rep Ser 894:i–xii, 1253. Geneva: World Health Organization. 2000.

2. Flegal KM, Carroll MD, Ogden CL, Johnson, CL. Prevalence and trends in obesity among US adults, 1999-2000. JAMA. 2002;288(14):1723-1727.

3. Skinner A, Skelton JA. Prevalence and trends in obesity and severe obesity among children in the United States, 1999-2012. JAMA Pediatr.

2014;168(6):561-566.

4. Centers for Disease Control and Prevention. Health consequences. [Internet]. 2012 Apr [cited 2015 May 31]. Available from: http://www/cdc/gov/obesity/ causes.health.html

5. Sabin JA, Marini M, Nosek BA. Implicit and explicit anti-fat bias among a large sample of medical doctors by BMI, race/ethnicity and gender. PloS One 2012;7(11):e48448.

6. Phelan SM, Dovidio JF, Puhl RM, et al. Implicit and explicit weight bias in a national sample of 4,732 medical students: The medical student changes study. Obesity 2014;22(4):1201-1208.

7. Persky S, Eccleston CP. Medical student bias and care recommendations for an obese versus non-obese virtual patient. Int J Obes. 2011;35(5):728-735.

8. Foster GD, Wadden TA, Makris AP, et al. Primary care physicians' attitudes about obesity and its treatment. Obes Res 2003;11:1168-77.

9. Magliocca KR, Jabero MF, Alto DL, Magliocca JF. Knowledge, beliefs, and attitudes of dental and dental hygiene students toward obesity. J Dent Educ. 2005;69(12):1332-1339.

10. Schwartz MB, Chambliss HO, Brownell KD, Blair SN, Billington C. Weight bias among health professionals specializing in obesity. Obesity Res 2003;11(9):1033-1039.

11. Bacon JG, Scheltema KE, Robinson BE. Fat phobia scale revisited: the short form. Int J Obes. 2001;25:252-257.

12. Crandall CS. Prejudice against fat people: ideology and self-interest. J Pers Soc Psychol. 1994;66(5):882-894.

13. Wellborn SE. Comparison of obesity bias, attitudes, and beliefs among undergraduate dietetic students, dietetic interns, and practicing registered dietitians (unpublished dissertation). East Tennessee State University, Johnson City, Tennessee. 2013.

14. Walter ME, Ragan K, Sulak TN, Bagby JH. Implicit and explicit biases toward obesity: perspectives of school of education students. J Community Med Health Educ. 2013;3(3):1-6.

15. Kading CL, Wilder RS, Vann Jr. WF, Curran AE. Factors affecting North Carolina dental hygienists' confidence in providing obesity education and counseling. J Dent Hyg. 2010;84(2):94-102.

16. Suvan J, D'Aiuto F, Moles DR, Petrie A, Donos N. Association between overweight/obesity and periodontitis in adults. A systematic review. Obesity reviews. 2011;12:e381-e404.

17. Genco RJ, Grossi SG, Ho A, Nishimura F Murayama Y. A proposed model linking inflammation to obesity, diabetes, and periodontal infections. J Periodontol. 2005;76:2075-2084.

A Comparison of Attrition Rates in Dental Hygiene Programs Using Selective and Nonselective Admissions

Brittany E. Moore, BSDH, MDH; Michele P. Carr, BS, MA; Rachel C. Kearney, BSDH, MS; Jill Clutter, PhD, MCHES

Abstract

Purpose: The purpose of this study was to determine if there is a difference between attrition rates for dental hygiene programs that use selective admissions and nonselective admissions. Admissions to dental hygiene programs is based on a predetermined class size; therefore, applicants must meet the criteria to be considered for selection. Dental hygiene programs want to retain their enrolled students and maximize their student successes; therefore, it is imperative to validate current admissions practices that help reduce attrition rates.

Methods: An online survey consisting of forced choice and open-ended questions was sent to the directors of accredited dental hygiene programs in the United States. Surveys were analyzed using descriptive statistics and frequency distributions. Open-ended questions were analyzed using the constant comparative method to identify recurring themes.

Results: Ninety-nine surveys were returned for a 30% response rate. There was no statistical difference in attrition rates when selective or nonselective admissions criteria was used in dental hygiene programs (year 2011 p=.435 and year 2012 p=.784). Results of this study also showed baccalaureate degree dental hygiene programs have significantly higher completion rates than associate degree dental hygiene programs (2011 p=.002 and 2012 p=.005).

Conclusion: Evidence from this study suggests there is no difference between attrition rates for dental hygiene programs that use selective admissions versus nonselective admissions. Additionally, this study determined that baccalaureate degree dental hygiene programs have less attrition compared to associate degree dental hygiene programs.

Keywords: dental hygiene education, admissions, attrition, entry-level dental hygiene

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

Introduction

Attrition in dental hygiene programs impacts the individual, the institution, and the community. When a student is not successful, the financial, time, and emotional impact on the individual and the individual's family can be devastating. Retention of students is particularly important to institutions whose programs are evaluated and funded based on retention and graduation.[1] The early identification of factors affecting student success and providing support interventions can influence student persistence. Researchers and admissions personnel continue to discuss, debate, and seek reliable predictors of student performance in academic programs.[2] Many dental hygiene programs apply selective admission criteria to prospective students in an effort to fill their classes with the highest academic achievers.[3] According to the *Princeton Review*, colleges in general may be very selective, not selective at all, or somewhere inbetween.[4] Highly selective colleges consider transcripts, extracurricular activities, standardized test, essays, teacher recommendations, etc. Admission to these schools is competitive in terms of both the number and the quality of the applicants. Colleges utilizing nonselective admissions still have standards, yet they usually operate on a more open admission basis, or rolling admission, where they will accept college applications until their class size is full.[4]

Dental hygiene programs typically develop their own point or evaluation system to assist in determining which applicants are most likely to be suc-

cessful. According to the American Dental Hygienists' Association (ADHA), admissions requirements and prerequisites vary from institution to institution, but generally include: high school diploma or GED; high school courses in mathematics, chemistry, biology, English; minimum "C" average in high school; college entrance test scores; typically up to 40 credit hours of prerequisite college courses in chemistry, English, speech, psychology and sociology; and then dependent on the institution a personal interview, dexterity test, and/or essay.[5] Dental hygiene programs not only utilize preadmission criteria to help select candidates for admittance but also assess criteria that can ensure student retention.[6]

Downey et al. examined the predictive reliability of GPA and Scholastic Aptitude Test scores in predicting dental hygiene program success and National Board Dental Hygiene Examination (NBDHE) score. A retrospective review of 134 dental hygiene graduates of the Medical College of Georgia from 1996-2001 revealed that incoming GPA added significantly to the ability to predict the dental hygiene GPA.[7] A follow-up study was completed to assess the relationship between the predicted success from the aforementioned study and the actual success of entry-level students who graduated between 2002 and 2007. The authors confirmed incoming GPA and total SAT scores remained useful in predicting student success.[8] In addition, the authors analyzed dental hygiene GPA at the end of the first year in the program in lieu of incoming GPA, and a stronger correlation was found when predicting student success.[8]

Alzahrani et al. examined predictors used by Old Dominion University Gene Hirschfeld School of Dental Hygiene to select dental hygiene students who are most likely to graduate and pass the NBDHE. The results suggested the final course grade in oral pathology was a significant predictor of successful graduation and final course grades in oral pathology, oral anatomy and histology, and admissions criteria points were significant predictors of NBDHE success.[1]

Bauchmoyer et al. obtained data on 173 graduates of the dental hygiene program at The Ohio State University from 1998-2002 to examine the relationship between preadmission requirements, site of academic preparation, cumulative dental hygiene GPA, and NBDHE scores. NBDHE success was strongly predicted by the cumulative dental hygiene GPA, followed by the science GPA, and then entering cumulative GPA.[9] The study also reviewed 10 individual courses that comprise the preadmissions requirements and basic college science requirements for the dental hygiene program to determine whether or not a correlation existed between course grades and program and NBDHE success. The strongest correlation with program success was demonstrated by course grades in biology and chemistry, and the strongest correlation with NBDHE success was determined by course grades in biology and psychology.[9]

The study of grade point average as a predictor variable appears often in the literature.[6-9] Researchers have studied high school GPA, college course preprofessional program GPA, science and other prerequisite course GPA, and dental hygiene GPA at specific intervals and at graduation. A study by Sanderson determined that the use of overall high school GPA, overall college GPA, and interviews were positive predictors of dental hygiene student retention and therefore were useful in the admissions process.[6] Sandow et al. conducted a study to assess current information on the relationship between admission criteria and dental school performance, including the association of admissions criteria and dental school outcomes such as remediation and attrition. In order to determine whether a strong correlation existed among the admissions criteria of students who did not graduate or who required substantial remediation in order to graduate, they compared the mean of each admission score across the groups through the dental program. The study demonstrated that the undergraduate science GPA and the admissions interview score were the most consistent criteria of dental school GPA at the University of Florida College of Dentistry.[10] Conflicting medical research reported that the use of interview was not a valid predictor of student success in medical school.[11]

Currently, there are several standardized tests that are utilized for dental hygiene admissions, such as the American College Test (ACT) and the Scholastic Aptitude Test (SAT). Sanderson determined there was no statistical relevance that retention rates were higher when standardized tests were utilized.[6] The SAT has been found to be a positive predictor of program success.[8] Sandow et al. determined that standardized tests used in dentistry, specifically the academic component of the Dental Aptitude Test (DAT) as well as the Perceptual Motor Aptitude Test (PMAT), positively correlated with dental school performance.[10]

Research has been done on predictors of dental hygiene program success along with studies on attrition and retention in postsecondary education in general with respect to admissions procedures.[1,3,6-11] Historically, dental hygiene programs have evidenced a higher degree of structure in the admissions process.[12] Although many studies have investigated preadmission criteria and criteria within dental hygiene programs to ensure success of students, the purpose of this study is to determine if there is a difference in attrition rates in dental hygiene programs when selective versus nonselective admissions are utilized and determine the types and variation of selective admissions criteria.

Table I: Demographics of Respondents (n=99)

Type of Institution	Community/Junior College 53 (54%)	Technical College 11 (11%)	Dental School 9 (9%)	University College 26 (26%)
Degree Awarded	Certificate 0 (0%)	Associates Degree 77 (78%)	Bachelor's Degree 22 (22%)	
Admissions Type	Selective 87 (88%)	Nonselective 12 (12%)		

Methods and Materials

This study utilized an electronic survey design with a convenience sample. A survey instrument was developed by the researcher to investigate admissions criteria and attrition rates in dental hygiene programs. The survey instrument consisted of 10 forced-choice and 7 open-ended questions. Sections regarding type of program and admissions criteria, and questions related to the dental hygiene class that entered in 2011 and the dental hygiene class that entered in 2012, and remediation within the dental hygiene program, were included. The instrument was pilot-tested for content and organizational structure by 7 dental hygiene faculty, and was revised accordingly prior to distribution. The study protocol was approved and determined exempt by the University's Institutional Review Board.

Qualtrics software (Provo, UT) was utilized to distribute and analyze the survey. The population for this study included 335 dental hygiene program directors of accredited dental hygiene programs. Programs were identified from a 2014 list of 335 accredited entry-level dental hygiene education programs made available through the American Dental Hygienists' Association (ADHA).[13] A follow-up email was sent 14 days after initial distribution to all program directors to request completion of the survey from nonrespondents. No other requests to complete the survey were made. Informed consent was implied by way of accessing and answering the survey.

All of the respondents remained anonymous, IP addresses were not collected, and data was encrypted. Data was analyzed using descriptive statistics and frequency distributions. Independent sample t-tests were used to determine differences in attrition rates. Open ended questions were collected to identify recurring themes. For the purposes of this survey, "selective admissions" was defined as the ability of a college/institution/program to choose a student from an applicant pool utilizing academic and character-related criteria into account when selecting students. "Nonselective admissions" was defined as the ability of the college/institution/program to choose a student from an applicant pool without asking for evidence of academic successes or experiences.

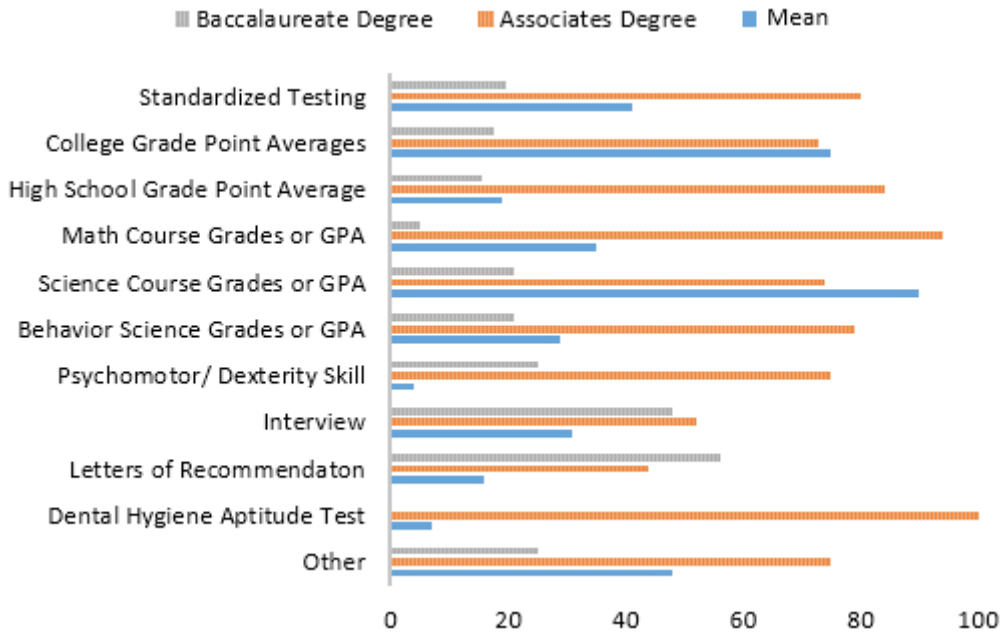
Results

Ninety-nine surveys were returned for a 30% response rate, which is common for online surveys of this nature.[14] The survey revealed that over half of the responding institutions were from a community or junior college (54%), followed by a university (26%). Eleven percent of the responding institutions were within a technical college, and 9% were within a dental school. Seventy-seven responding institutions (77%) offered an associate's degree in dental hygiene, while 22 (22%) offered a baccalaureate degree in dental hygiene. This is comparable to ADHA's 2014 data on entry-level dental hygiene programs, listing 288 associate degree programs (84%) and 56 baccalaureate degree programs (16%).[13] Eighty-seven program directors responded that they utilize selective/competitive admissions (applications are evaluated each year against the entire applicant pool); the remaining 12 program directors utilize nonselective admissions (applicants are required to meet established criteria and are admitted as spaces becomes available or are wait-listed) (Table I).

Science course grades (90%) and college GPA (75%) were the most used as admissions criteria, followed by standardized testing (41%) and math course grades (35%), which are displayed in Figure 1. Science course grades and standardized testing (ACT, SAT, Entrance Test Scores, etc.) were utilized more by associate's degree programs. Other requirements that were specified included but were not limited to: job shadowing, essay, English, Health Education Systems Incorporated exam (HESI), previous dental experience, and critical reasoning test.

The average number of students who matriculated into a dental hygiene program in 2011 and 2012 was 26.68, with a range of 9 to 90. Of the students who entered the program in 2011 and 2012, an average of 23.71 students, with a range of 9 to 83, successfully completed the first year of the dental hygiene program. The data shows an overall average attrition

Figure 1: Frequency of Criteria used in Dental Hygiene Admissions (%)



rate of 2.97% during the first year of the dental hygiene program (Table II).

From a list of prescribed force choices, respondents were asked to report all of the situations that have influenced student attrition for the students who had matriculated into a dental hygiene program in 2011 and 2012. Table III displays that failure to meet academic standards, personal issues, and preclinical course failures were the most common factors that played a role in the students' attrition, followed by clinical skills and dissatisfaction with career choice.

The mean number of students who graduated with their matriculated class of 2011 and 2012 was 22.83, with a range of 9-72. After completing the first year of the program, only 0.89% of students did not successfully complete the rest of the dental hygiene program. The most common factors that played a role in the students' attrition prior to graduation were failure to meet academic standards, personal issues, and clinical skills, followed by preclinical course failures and dissatisfaction with career choice. The data shows an overall average attrition rate for the matriculated class of 2011 and 2012 was 3.85% (Table II).

Table II: Mean Number of Students per Class

Matriculated		Completed First Year	Graduated With Matriculated Class	Attrition Rate
2011	27.98	24.47	23.84	4.15%
2012	25.37	22.95	21.81	3.56%

Two additional questions were explored to determine the forms of remediation offered in the participating dental hygiene programs and if additional compensation is received by the faculty who provide the remediation. One-on-one assistance from faculty (88%), individual remedial plans of success (69%), and repeating a course out of sequence (28%) were among the top responses. Supplemental clinical course work (19%) and other specified answers such as referral for tutoring, reapplying the following year, and repeating the entire year were also among the responses. Only 16% of program directors stated their faculty receive some form of additional compensation for remediation.

Attrition rates were compared for selective and nonselective admissions using an independent sample t-test. Statistical data was analyzed using selective and nonselective admissions criteria and the results showed no statistical difference in the attrition rates (year 2011 p=.435 and year 2012 p=.783) (Figure 2). An additional independent sample t-test, comparing the attrition rates for associate degree programs and baccalaureate degree programs, indicated a higher completion rate for the years 2011 and 2012 for baccalaureate degree programs (p=.002 and .005, respectively). In 2011, the mean attrition rate for associate degree programs was 9.75% while the mean attrition rate of baccalaureate degree programs was 3.72%. For the year 2012, the mean attrition rate for associate degree programs was 10.91% while the mean attrition rate of baccalaureate degree programs was 4.31%.

The final questions of the survey asked program

Table III: Factors in Student Attrition (Number of Respondents n=99)

	Matriculating Class of 2011		Matriculating Class of 2012	
	During First Year	Prior to Graduation	During First Year	Prior to Graduation
Failure to Meet Academic Standards	42 (61%)	24 (52%)	43 (70%)	20 (45%)
Preclinical Course Failures	19 (28%)	6 (13%)	21 (34%)	8 (18%)
Clinical Skills	13 (19%)	26 (35%)	13 (21%)	17 (39%)
Personal Issues (including medical and family responsibilities)	35 (51%)	19 (41%)	32 (52%)	17 (39%)
Dissatisfaction With Career Choice	13 (19%)	3 (7%)	15 (25%)	3 (7%)
Professional Standards	1 (1%)	2 (4%)	1 (2%)	1 (2%)
Academic Dishonesty	6 (9%)	4 (9%)	3 (5%)	2 (5%)
Geographic Relocation	1 (1%)	0 (0%)	1 (2%)	0 (0%)
Financial Difficulties	6 (9%)	3 (7%)	7 (11%)	5 (11%)
Disability Hindered Skill Development	2 (3%)	0 (0%)	0 (0%)	0 (0%)
Time Restraints Due to Work	4 (6%)	3 (7%)	4 (7%)	3 (7%)
Other	9 (13%)	10 (22%)	7 (11%)	6 (14%)

directors to provide additional comments related to dental hygiene admissions. Twenty-four directors (24%) added comments. Although responses varied, two themes emerged from these responses. The first theme focused on attrition rates. Seven program directors stated that attrition was not an issue in their program. One program director explained that they have had a consistent 1%-1.5% attrition rate for the last 38 years, while another had only lost one student in the past 10 years. A second theme referred to the applicant pool. Five program directors commented that the applicant pool is a contributing factor to attrition. One director stated more students have to work, which has a negative effect on success, while another director commented that applicants are not ready for a structured program.

The results of the study showed that there was no statistical difference in attrition rates when selective or nonselective admissions criteria is used in dental hygiene programs (year 2011 p=.435 and year 2012 p=.784). The mean for nonselective admissions was .8969 and for selective admissions was .9206 for the year 2011. The mean for nonselective for the year 2012 was .9130 and selective admissions was .9052. Results of this study also showed baccalaureate degree dental hygiene programs have higher completion rates than associate's degree dental hygiene programs (2011 p=.002 and 2013 p=.005).

Discussion

A significant challenge for dental hygiene admissions committee members is selecting the most qualified applicants.[6] Dental hygiene programs who utilize selective admissions have developed their own rating system, based on evidenced-based criteria, to assist in ranking applicants to determine those who will be most likely to succeed.

Investigations of cognitive variables such as GPAs, science course grades, and scores on standardized tests have produced mixed results in determining correlation between the variable of interest and academic success. Studies of noncognitive variables, such as dental assisting experience, personality tests, and admissions interviews, have produced equally mixed results.[1] The study of GPA as a predictor variable appears often in the literature. Researchers have studied high school GPA, college course preprofessional program GPA, science and other prerequisite GPA, and dental hygiene GPA at specified intervals and at graduation. While the literature supports a strong correlation between GPA and success in a given dental hygiene program, the exact definition of GPA varies widely.[1] The current study showed that

science course grades (90%) and college GPA (75%) are the most commonly used selective admissions criteria, followed by standardized testing (41%) and math course grades (35%). These findings are similar to a study by Sanderson who reported that 70% of accredited dental hygiene programs utilize overall college GPA, and overall high school GPA is used by 23% of programs.[6]

The mean student attrition rate for participating dental hygiene programs in this study was 3.85%. The rate is lower in this study when compared to rates of attrition reported in other studies.[3,6,15] The attrition rate findings in this study are also lower than reported in the ADA's 2012-2013 Survey of Dental Hygiene Education Programs where approximated attrition rates for dental hygiene programs were calculated at 11%.[16] The differences may be attributed to the fact that the response rate in this study was 30% whereas the ADA survey must be completed by each dental hygiene program accredited by the Commission on Dental Accreditation. Sanderson found the mean attrition rate of participating accredited dental hygiene programs was 9%.[6] Attrition in postsecondary education in general is an issue, but the results of this study suggest that it may not be as much of a concern as previous studies propose and is not correlated to the selectivity of the admissions process.[3,6,15] The open-ended statements from the respondents showed that some programs do not struggle with attrition, and it is not a problem at their institution.

The primary reasons reported for student attrition in this study included failure to meet academic standards, personal issues (including medical and family responsibilities), as well as preclinical course failures and dissatisfaction with career choice. This portion of the study paralleled the research of Holt, who investigated student retention practices in associate degree, entry-level dental hygiene programs and reported similar reasons for attrition.[3] Reasons for student attrition can be complex, and it is recommended that additional research in this area be conducted to further explore attrition and retention issues in dental hygiene education. When the student is unsuccessful, the financial, time, and emotional impact of the individual and the individual's family can be vast.[1]

The attrition rate for students at community colleges, even those students who are committed to pursue baccalaureate degrees, is greater than the attrition rate of students at four-year colleges.[17] National data representing the 2007 entry cohort reported the percent of college freshmen returning for their second year at four-year public colleges and universities was 80%.[17] For the 2010 entry cohort at two-year community colleges, the reported first- to second-year retention rates are far worse at 60%.[17] Holt reported entry-level associate degree dental hygiene programs graduate 83% of students compared to 46% overall student retention in most two-year institutions.[3] Therefore, the findings from this study reporting lower attrition rates for baccalaureate degree dental hygiene programs compared to associate dental hygiene programs are similar to national educational statistics.

Limitations

A major limitation of this study was that there was a maldistribution of the two groups, selective and nonselective admissions. Specifically, the participants represented a majority of selective admissions dental hygiene programs. There also are more associate degree programs compared to baccalaureate degree programs in the United States; therefore, the number of associate degree programs that responded to the survey was greater than the number of baccalaureate degree programs.

Even though selective and nonselective admissions were defined in the survey, the interpretation of the definition may have been varied. Some dental hygiene programs may be competitive, while others have minimal institutional requirements to apply for admittance to the program. With a diverse interpretation of selective admissions, the responses may be skewed.

In the survey, program directors were asked to list reasons for student withdrawal or attrition. The most common choice was failure to meet academic standards, which was not clearly defined. With no standardized definition among dental hygiene programs, there is uncertainty on what level or what course(s) were the actual cause of student attrition.

Conclusion

The results of the study showed that there was no statistical difference in attrition rates when selective or nonselective admissions criteria is used in dental hygiene programs. Results also showed baccalaureate degree dental hygiene programs have higher completion rates than associate's degree dental hygiene programs. The results suggest that baccalaureate degree dental hygiene programs have less attrition compared to associates degree dental hygiene programs and may provide data to justify exploring the student population and differences in the two program types that may influence attrition rates.

Brittany E. Moore, BSDH, MDH is Clinical Instructor, Dental Hygiene, at Owens Community College. Michele P. Carr, BS, MA, is Associate Professor and Chair, Division of Dental Hygiene, at The Ohio State University. Rachel C. Kearney, BSDH, MS, is an Assistant Professor, Division of Dental Hygiene, at The

Ohio State University. Jill Clutter, PhD, MCHES, is a Professor, School of Health and Rehabilitation Sciences, at The Ohio State University.

References

1. Alzahrani M, Thompson E, Bauman D. Predictors of student success in an entry-level baccalaureate dental hygiene program. J Dent Hyg. 2007;81(2):51.

2. Hopkins TH. Early identification of at-risk nursing students: a student support model. J Nurs Educ. 2008;47(6):264-269.

3. Holt MP. Student retention practices in associate's degree, entry-level dental hygiene programs. J Dent Hyg. 2005:79(3):6.

4. The Princeton Review. Your guide to college admissions. Available from: http://in.princetonreview.com/in/2011/02/college-speakselectivity-reach-match-and-safety.html [Cited 2015 Jul 10].

5. American Dental Hygienists' Association. Dental Hygiene Education. Curricula, Program, Enrollment and Graduate Information. [Cited 2015 Oct 21]. Available from: https://www.adha.org/.../72611_Dental_Hygiene_Education_Fact_Sheet.pdf

6. Sanderson TR. Relating admissions criteria to dental hygiene Student retention. J Allied Health 2014;43(4):235-240.

7. Downey MC, Collins MA, Browning WD. Predictors of success in dental hygiene education: a six-year review. J Dent Educ. 2002;66(11):126973.

8. Ward ST, Downey MC, Thompson AL, Collins MA. Predictors of success in dental hygiene education: a follow-up study. J Dent Hyg. 2010;84(1);24-28.

9. Bauchmoyer SM, Carr MP, Clutter JE, Hobery PD. Predicting academic and national board dental hygiene examination performance based on academic factors. J Dent Hyg. 2004;78(1):39-45.

10. Sandow PL, Jones AC, Peek CW, Courts FJ, Watson RE. Correlation of admission criteria with dental school performance and attrition. J Dent Educ. 2002;66(3):385-392.

11. Smith SR. Medical school and residency performances of students admitted with and without an admission interview. Acad Med. 1991;66(8):474-476.

12. Dietrich MC, Crowley JA. A national study of student selection practices in the allied health professions. J Allied Health 1982;11(4):248-260.

13. American Dental Hygienists' Association. Entry-level dental hygiene programs. Available from: http://www.adha.org/resourcesdocs/71617_Entry_Level_Schools_By_States.pdf [Cited 2015 Jan 7].

14. Sheehan K. Email survey response rates: A review. J Computer-Mediated Communication 2006:6(2).

15. Freudenthal J, Bowen D. A scholastic appeals process for dental hygiene student remediation and retention. J Dent Educ. 2010:74(3):268-271.

16. American Dental Assocation.2012-13 Survey of Dental Hygiene Education Programs. Chicago: ADA; 2014. Available from: http://www.ada.org/en/science-research/health-policy-institute/datacenter/dental-education

17. Kena G, Musu-Gillette L, Robinson J, et al. The Condition of Education 2015 (NCES 2015-144). U.S. Department of Education, National Center for Education Statistics. Washington, DC. Available from http://nces.ed.gov/pubsearch

RESEARCH

A Dental Radiography Checklist as a Tool for Quality Improvement

Monica Williamson Nenad, RDH, DHEd; Colleen Halupa, EdD; Ann Eshenaur Spolarich, RDH, PhD; JoAnn R. Gurenlian, RDH, PhD

Abstract

Purpose: A checklist intervention was applied to the dental radiographic acquisition process to determine its effectiveness in improving the diagnostic value of bitewing images and reducing patient exposure to unnecessary radiation.

Methods: A mixed-method, nonrandomized research design using two dental hygiene program cohorts (n=33) as control and intervention groups was used to assess the effect of a radiographic checklist on the number and type of radiographic imaging errors. The relationship between perceived value of the checklist and willingness to continue its use was examined and analyzed using descriptive statistics. The effect of previous radiography experience, type and number of acquisition errors, and number of retake exposures were analyzed using Fisher's Exact test, chi-square analysis, Spearman's rho, ANOVA, Cronbach's alpha, Breslow-Day, and Pearson correlation coefficient test.

Results: Checklist use did not contribute to an improvement in the diagnostic value of radiographs, nor did the intervention reduce patient exposure to unnecessary radiation. Additionally, analysis did not reveal a statistically significant difference between types of radiographic errors and previous radiography experience. A positive correlation was found between perceived value and willingness to continue checklist use.

Conclusion: Similarities between the professions of medicine and dentistry suggest that dental procedures may also benefit from application of checklists. Although a positive association between checklist use and error and retake rate was not realized in this study, checklist use may help to improve the quality of radiographic exposures, thereby impacting patient safety by limiting unnecessary exposure to radiation. Additional research is needed to continue to evaluate the effects of checklist use on dental radiographs. As the body of knowledge related to checklist development and use continues to grow, dental hygienists can look for additional ways to incorporate checklists into practice.

Keywords: clinical research; dental radiography; risk assessment; self-assessment

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

Introduction

Checklists are used successfully in a number of professions to assist with safety protocol and job performance accuracy. Although checklists have been used as a procedural standardization tool in aviation since the 1930s and increasingly employed in medicine since the 1990s, their application to dentistry has been considered only recently.[1-3] Advances in technology and its relevance to all aspects of health care have contributed to treatment innovations and improved patient outcomes. Yet in spite of increasingly specialized health care knowledge and practice, mistakes and failures persist and remain largely attributable to human error.[2] Checklist use provides health care practitioners the opportunity to pause at specific procedural points, assess readiness, and address details that can lead to undesirable outcomes.

The medical profession has embraced checklist use on an increasingly broader scale since the early 2000s. Often credited as the impetus behind the medical checklist, Pronovost demonstrated that checklist use can realize dramatic improvements in patient treatment outcomes.[2] Pronovost created a checklist to accompany the placement of central lines in patients in the intensive care units at Johns Hopkins Hospital with a goal of reducing the occurrence of infections. Over the course of one year, the 10-day line-infection rate went from 11% to 0%.[4]

In 2007, the World Health Organization (WHO) convened a group of international experts to develop a solution to the problem of unsafe surgery.[5] Whatever the group devised had to be cost-effective, widely applicable, and measurable. The solution was a 19-item checklist known as the Surgical Safety Check-

list designed for use by a surgical team at three key points: prior to induction of anesthesia, prior to skin incision, and before the surgical team left the operating room. Between October 2007 and September 2008, the checklist was piloted in 8 diverse hospitals throughout the world. A 36% reduction in postoperative complication rates and deaths was realized even when analysis was adjusted for case variables. Additionally, the effect was not restricted to high- or low-income sites nor was a single site responsible for the overall effect.[6] In a follow-up review of data published through February 2012 on the Surgical Safety Checklist initiative and its effect on patient outcomes, Fudickar and colleagues found approximately 36% reduction in surgical complication rates and up to 62% reduction in mortality.[7] These findings led the authors to suggest that a checklist intervention might improve outcomes in other medical areas as well.

Dentistry has been slow to adapt checklists to the profession. Pinsky et al. were among early advocates for adaptation of aviation checklists to dentistry. The authors note a number of similarities between the professions and suggest that checklists can help dental personnel organize their thoughts, identify errors, and increase situational awareness. Based on WHO surgical checklist guidelines, the 2007 American Dental Association guide for dental records, and personal experiences in dentistry and aviation, the authors proposed a dental checklist for outpatient dental visits. The checklist leads the dental team from the beginning to the end of the dental appointment ensuring that all pertinent safety issues are addressed. To date, the authors have not tested the checklist in a clinical trial.[8]

Radiographic images are among the essential diagnostic tools of dentistry. Dental hygienists typically expose a high volume of radiographic images in the clinic setting. The ability to acquire images that meet diagnostic criteria is highly advantageous. Early detection of disease, verification of the accompanying treatment required to address it, decreased risk of professional malpractice, and minimal patient exposure to radiation are key benefits of a reliable radiographic acquisition process.

The radiographer's goal is to obtain the highest quality images while exposing the patient to the lowest possible amount of radiation.[9] Nondiagnostic images often necessitate a retake exposure to capture all areas of interest, effectively doubling the patient's radiation exposure. A radiography checklist can highlight those aspects of image production that are essential to attain diagnostic exposures, reduce the incidence of errors that require image re-exposure, and increase patient safety. However, the application of a checklist to the radiographic acquisition process had not been studied. Therefore, this study was designed to address the following three purposes.

- Determine if a checklist intervention improves the diagnostic value of bitewing radiographs and reduces unnecessary radiographic exposure.
- Determine if previous radiography experience affects the number of retake exposures.
- Determine if students will value the use of a checklist intervention such that they will adopt it within and outside the educational setting.

Methods and Materials

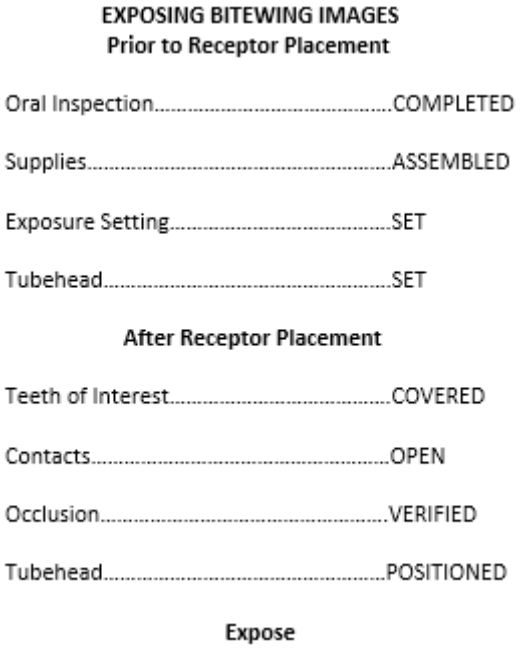
A convenience sample of first-year dental hygiene students from two schools within the same community college district in Arizona was solicited for participation. Shared program admission requirements created a pool of study participants with a similar didactic foundation. Both dental hygiene programs are required to implement the same district-mandated curriculum and course competencies.

This study used a mixed-method research design incorporating both quantitative and qualitative assessments. A nonrandomized control group design was implemented with student participants during the spring semester of 2015 in two community college dental hygiene programs. One program cohort served as the control group and the other as the experimental group.

Participants in the control group used their customary supplies and equipment to acquire radiographic images on patients during regularly scheduled clinic sessions. Participants exposed bitewing images according to the usual protocol: inspect the patient's oral cavity, determine the number and type of exposures needed, choose and assemble supplies and exposure aids, and acquire images with consideration for the patient's specific oral conditions. There were no changes incorporated into the educational training and image acquisition process for the control group.

A checklist intervention implemented with the experimental group generated data for quantitative comparison. Participants in the experimental group used their customary supplies and equipment to acquire radiographic images on patients and, additionally, were instructed to follow the radiography checklist each time a four-image bitewing survey was exposed. The step-by-step, laminated checklist was hung on the wall in each treatment room and referenced as students prepared to expose bitewing images. Faculty in both the control and experimental group recorded the same evaluative data in the same manner for all bitewing images. Data collection concluded after 12 weeks when the semester came

Figure 1: Checklist


EXPOSING BITEWING IMAGES
Prior to Receptor Placement

Oral Inspection.....COMPLETED

Supplies.....ASSEMBLED

Exposure Setting.....SET

Tubehead.....SET

After Receptor Placement

Teeth of Interest.....COVERED

Contacts.....OPEN

Occlusion.....VERIFIED

Tubehead.....POSITIONED

Expose

to an end. The goal was to collect data for five bitewing series for each participant in both the control and experimental group.

Prior to the start of the checklist intervention, the PI met separately with the faculty who graded student images in both the control and experimental groups for study training and calibration. Evaluation criteria for diagnostic and nondiagnostic images as well as what constituted a failure and retake exposure for study purposes were reviewed. Program faculty evaluated all participant image exposures for technique and exposure errors, and the need for retakes. In addition to any programmatic evaluation and diagnosis requirements, evaluating faculty indicated on a data collection form when and how an image failed to meet minimum diagnostic criteria and whether a retake exposure was required to visualize all critical areas. Faculty recorded these data for all bitewing series exposures until each participant had exposed five four-image series or the semester concluded.

The intervention in the study was a radiography checklist that consisted of 8 procedures that a radiographer must perform in preparation for and during acquisition of bitewing images. The purpose of the checklist was to serve as a reminder of procedures that have already been learned; it did not include any instruction or information that the participants had not already received during the course of their education. The laminated checklist was hung on the wall in each radiography treatment room for the duration of the study. The checklist was optimally visible to the operator and sized and formatted for ease of use. The document served as a reference only; a physical checkmark as each task was addressed was not required. Creation of the checklist was based on the literature and incorporated those elements recommended for maximum impact including critical, actionable steps and a logical format[2] (Figure 1).

Students in both the control and experimental groups completed a survey after the checklist intervention had concluded that addressed questions regarding individual demographics and prior radiography experience. Students in the experimental group also completed a perceived value survey and Radiography Checklist Intentions Survey that addressed their perceptions of the value of the checklist intervention and willingness to use the instrument within and outside of the educational setting. All study instruments were original tools, with the exception of the Radiography Checklist Intentions Survey, and developed based on the literature. The instruments were distributed to several currently licensed dental hygienists prior to use to evaluate content validity using a Content Validity Index.[10] All instruments were also pilot-tested and evaluated for reliability using a test/retest method with a cohort of dental hygiene students and faculty in a third program housed within the same community college district as the control and intervention groups. Suggestions for improvements and modifications were incorporated into the instruments as deemed appropriate.

All data were analyzed using SPSS statistical software Version 22 (IBM Corp., Armonk, NY). A 95% confidence interval and $\alpha = 0.05$ were adopted as criterion for two-tailed statistical significance. Descriptive statistics were used to report characteristics of subjects in both the control and intervention groups. Statistical tests used for data analysis included Fisher's Exact test, chi-square analysis, Spearman's rho, ANOVA, Cronbach's alpha, Breslow-Day, and Pearson correlation coefficient test.

Results

A total study sample of 33 study participants ranged from 21 to 43 years of age. The majority of study participants (54%) had some type of dental office experience prior to entering the dental hygiene program. Among those individuals, 79% had experience exposing radiographic images. Of the individuals with radiographic experience, approximately half received their radiography training on the job and half had formal training. Table I presents all participant demographic data.

The image fail rate in the control group was 23.2% and 31.4% in the intervention group. Fisher's Exact test revealed a significant difference ($p=0.030$) in the number of failing images between the interven-

Table I

Characteristics	Control (n=15)	Intervention (n=18)
Gender		
Female	15	18
Age (average years)	31.2	26.8
Prior dental experience		
Observation only	6	9
Front office	2	2
Back office	1	2
Dental hygiene assistant	0	3
Dental assistant	6	7
Prior radiography experience		
Yes	7	8
No	2	1
Prior radiography system experience		
Traditional film	4	4
Phosphor plate	2	2
Sensor	4	5
Total years radiography experience		
1-3 years	3	4
4-6 years	2	4
7-9 years	2	0
Prior radiography training		
On-the-job	5	2
Formal course	2	6

Note. Individual participants may have selected multiple options in Prior Dental Experience and Prior Radiography System Experience categories.

tion and control group. Data indicated checklist use did not contribute to an improvement in the diagnostic value of radiographs.

Radiographic errors documented for individual participants in both groups for the first 3 bitewing series were similar in both type and number. In the intervention group, there was a significant increase in the number of failing images in the fourth series of bitewings; however, the number of failing images rebounded back to the level observed in the control group in the fifth bitewing series. This data trend could not be explained by the natural course of study events. It is possible that unforeseen circumstances unrelated to the study influenced participant performance.

To determine whether a checklist intervention reduced patient exposure to unnecessary radiation, analysis was completed using the retake rate as the dependent variable and checklist use as the independent variable. The retake rate for the control group was 18% and 31.1% for the intervention group. Two-tailed Fisher's Exact test demonstrated a statistically significant ($p<0.001$) difference in the retake rate between the control group and intervention group. Data indicated a checklist intervention did not reduce patient exposure to unnecessary radiation.

It is noteworthy that all failing images do not necessarily require re-exposure as an adjacent image may adequately depict what is missing thus "saving" the failed image from a retake. However, this phenomenon accounted for just 16 total images (2.8%) in the study: 15 from the control group and one from the intervention group.

Also notable was the substantial number of failing images in series 4 in the intervention group. The intervention group experienced 23 failing images out of 48 compared to 3 failing images out of 52 in the control group. When considering only bitewing series 1, 2, 3, and 5, analysis demonstrated a 27.2% fail rate for the control group and a 28% fail rate for the intervention group. Two-tailed Fisher's Exact test ($p=0.917$) failed to demonstrate a significant

Table II: Years of Radiography Experience and Retake Percentage Rate

Years of Radiography Experience	Retake % Rate	
	No	Yes
None	71.6	28.4
1-3 years	83	17
4-9 years*	75.5	21.2

Note. *Categories 4-6 years and 7-9 years experience were combined due to sparse counts.

Table III: Years of Radiography Experience and Mean Retake Percentage by Group

Group	Years of Radiography Experience	Mean % (SD)[b]
Control	No Experience (n=9) 1-3 years (n=3) 4-9 years (n=4)	23.15 (11.01) 8.33 (7.64) 16.98 (10.82)
Intervention	No Experience (n=10) 1-3 years (n=4) 4-9 years (n=4)	33.83 (15.03) 23.96 (15.73) 24.79 (16.93)

Note. [b]SD = Standard Deviation.

difference. When excluding series 4 from data analysis regarding retake rate, the control group had a 21.1% rate, and the intervention group experienced a 27.6% rate. Fisher's Exact test failed to demonstrate a significant difference (p=0.130) when series 4 data was eliminated from analysis. Series 4 alone was the cause of the statistically significant difference between the study groups.

Participants with no prior radiography experience had a 28.4% retake rate, individuals with 1-3 years of experience had a 17% retake rate, and those with 4-9 years of experience had a 21.2% rate (Table II). Data revealed an overall retake rate of 24.5% for all groups combined. The number of retake exposures was compared between students who had and did not have previous radiography experience. Chi-square analysis revealed a statistically significant difference (p=0.032) between years of experience and number of retake exposures. A correlation between experience and retake percentage using Spearman's rho was not significant (r_s=-.32, p=0.071).

In this study, more experience did not equate to fewer retakes. Also notable, upon closer analysis, within every category of experience, participants in the intervention group exposed the greatest percentage of retakes (Table III). However, a two-way ANOVA test of the interaction (years of experience x group assignment) did not yield significant results in predicting percentage retake (p=0.854).

Overall, film placement errors occurred with the greatest frequency (20.7%) followed by horizontal angle errors (4.8%) and then vertical angle errors (2.8%). When comparing types of radiographic acquisition errors with previous radiography experience, chi-square analysis revealed no statistical significance regarding film placement (p=0.077), horizontal angle (p=0.107), and vertical angle (p=0.755). When considering control and intervention groups separately to the variables of previous radiography experience and type of error, odds ratio tests (Breslow-Day 2-sided significance = 0.401) confirmed these findings.

Table IV: Years of Prior Radiography Experience by Percentage and Type of Radiography Errors

Prior Radiography Experience	Film Placement	Horizontal Angle	Vertical Angle
None	24.1	4.7	3.1
1-3 years	15.2	1.8	1.8
4-9 years	17.4	7.6	3.0

Within each study group, those with the least amount and greatest amount of experience had more errors than those with 1-3 years of experience (Table IV). A two-way ANOVA test of the interactions did not reveal any statistically significant differences regarding previous radiography experience and film placement (p=0.316) horizontal angle (p=0.304) and vertical angle, (p=0.850).

A two-tailed Pearson correlation coefficient was computed to assess the relationship between perceived value and willingness to use the checklist. A positive correlation was found between the two variables (r=0.562, n=18, p=0.019). Table V lists the mean scores of questions related to perceived checklist value.

Three questions on the Perceived Value of a Radiography Checklist survey solicited qualitative comments. Overall, students had a positive attitude toward checklist use and saw it as a useful aid to the radiographic acquisition process. Participants provided 11 comments regarding aspects of the checklist that caused it to be effective. Physical characteristics were cited 4 times and referred to document simplicity and size. Four participants noted the checklist served as a "reminder." Several individuals mentioned using the checklist made them think about what they were doing. These comments confirm that the checklist met the researcher's intended criteria for appearance and use.

When asked what aspects of the checklist caused it to be ineffective, 11 comments were offered, in-

cluding 3 that indicated no aspects were considered ineffective. Two comments were made regarding the physical characteristics of the checklist and one concerning the additional time it took to use. Two participants noted they forgot to use the checklist at times. One individual mentioned instructor pressure to use the checklist and another stated, "I already have experience." One participant commented the checklist was implemented after habits were built.

Finally, participants were asked what they would change about the checklist to make it more useful. Ten comments were provided, including 3 that indicated no changes should be made and one that said it was very useful as currently written. The remaining 4 comments related to physical characteristics of the checklist (use of color, include images of teeth to be included on each bitewing) and locating additional checklists outside of the exposure room to assist in setting up for the procedure.

Discussion

This study examined whether use of a checklist application by dental hygiene students during radiographic exposure could improve outcomes related to radiographic imaging technique and patient exposure. Although improvements to the diagnostic value of images were not realized as a result of the checklist intervention, the study raised several notable areas of interest for discussion.

An unusual, unexpected study event was the type of bitewing orientation used by participants in each program cohort. The intervention group exposed vertical bitewings 91.5% of the time and the control group exposed horizontal images exclusively. The challenges of acquiring diagnostically acceptable vertical bitewings are known to dental radiographers. The discomfort experienced by patients due to the vertical orientation of the receptor and limitations imposed by normal oral anatomy can contribute to exposure errors.[11,12] Although a search of the literature did not reveal any definitive guidelines regarding selection criteria for exposure of vertical versus horizontal bitewings, the dental radiographer must use clinical judgment to determine which are most appropriate. If a goal of bitewing imaging is to visualize the height of maxillary and mandibular alveolar bone, one must consider the need for vertical images based on the patient's medical, dental, and social history. The checklist was designed to be effective for both horizontal and vertical bitewing acquisition. Excluding the fourth series, error rates did not differ between the groups, so observed differences in bitewing film orientation did not seem to influence study outcomes.

Data indicate the intervention group participants had generally positive attitudes toward checklist use and found benefits to its application. However, the reported value for checklist use did not translate into improved radiographic outcomes. Although the difference in retake rate between the intervention and control groups was only statistically significant for series 4, the clinical significance of any radiographic exposure is more compelling. The effects of radiation are cumulative and every exposure must be carefully considered.

The exposure of diagnostically acceptable radiographic images on the first attempt should be the goal of every dental radiographer. The hazards of ionizing radiation are well documented, as are the safety precautions that must be observed when working with radiation. Although dentistry generally incorporates low-level radiation exposures, there is no established lower threshold for safety.[9,13] Based on the success of checklist applications to medical procedures, the researchers hypothesized that the dental radiographic acquisition process may benefit from a similar practice.

The use of digital imaging in dentistry continues to grow and is credited with a number of advantages over traditional film-based imaging including reduced radiation dose to the patient, fewer retakes due to density and contrast errors, and wider dynamic range and an associated reduction in retakes.[14,15,16] When evaluating claims of reduced patient exposure to radiation as a byproduct of digital radiography, Wenzel, Møystad, and Berkhout et al. found the claims could not be substantiated.[16,17] Al-

Table V: Perceived Value of the Radiography Checklist

Question	Mean[a] (SD)[b]
The radiography checklist was easily adaptable to the bitewing acquisition process.	4.11 (.76)
The radiography checklist was not disruptive to the radiographic acquisition process.	4.06 (.99)
The radiography checklist required little or no additional time to incorporate into the radiographic acquisition process.	3.72 (.83)
The radiography checklist was thorough and included all steps necessary for acquiring diagnostic images.	4.17 (.71)
The radiography checklist was effective at improving the quality of my bitewing exposures.	3.17 (.51)

Note. [a]n=18. [b]SD = Standard Deviation. Strongly Disagree=1, Disagree=2, Neither Agree nor Disagree=3, Agree=4, Strongly Agree=5.

though digital imaging systems require less radiation for exposure, retakes will minimize or even eliminate this benefit. This study supports the findings of these authors. The retake rate between both the control and intervention groups was compelling but even more so for the intervention group.

Limitations imposed by the type of radiography system used can impact the benefits that are realized as well as the need for retakes. Horner et al. and Thomson note the potential for mechanical damage to photo-stimulable phosphor plates (PSP) plates as well as the laser processing step they require can both contribute to poor image quality and need for retakes.[18,19] Nearly all images in this study were acquired using PSP receptors, yet not one error and associated retake due to these factors was noted by evaluating faculty.

The literature contains relatively few examples of studies comparing radiographer experience with error and image retake rate. While many studies emphasize the clinician's diagnostic ability, this skill depends to a large degree on high-quality exposures. Some radiographers tend to overestimate their abilities, and others possess significant skills without specialized training.[20,21] This study did not demonstrate that radiographers with more experience performed better than those with less experience, although they did perform better than those with no experience. Self-assessment as a form of quality assurance can assist the clinician with identifying strengths and weaknesses in their performance and contribute to high-quality patient care.

Several limitations were present in this study. Every image in the study was acquired using a paralleling aiming device. Results may vary for images acquired using tabs or another type of holding device. The majority of bitewing images in the study were acquired using PSP receptors. Results obtained using traditional film or digital sensors may vary. Participants in the intervention group acquired mostly vertical bitewing series, while control group participants acquired horizontal bitewing series exclusively. Further, it was not possible to determine if participants in the intervention group referenced the checklist for each exposure as a manipulation check of the dependent variable was not implemented as part of the study protocol. Participants were occasionally verbally reminded by faculty to use the checklist.

Checklist applications to a number of professions have resulted in improved safety and patient care outcomes. The similarities between medicine and dentistry suggest that the success seen in medical checklist applications demonstrate promise for dentistry as well. Patient-centered care compels the dental professions to search for innovations that improve the quality and safety of dental services. Checklists are a simple and cost-effective method to apply toward this goal. In light of the current research and growing uses for checklists, the following suggestions for future research are made:

- Introduce the checklist during the initial preclinical radiology course. This may have the effect of preempting certain habits that may be acquired during the training phase as well as socializing students to routine checklist use thereby resulting in fewer errors, less retakes, greater perceived value, and checklist adoption.

- Conduct the same research with one cohort of participants divided into control and intervention groups. This may have the effect of minimizing potential evaluator discrepancies in diagnosing type of bitewings to expose and assessment of radiographic images.

- Investigate further the increased image retake rate among individuals with more radiographic experience compared to individuals with less radiography experience.

Conclusion

Checklist applications to medicine have demonstrated improved patient outcomes. Similarities between the professions of medicine and dentistry suggest that dental procedures may also benefit from application of checklists. Although a positive association between checklist use and error and retake rate was not realized in this study, checklist use may help to improve the quality of radiographic exposures thereby impacting patient safety by limiting unnecessary exposure to radiation. Additional research is needed to continue to evaluate the effects of checklist use on dental radiographs. As the body of knowledge related to checklist development and use continues to grow, dental hygienists can look for additional ways to incorporate checklists into the profession. The demonstrated success of checklist application to a variety of professions is too compelling to ignore.

Monica Williamson Nenad, RDH, DHEd is Director of Faculty Development, Accreditation, and Continuing Dental Education and Assistant Professor, A.T. Still University, at the Arizona School of Dentistry & Oral Health. Colleen Halupa, EdD, is Associate Professor, A.T. Still University, College of Graduate Health Studies. Ann Eshenaur Spolarich, RDH, PhD, is Director of Research, Professor, A.T. Still University, at the Arizona School of Dentistry & Oral Health. JoAnn R. Gurenlian, RDH, PhD, is Graduate Program Director, Professor, at Idaho State University.

References

1. Schamel J. How the pilot's checklist came about [Internet]. 2012 Sep [cited 2015 Oct 20]. Available from: http://www.atchistory.org/History/checklst.htm

2. Gawande A. The checklist manifesto. New York (NY): Picador; 2009. p. 215.

3. Bailey L. Reducing dental errors using pilot safety protocol. The Incisal Edge [Internet]. 2010 Aug 10 [cited 2015 Oct 20]. Available from: http://theincisaledge.co.uk/2010/08/10/reducing-dental-errors-using-pilot-safetyprotocol/

4. Berenholtz SM, Pronovost P J, Lipsett PA, et al. Eliminating catheter-related bloodstream infections in the intensive care unit. Crit Care Med. 2004 Oct; 32(10):2014-2020. doi: 10.1097/01.CCM.0000142399.70913.2F.

5. Safe surgery saves lives frequently asked questions [Internet]. Geneva, Switzerland; World Health Organization; 2014 [cited 2015 Oct 22]. Available from: http://www.who.int/patientsafety/safesurgery/faq_introduction/en/index1.html

6. Haynes AB, Weiser TG, Berry WR, et al. A surgical safety checklist to reduce morbidity and mortality in a global population. N Engl J Med. 2009 Jan;360:491-499. doi: 10.1056/NEJMsa0810119.

7. Fudickar A, Hörle K, Wiltfang J, Bein B. The effect of the WHO surgical safety checklist on complication rate and communication. Dtschs Arztebl Int 2012; 109(42):695–701. doi: 10.3238/arztebl.2012.0695.

8. Pinsky HM, Taichman RS, Sarment DP. Adaptation of airline crew resource management principles to dentistry. J Am Dent Assoc. 2010 Aug;141:1010-1018. doi: 10.14219/jada.archive.2010.0316.

9. Johnson, ON, Thomson, EM. Essentials of dental radiography for dental assistants and hygienists. 8th ed. Upper Saddle River (NJ); Pearson; 2007. p. 436.

10. Polit DF, Beck CT. The content validity index: are you sure you know what's being reported? critique and recommendations. Res Nurs Health. 2006 Oct;29(5):489–497. doi: 10.1002/nur.20147.

11. Bollu P, Mardini S, Gohel A. Horizontal versus vertical bitewing radiographs in opening interproximal tooth contacts. Poster session presented at: American Association of Dental Researchers 37th Annual Meeting and Exhibition; 2008 Mar 31-Apr 5; Dallas TX.

12. Miles DA, Van Dis ML, Williamson GF, Jensen CW. Radiographic imaging for the dental team. 4th ed. St. Louis (MO): Saunders; 2009. p. 329.

13. Ludlow JB, Davies-Ludlow, LE, White SC. Patient risk related to common dental radiographic examinations: the impact of 2007 International Commission on radiological protection recommendations regarding dose calculations. J Am Dent Assoc. 2008 Sep;139(9):1237-1243. doi: 10.14219/jada.archive.2008.0339

14. Gart C, Zamanian K. Global trends in dental imaging: the rise of digital. Dental Tribune [Internet]. 2010 July [cited 2015 Oct 22]; Available from: http://www.dentaltribune.com/articles/news/usa/2608_global_trends_in_dental_imaging_the_rise_of_di gital_.html

15. Levato CM. Digital radiography in general practice: is it time to convert? Comp Contin Educ Dent. 2013 Jul-Aug [cited 2015 Oct 22];34(7):2-3. Available from: http://comprehensivedentistry.com/wp-content/themes/levato/lectures/2013+Compendium+Radiology_Levato_3rd+(2).pdf

16. Wenzel A, Møystad A. Work flow with digital intraoral radiography: a systematic review. Acta Odontol Scand. 2010 Mar;68(2):106-114. doi: 10.3109/ 00016350903514426.

17. Berkhout WER, Sanderink GCH, Van der Stelt PF. (2003). Does digital radiography increase the number of intraoral radiographs? a questionnaire study of Dutch dental practices. Dentomaxillofac Radiol. 2003 Mar;32(2):124-127. doi: 10.1259/dmfr/ 97410196.

18. Horner K, Drage N, Brettle D. 21st century imaging. London: Quintessence; 2008. p. 169.

19. Thomson EM. Reduce retakes. Dimens Dent Hyg. 2011 Oct;9(10):58-61.

20. Andersen ER, Jorde J, Taoussi N, Yaqoob SH, Konst, B, Seierstad, T. Reject analysis in direct digital radiography. Acta Radiol. 2012 Mar;53(2):174-178. doi: 10.1258/ar.2011.110350.

21. Blane CE, Desmond JS, Helvie MA, Zink BJ, Bailey JE, Yang LD, Dunnick NR. Academic radiology and the emergency department: does it need changing? Acad Radiol. 2007 Jun;14(5):625-630. doi: 10.1016/j.acra.2007.01.035.

This page intentionally left blank.