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STATEMENT OF PURPOSE

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

SUBSCRIPTIONS

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Please submit manuscripts for possible publication in the *Journal of Dental Hygiene* to JoshS@adha.net.

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Features

Editorial

Rebecca S. Wilder, RDH, BS, MS

Thank You for your Contributions

The Journal of Dental Hygiene (JDH) has seen changes this past year culminating in growth from four issues of JDH published yearly to six! In addition, we published a monumental supplement to celebrate the 100th anniversary of the dental hygiene profession. We have much to be thankful for in our profession. As editor, I am grateful for the work of a large number of individuals who have contributed to the growth and success of the Journal. First, I would like to thank the contributors, those authors who value the JDH and want to see their papers in our publication. Many professionals are writing and making contributions to our literature. We would not exist without you!

Our editorial review board is made up of a group of ultimate professionals from dental hygiene, dentistry, basic science, pathology, radiology and physical therapy. As dental hygiene expands and continues to collaborate with other health care professionals, having board members with specific expertise in dental hygiene as well as those with a broader view will be important. Thanks to all of the members who have contributed their time and expertise to improving the writing skills of others and enhancing the quality of our publication.

I wish to gratefully acknowledge the support and valuable contributions of the American Dental Hygienists' Association for their commitment to the JDH and for recognizing the value of scholarship to the growth of the profession. Specifically, I wish to thank our Journal Staff Editor, Josh Snyder, for his attention to detail, professional manner, patience with authors, review board members and me! Also, thanks to Ann Battrell, Executive Director of the ADHA, for her support of the Communications Divisions and her leadership at the ADHA.

We are proud of the peer review process and the quality publications that culminate from the efforts of the editorial review board and the other academicians who assist us with quality reviews. These volunteers, whether regular members or guest reviewers, make our publication one that all of us can be proud of as we strive to continuously grow our body of knowledge.

Thank You!

Sincerely,

Rebecca Wilder, RDH, BS, MS
Editor–in–Chief, Journal of Dental Hygiene

Critical Issues in Dental Hygiene

Doctoral Dental Hygiene Education: Insights from a Review of Nursing Literature and Program Websites

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Abstract

Purpose: Because dental hygiene education has had a similar trajectory as nursing education, this critical review addressed the question "What can the dental hygiene discipline learn from the nursing experience in their development of doctoral education?" Information on admission and degree requirements, modes of instruction, and program length and cost was collected from the websites associated with 112 of 125 PhD nursing programs nationally, and 174 of 184 Doctor of Nursing Practice (DNP) programs. In addition, searches of PubMed, Cumulative Index Nursing Allied Health Literature (CINAHL) and the Web of Science were utilized to identify key articles and books. The following 4 insights relevant to future dental hygiene doctoral education emerged from a review of nursing doctoral education: First, nursing doctoral education offers 2 main doctoral degrees, the research-focused PhD degree and the practice-focused DNP degree. Second, there is a well-documented need for doctoral prepared nurses to teach in nursing programs at all levels in managing client-care settings. Third, curricula quality and consistency is a priority in nursing education. Fourth, there are numerous templates on nursing doctoral education available. The historical background of nursing doctoral education was also reviewed, with the assumption that it can be used to inform the dental hygiene discipline when establishing doctoral dental hygiene education. The authors recommend that with the current changes toward medically and socially compromised patient populations, impending changes in health care policies and the available critical mass of master degree- prepared dental hygiene scholars ready to advance the discipline, now is the time for the dental hygiene discipline to establish doctoral education.

Keywords: nursing doctoral degree, PhD, DNP, scholarship, nursing degrees

This study supports the NDHRA priority area, **Professional Education and Development:** Investigate how other health professions have established the masters and doctoral levels of education as their entry level into practice.

Introduction

Dental hygiene, like nursing, has had a challenging path to professional recognition. Both professions have experienced conflict and controversy, yet they both represent unique disciplines.[1,2] The dental hygiene discipline is unique because its conceptual models focus on oral disease prevention and health promotion, and advocacy. This focus results in clients who are empowered, chronic conditions that are improved, enhanced quality of life and ultimately reductions in needed care and associated costs.[2,3]

Dental hygiene initially developed solely as a dental auxiliary health care profession. With the growing complexity of the field and the development of dental hygiene graduate education, however, dental hygiene has become a nascent academic discipline, building its own body of knowledge out of necessity, because it asks questions no other discipline explores. With a critical mass of dental hygienists with masters' degrees, the dental hygiene discipline is poised to move forward with doctoral education to maximize its potential to benefit the public's oral health.

Dental hygiene education is on a similar trajectory as nursing education was in the last century.[3,4] Currently, dental hygiene dedicates associate and baccalaureate degree-programs to developing bio-medically-oriented, patient-centered clinicians, and master degree programs to developing educators and thought leaders.

Although there are currently no dental hygiene doctoral programs, this topic has been discussed recently in dental hygiene scholarly communities. For example, the 2012 American Dental Education Association (ADEA) Scientific Session held a special panel on future doctoral dental hygiene education. Moreover, in 2008, the American Dental Hygienists'

Association (ADHA) reported on their website findings from a 2006 national survey of graduate dental hygiene program directors indicating that up to 25% of the dental hygiene master-degree students at that time were interested in pursuing doctoral education.[5] In addition, unpublished data from a survey of 724 baccalaureate dental hygiene graduates from one program[6] found that 20% of the responders (n=387) said they would be interested in enrolling in a dental hygiene doctoral program (Rowe, personal communication, July 2012). No other reports or related studies were found in the dental hygiene literature. The question arises: What can the dental hygiene discipline learn from the nursing experience in their development of doctoral education? This paper reports the insights learned from reviewing nursing doctoral program websites, and the nursing literature related to doctoral nursing education.

Methods and Materials

This study used a 2-phased approach. First, a list of U.S. schools that offer a doctoral degree in nursing was obtained from the American Association of Colleges of Nursing (AACN) website. Information from these schools' websites was organized around the following themes for analysis: type of doctoral degree offered, admission and degree requirements, program duration, and modes of instruction (onsite programs vs. online programs vs. hybrid programs).

Secondly, a review of the nursing literature was performed, related to the nursing doctoral education history beginning with the last half of the twentieth century to the present in the U.S. and Canada. Key words used were Doctor of Philosophy ("PhD"), Doctor of Nursing Practice ("DNP"), "nursing doctorate education," "graduate education," "nursing degrees" and "scholarship." The databases searched were PubMed, the University of California, San Francisco, Cumulative Index Nursing Allied Health Literature and the Web of Science. Based on initial abstract review, articles relevant to the study question were read and organized into 3 categories: nursing doctoral education, nursing PhD education and DNP education. Articles were re-read for common themes. In addition, nursing education-history books, dental hygiene text books, the Journal of Dental Hygiene and the ADHA website were used as primary references to identify nursing and dental hygiene perspectives on doctoral education.

Data Analysis

For website data, the percentage and number of nursing schools offering doctoral degrees by type of degree, specific admission and degree requirements, program duration, and instruction modes was calculated. In published articles, strategies for developing doctoral nursing programs were identified using a yellow marker to highlight major concepts and key terms. The concepts and key terms that reoccurred in 5 or more articles were identified as major themes for analysis.

Results

The Nursing Literature

In addressing the question about nursing doctoral education, 70 articles were identified based on key words. Of these articles, 36 dating from the 1980s were identified from abstract review. The 2 most referenced journals were Nursing Outlook, currently the official journal of the American Academy of Nursing and the Journal of Professional Nursing, published by the AACN. Four insights were identified as relevant to future doctoral dental hygiene education. First, nursing doctoral education offers 2 main doctoral degrees, the PhD and the DNP. Second, there is a need for doctoral prepared nurses to teach in nursing programs at all levels and in management of client-care settings. This theme was revealed in 15 of the 36 articles reviewed (42%). A third insight related to the need for standardization of the quality and content of nursing doctoral curricula across all doctoral programs. This theme was highlighted in 14 of the 36 articles reviewed (39%). Finally, the fourth insight, derived from 7 of the 36 articles, was there are templates available in the literature for nursing doctoral curriculum development and faculty and student program evaluation as a possible resource for dental hygiene.

Nursing Schools' Websites

A primary insight revealed by the website review was that the nursing profession has 2 main doctoral degrees, the PhD and the DNP. Currently there are 125 nursing PhD programs in the U.S.[7] Figure 1 shows the number and distribution of nursing PhD programs by state. Regionally, the East Coast states have the greatest number of programs. Most states have at least one PhD nursing program, with the exception of a few northwestern states.

Currently, there are 184 DNP programs.[7] Figure 2 shows the number and distribution of DNP programs by state. Similarly, the East Coast states have the greatest number of programs, and states such as Michigan, Indiana, Illinois, Wisconsin, Minnesota and Alabama have more DNP programs than PhD programs available.

Table I shows that most nursing PhD or DNP programs (94% or higher) require a master's degree for

entry. However, more than half the schools have a BSN entry-level track that requires only a bachelor degree for admission. More than half of the schools require interviews, English writing proficiency and RN licensure as admission criteria. Less than half of the PhD programs and at least half of the DNP program require prerequisite statistic and/or computer courses. Although not shown in Table I, most PhD program websites provided a list of research topics and available mentors to contact if there was a match in research interests. DNP admission websites, however, usually only described the programs' areas of practice focus from which the candidate could choose a field of study.

Figure 1: PhD Programs in Nursing

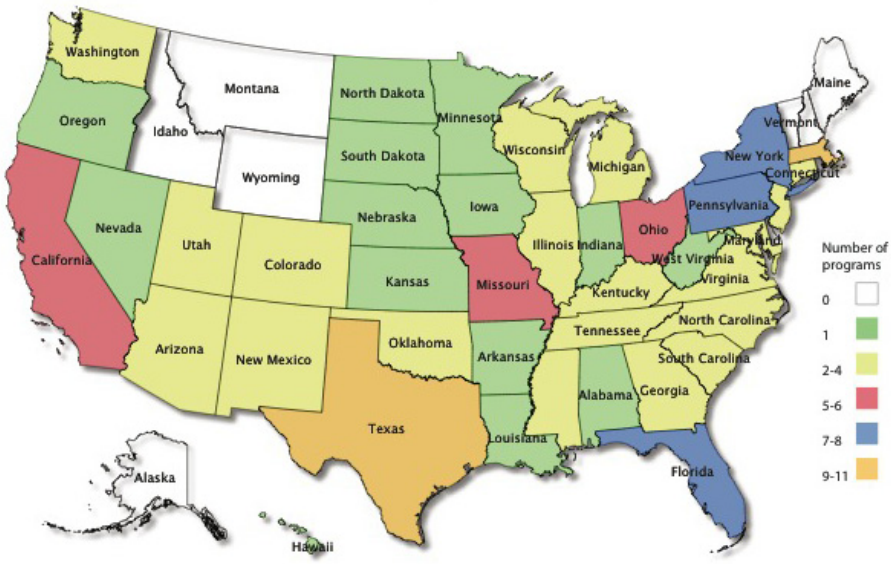

Figure 2: DNP Programs in Nursing

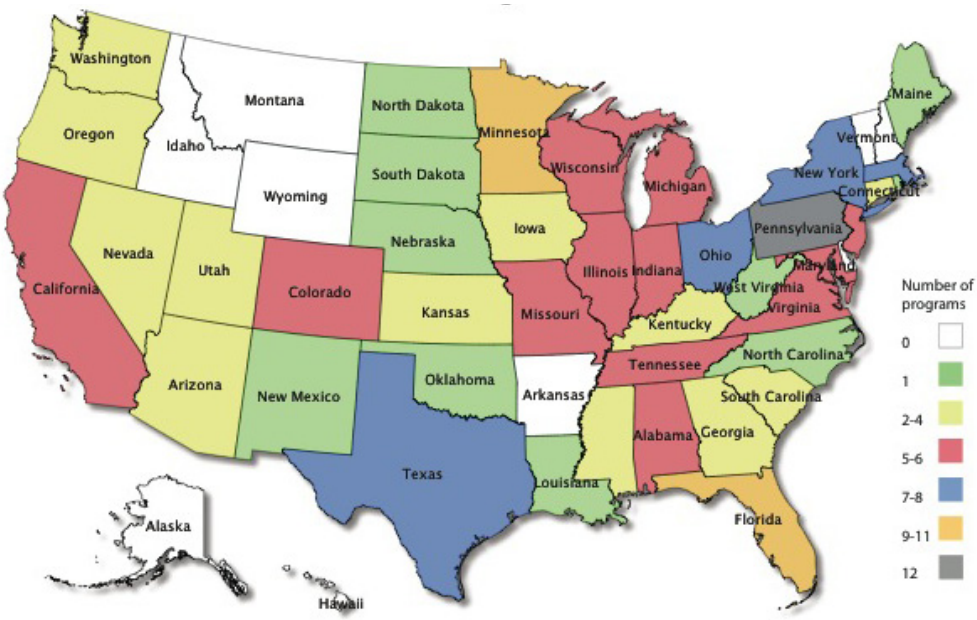

Table II shows the degree requirements for most PhD and DNP programs as listed on the schools' websites for post master students. The PhD curriculum model consisted of 2 to 3 initial years of specific course work in theory and research design, a candidacy qualifying exam, usually oral, followed by a dissertation. Some programs offered paid residencies in teaching and research while completing their dissertation.

The DNP curriculum model involved a capstone project and required a minimum of 500 clinical residency hours. Enrolling part time in a DNP program is possible and allows students to work part time and in some instances full time.

Websites described 3 possible modes of instruction: in classroom instruction, online instruction, and hybrid instruction (part on campus and part online). Table III shows that PhD programs use classroom mode of instruction more than DNP programs, and DNP programs use more online and hybrid modes of instruction than PhD programs.

Website data indicated 45% of the PhD programs required 3-plus years to complete the degree, whereas 38% were completed in less than 3 years. Of the DNP programs, 42% required 2 to 3 years, 6% took longer than 3 years to complete and 13% could be completed in 1 to 2 years.

Tuition ranged in cost depending on fee systems and whether the institution was private or public. Most programs charged by units (credit hours) or

Table I: Admission Requirements for PhD and DNP Nursing Degrees by Percentage and Number of Nursing Schools in the U.S. as Listed on Specific Nursing School Websites

	MSN	BSN	GRE	GPA 3.0	GPA 3.5	Interview	Statistics and/ or Computer Course	English Writing Proficiency	Current RN license
	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)
PhD n=112	95 (106)	68 (76)	82 (92)	35 (39)	32 (36)	63 (71)	45 (50)	91 (102)	76 (85)
DNP n=175	94 (165)	54 (95)	31 (55)	51 (90)	15 (27)	68 (119)	58 (102)	88 (154)	92 (161)

MSN=Master of Science in Nursing
BSN=Bachelor of Science in Nursing
GRE=Graduate Record Examination
GPA=Grade Point Average

by semesters. Few websites listed the overall cost of the program. The fees for a PhD degree ranged from a low of $456.00 per credit hour to a high of $1,000.00 per creadit hour. The lowest fee per semester was $2,800.00 compared to the highest fee of near $10,000.00 per semester.

For the DNP degree, cost for credit hour ranged from $173.00 to $1,200.00. DNP semester rates ranged from $2,200.00 to $11,000. For both degrees, non-residents attending a publically supported institution generally paid double that of residents.

Discussion

This study found that nursing doctoral education is rich and abundant with information for dental hygiene scholars to contemplate as the dental hygiene discipline moves forward in developing doctoral education. We identified from the nursing schools' websites and the nursing literature 4 main insights related to potential dental hygiene academic strategies.

The first insight is that nursing has 2 main doctoral degrees, the PhD, which is research focused, and the DNP, which is practice focused.[8-11] These 2 doctoral nursing degrees parallel the 2 main categories of degrees in academia: academic and professional. Academic degrees focus on knowledge development through research.[12] The master of arts (MA) and the master of science (MS) and the PhD are names given to academic degrees. Professional degrees focus on the application of knowledge to professional practice. For example, professional masters-level degree names, such as master of business administration (MBA), master of social work (MSW), doctor of education (EdD), doctor of medicine (MD), doctor of dental medicine (DMD) and doctor of dental surgery (DDS), are well known and highly regarded. Both academic and professional doctoral degrees need to be considered as the highest level degrees in dental hygiene as the discipline moves forward in developing doctoral dental hygiene education.

Table II: Degree Requirements for PhD and DNP Nursing Degrees by Percentage and Number of Nursing Schools in the U.S. as Listed on Specific Nursing School Websites

Requirements	Percentage	n
PhD Core Courses	40	45
PhD Dissertation	100	43
DNP Capstone or Scholarly Project	62	109
DNP Clinical Residency	54	94

Table III: Modes of Instruction for PhD and DNP Nursing Programs by Percentage and Number of Nursing Schools in the U.S. as Listed on Specific Nursing School Websites

	Percentage	n
PhD Classroom Instruction Only	68	76
PhD Online Instruction Only	18	20
PhD Hybrid Program	14	16
DNP Classroom Instruction Only	39	69
DNP Online Instruction Only	29	50
DNP Hybrid Program	32	56

A second insight into nursing doctoral education gained from the literature review is the need for doctoral-prepared nurses to meet the frequently referenced shortage of nursing faculty.[10-20] In an AACN survey of 603 nursing schools with graduate programs nationally, a total of 1,088 faculty vacancies were identified.[18] Most of the vacancies (91.4%) were faculty positions requiring or preferring a doctoral degree.[18] As asserted by one 2008 paper: "The

current system for doctoral education in nursing does not prepare the number of graduates necessary to either replace retiring faculty or expand capacity for nursing education at any level."[19]

Dental hygiene education shares similar faculty shortage statistics as the nursing profession. The growing need for dental hygiene educators and administrators is well documented.[21,22] A 2002 to 2003 survey of 264 U.S. entry-level dental hygiene programs conducted by ADEA concluded that "there is in fact not only a current faculty shortage, particularly in the area of culturally diverse educators, but the dearth of qualified faculty will likely be of critical proportions in the very near future."[22] The same survey reported that 38% of the dental hygiene programs responding had unfilled faculty vacancies due to a lack of qualified applicants. In addition, 68% of dental hygiene program directors indicated a need to replace fulltime faculty within the next 5 years due to projected retirements.[21,22] Compounding the problems associated with the very small number of dental hygienists entering academic careers is the aging of the current faculty and the potential leadership vacuum in the near future caused by the retirement of the current dental hygiene educators.[22] And as the population grows older and more medically complex,capacity building is needed to ensure quality dental hygiene faculty to prepare the dental hygiene workforce.[23] Doctoral prepared dental hygienists will be needed to teach masters-level graduate dental hygiene learners and to engage in administrative and leadership roles in health care organizations with impending changes in health care policies. There is evidence that with higher levels of education there is a correlation with better patient outcomes.[13]

The third insight into nursing doctoral education with implication for dental hygiene is the need for standardization to ensure quality and consistency among doctoral programs.[24-37] This need is reflected in a quote from a 1993 nursing paper: "There is a general concern that doctoral programs be of high quality because of their pivotal position in knowledge development for the discipline of nursing."[38] A reoccurring theme, also applicable to dental hygiene, is the need for the curriculum to address and reinforce nursing theory, concept development and nursing's distinct knowledge.[36] Of articles reviewed, a representative quote is: "Doctoral programs remain the most logical place in which to educate future scholars regarding nursing's unique philosophical foundations and their implications for scientific inquiry."[36] The need for quality and consistency among nursing doctoral programs is relevant as well for dental hygiene's development of doctoral programs. Insight gained from the nursing literature, informs dental hygiene that each discipline's paradigm concepts should be the thread that unifies all doctoral programs in the discipline to promote quality and consistency among the discipline's doctoral programs. These concepts define the core of the discipline, making it unique from other disciplines, and defining the discipline's boundaries.[3] As in nursing, the definition of the discipline of dental hygiene and its paradigm concepts should be the guiding principle for dental hygiene doctoral curriculum development.

The fourth insight gained from this review relates to actual steps and procedures used in developing and evaluating doctoral programs.[37-43] Evidence was provided from the perspective of faculty who presented concrete examples, models and perceptions about doctoral education along with student feedback from surveys.[38,40,41] Many of these articles included a detailed description of the steps involved in setting up a doctoral program from creating an exploratory task force to survey questions when evaluating a program five years post-graduation.[40] In addition, a variety of topics are discussed such as, student recruitment, online program development, quality assurance through systematic monitoring, creating budgets, getting buy-in from faculty, time tables, and general recommendations on what works and what does not work.

Finally, briefly reviewing the historical background of nursing doctoral education has important implications for the dental hygiene discipline because the current dental hygiene educational context resembles that of nursing at mid-twentieth century. Like some dental hygiene scholars today, in the 1950s, nursing educators strategically focused on developing nursing doctoral programs to educate masters-level nurses who would teach in the rapidly developing nursing baccalaureate programs.[4] In addition, nursing doctoral programs were needed to prepare faculty to do research that would target nursing actions and create a body of knowledge specifically for the discipline.[2]

Prior to 1980, the PhD degree was given primary consideration by nursing scholars to promote the development of the knowledge base for the discipline. However, the programs awarding professional nursing doctoral degrees (i.e. the Doctor of Nursing Science, i.e., DNSc/DNS) and academic nursing doctoral degrees (the PhD) were very similar in their objectives and end products.[4] Reasons for this similarity were threefold:

1. Doctoral degree granting institutions were skeptical that nursing was, or ever could be, an academic discipline, so the professional degree was

the only one possible, whether it was structured as a research-training degree or a more practice-oriented degree
2. Doctoral faculty in nursing were eager to build the nursing body of knowledge rather than the fields in which they had earned their degrees
3. Conceptual clarity about the relationship of the academic and practice elements of the discipline only gradually emerged (Flood, personal communication, May 2012)

The movement toward establishing the DNP began at the turn of the twenty-first century. The DNP was envisioned as a practice-focused degree for generalist MSN-prepared nurses, though currently for a transitional period a defined pathway for BSN-prepared nurses with advanced practice preparation, i.e. the specialist MSN, will also lead to the DNP degree.[44] Additionally, the AACN 2004 Position paper on the DNP put forth recommendations to establish the degree title of DNP as the title "to represent practice-focused doctoral programs that prepare graduates for the highest level of nursing practice." Although at present dental hygiene has no doctoral degree, currently, dental hygiene does have the academic master's degree (the MS in dental hygiene) and the professional master's degree (the MDH) but no clear distinctions between these degrees have been established in the discipline.

Currently, the 2 major doctoral degrees granted in the nursing profession are the PhD (the research-focused degree) and the DNP (the practice-focused degree). The dental hygiene discipline needs to look at the appropriateness of these 2 types of doctoral degrees when designing doctoral education programs. There is clearly a need to expand the knowledge of the dental hygiene discipline so the PhD degree seems a natural choice; however, there also could be an important benefit to developing a professional degree and both need to be considered carefully.

This study has several limitations. First, the articles available for our review fell into the 2 lowest levels of evidence (i.e., ideas, editorials and opinions, and case reports) based on ability to control for bias and to demonstrate cause and effect.[45] Secondly, the majority of articles found came from the Journal of Professional Nursing the publication of the AACN. Their membership includes over 700 nursing schools, and their mission is to promote and support higher education for nursing and so presents a bias towards higher education. A third limitation is that websites may be incomplete due to the priorities or oversights of the site's designers. For example, some PhD programs did not post information that was easily found about a dissertation requirement on the website, yet the dissertation, or a comparable published report of original research, is an integral part of all PhD education. Further research into the curriculum via college catalogues, academic calendars, and alternative web searches were necessary to learn about the dissertation requirements.

Conclusion

This website and literature review identified 4 insights and strategies for consideration by the dental hygiene discipline when establishing doctoral dental hygiene programs. With the current changes toward medically and socially compromised client populations, impending changes in health care policies, and the critical mass of master degree- prepared dental hygiene scholars ready to advance the discipline, now is the time for the profession of dental hygiene to establish doctoral education.

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Factors Associated with Clinical Skill Remediation in Dental Hygiene Education Programs

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Abstract

Purpose: The purpose of this study was to examine the challenges related to formal clinical remediation in dental hygiene programs, which include timing of student identification, policy development, and the issues of methodology and scheduling.

Methods: A 23 item investigator-designed survey was electronically distributed to all 303 U.S. entry-level dental hygiene program directors. This questionnaire included 23 forced-choice questions with the options to add comments to 8 of the questions. A total of 111 surveys were returned yielding a response rate of 36%. Descriptive statistics and Chi-square analyses were utilized to analyze relationships between responses and the degree earned from the dental hygiene program.

Results: All schools reported having a remediation policy; however, 13.6% of the respondents revealed this information was not readily available to students. The majority of respondents (67.8%) reported identifying students with clinical deficiencies in the preclinical semester, and 15.5% identified students in the second year, second clinical semester. Instrumentation technique was identified as the area in greatest need of remediation (81%), followed by critical thinking and problem solving skills (12%). Coordination of faculty and student schedules to conduct remediation was identified as one of the greatest challenges by respondents (25.2%). Results of this study suggest that challenges exist with the process of remediation. Some of these challenges include involving the student in remedial plan development, the academic consequences associated with remediation and scheduling time and space for remedial activities.

Conclusion: These findings indicate that respondents are well aware of the need for remediation policies in dental hygiene programs. The point in time varies when students in need of remediation are identified. Therefore, further research needs to be conducted to determine the reasons for this difference. Some reasons may include inability to grasp the foundational skills and/or the complexity of advanced instrumentation in the second year. Also, it is suggested that investigation regarding methods used to address the challenge of faculty and student scheduling for remediation sessions would be useful.

Keywords: dental hygiene, remediation policies, faculty overload, clinical skills evaluation, faculty shortages

This study supports the NDHRA priority area, **Professional Education and Development:** Investigate the extent to which new research findings are incorporated into the dental hygiene curriculum.

Introduction

Assessment of clinical skills in health care professions education is vital to the development of competent clinicians. Students who fail to demonstrate adequate progress often require additional student instruction in a clinical environment. Evaluation of students in a clinical environment can be difficult for a variety of reasons including faculty calibration, patient conditions and institutional guidelines. Early identification of skill deficits is critical in order for remediation to begin early in the educational process before deficiencies become complex.[1]

Health care professional programs adhere to rigorous policies relating to progression through the curricula because many skills build upon one another.[2-4] Dental hygiene programs must follow standards for student skill progression as set by the Commission on Dental Accreditation (CODA). These standards are in place to ensure the quality and continuous improvement of dental-related education while reflecting the evolving practice of dentistry.[5] The standards offer a rule or basis of comparison established in measuring or judging capacity, quantity, quality, content and value of a program.[5] CODA's standards consist of many competencies which are written statements describing the level of knowledge, skills and values expected by program graduates.[5,6] Competency-based education employs a unique component in that it measures a learner's ability to perform professional tasks similar to real-life work situations. It measures student performance against a standard as defined by written competencies.[2]

Completion of these professional

tasks is dependent upon clinical skill acquisition. In dental hygiene this involves dexterity, tactile and visual components. Clinical skill acquisition is one of the most complex aspects of dental hygiene education.[3] Learning the basic clinical skills begins early in a program and continues at an accelerating pace throughout the curriculum. Skill development is competency-based and occurs in conjunction with didactic learning critical for the dental profession.

When a student is unable to demonstrate adequate skill development to move to the next level, either academically or clinically, remediation often becomes necessary. Standard 2-2 of the American Dental Association (ADA) CODA standards for Dental Hygiene Education Programs states that "Academic standards and institutional due process policies must be followed for remediation or dismissal."[5] Although this appears very simplistic in nature, the actual process can entail multiple components and can be quite complicated. There are multiple factors surrounding the clinical remediation process including student identification, remediation plan development, and communication, implementation of the remediation plan and teaching methodologies to employ.

Recognizing and Communicating the Need for Clinical Skills Remediation

Szumacher et al reported that students in a medical radiation science program who are having difficulty either with the didactic or clinical component of their training are usually identified after the curriculum is well under way.[7] This can cause the remediation process to not only be more time intensive, but can also put the student at risk for not completing the program in a timely manner. Early identification of student's academic or clinical deficits may help increase the probability of student success in their dental hygiene program, and is important since each new skill builds on a previously learned skill. In a study by Holt, students listed academic and clinical difficulties as a primary reason for leaving a dental hygiene program, creating a need to explore the remediation process in dental hygiene programs.[8]

A study of clinical remediation in dental hygiene education by Branson et al asked dental hygiene program directors in the U.S. to define procedures utilized for clinical skill identification, evaluation of the instructor/student communication process, and implementation and outcome of student remediation plans.[9] Only 54% of the 181 respondents reported having any type of written policy on clinical remediation. Branson et al's study focused only on policy and methodology and not on the specifics of remediation plan development. However, the authors recommended that written plans be developed. Other authors have also recommended the development of written remediation plans and that these be developed by the academic advisor, focusing on strategies and criteria specific to the student's learning needs.[3] Defined goals and objectives, a realistic time frame, and how remediation will be addressed, evaluated and documented are important parts of the remediation process and should be included in a student remediation contract.[3,9] Establishment of a positive and supportive learning environment, clearly understood clinical learning objectives by the faculty and the student, evaluation based on multiple sources of evidence, timely and relevant feedback in direct correlation with the learning objectives, and a fair clinical evaluation process to all concerned are suggested components in the course of action.[4] The remediation contract should also include the student's reflection on the area of his performance not meeting clinical competency, and the student's plans to enhance and improve his future performance.[3]

Instructional Methods for Clinical Remediation

An earlier study found instructional methods used in clinical remediation processes varied among individual dental hygiene programs.[9] Dental hygiene program directors reported the most common remediation methods were the same as those employed in basic clinical skills instruction: skill acquisition using typodonts, one-on-one faculty instruction and additional supervised clinical practice time.[9] Other methods of remediation include the faculty serving as a patient, peer tutoring, videotaping and occasionally dental office observation.[9] All of these methods can prove to be very challenging, due to the lack of available clinic times as well as the limited availability of both the student and the instructor.

Dental Hygiene Faculty and Clinical Remediation

All of the instructional methods described above involve a certain amount of faculty participation. This participation can add to the faculty workload and is often a barrier in conducting successful remediation plans.[3,10] Remediation must be supported and guided by the faculty who are able to assume responsibility for clinical skill remediation instruction.[4,11,12] This is often difficult due to faculty/student ratios. Accreditation standards outline student instructional time in clinics and laboratory sessions, as well as faculty to student ratios for these sessions. For dental hygiene educational programs and faculty, implementing these standards results in heavy clinical teaching loads and contact hours in all dental hygiene degree programs.[13]

Faculty shortages often lead to barriers in supplying the proper student/faculty ratios. Collins et al re-

ports that the inequity between salaries in education as compared to private practice has an effect on the number of dental hygienists applying for teaching positions.[13] Dental hygiene faculty must possess a baccalaureate or higher degree in order to provide didactic instruction in a dental hygiene program.[5] The number of baccalaureate programs is much smaller in number than the associate level programs, leading to a lower percentage of graduates who not only pursue, but are qualified to enter the educational professions.[10,12]

The Need for Updated Research on Dental Hygiene Clinical Skills Remediation

The Branson et al study examined remediation in dental hygiene programs, by exploring the clinical skills evaluation procedure, instructor/student communication process, and implementation and outcome of student remediation.[9] Freudenthal and Bowen focused on some of the policies and appeals processes for clinical remediation and found that early identification of the clinical skill deficit, a student-centered approach, learning contracts and faculty monitored remediation all contributed to high student retention rates and successful student outcomes.[3] However, Holt studied retention practices in associate degree programs and reported that associate degree, entry–level dental hygiene programs are committed to student retention.[6,8]

While literature on remediation issues in allied health programs is vast, the literature on dental hygiene remediation in educational programs is limited.[3,9,14-18] Limitations and gaps in exploring the topic of remediation in clinical dental hygiene education exist. These limitations include a lack of clarity in policies revolving around remediation and how these policies are communicated to the students, a lack of clarity in all types of instructional methodologies used to remediate students and an incomplete investigation of the barriers surrounding dental hygiene student remediation. Therefore, the purpose of this study was to examine the issues related to formal clinical remediation in dental hygiene programs. This study incorporated topics from previous works, and new questions were added to a survey previously distributed by Branson et al in 1995 that addressed the above mentioned limitations in the literature of clinical remediation.[3,9]

Methods and Materials

A survey developed by Branson et al on issues related to clinical skill remediation in dental hygiene education was modified for this study and distributed in an electronic format to 305 dental hygiene program directors in the U.S.[9] The questionnaire consisted of 23 questions and included topics relating to the need, timing, process, design and implementation of clinical remediation. In addition, general demographic information was sought. While 18 of the questions were forced-choice for ease of data analysis, participants were given the opportunity to provide additional information in the 5 remaining questions. The survey was delivered via email to the addresses of the 305 dental hygiene program directors which were provided by the American Dental Hygienists' Association (ADHA). Included were instructions for the program director to forward the survey to the faculty person most closely associated with clinical skill remediation.

Following the University of Missouri Social Sciences Institutional Review Board approval, the survey was pilot tested for review of content and face validity. This quasi-random pilot study selected programs from 5 different geographical regions in the U.S. prior to distribution. The different regions included the northwest, southwest, northeast, southeast and the central plain states. One associate degree program and one baccalaureate program was selected from each region to complete the pilot study. Seven programs participated in completing the pilot test. After reviewing the piloted results, the survey was revised for clarity and specificity.

The survey was delivered using Constant Contact, a public survey and marketing platform.[19] All participants received the survey on the same day and in approximately the same time frame. Survey responses were delivered back to the researcher via an Excel file created by the survey and marketing platform. Responses were anonymous to the researcher.

Non-responders were identified by the marketing platform 2 weeks after the initial survey was distributed, and contacted by the researcher in order to secure a higher response rate. The survey and marketing platform is automatically designed to contact non-responders, limiting the primary investigator's knowledge of those dental hygiene programs that did not reply within the first 2 weeks of launching the survey. All data were provided to the primary investigator in aggregate form to ensure anonymity.

Data were analyzed using descriptive statistics. A Chi-square analysis was conducted on 3 questions to determine if a relationship existed between the type of remediation policy offered, the greatest remediation challenge and method of faculty compensation in data from dental hygiene programs at the associate level versus the baccalaureate level.

Results

An overall response rate of 36% (n=111) was obtained. The degrees awarded at these institutions included Certificates, Associate of Applied Science, Associate of Science or Bachelor of Science. Com-

Table I: Availability of Written Policies for Formal Remediation (n=111)

Student/college handbook	32.7%
Course syllabi	54.5%
Clinic manual	50.9%
Other course material	13.6%
Not available to students	13.6%

*Sum is greater than 100% due to multiple answers allowed

Table II: Location of Policies for Academic Appeal (n=111)

Student/college handbook	94.5%
Course syllabi	21.6%
Clinic manual	25.2%
Not included in course materials	1.8%
Not included in school materials	0%

*Sum is greater than 100% due to multiple answers allowed

munity colleges represented 52.7% of the responses, 20% were university based (however, not in a dental school), 14.5% were from vocational and technical institutes, 8.1% were located in schools of dentistry, and 6.3% represented proprietary schools. A total of 63% listed a 5:1 student/faculty ratio in their preclinic setting. This ratio was consistent with accreditation guidelines and varied no more than 2% in all of the clinical settings during the entire program. The questionnaire sought the dental hygiene program's overall use and implementation of remediation plans - specifically whether they had formal plans in place should the need for remediation arise. The survey also investigated the most common time for a student to be identified as needing remediation, how plans are presented to the student, what instructional methods are used in remediation, how faculty are compensated for the "extra" time needed to implement remediation and overall challenges involving clinical remediation.

Presence of plans: Respondents revealed that 54.5% of programs had written policies for formal clinical remediation available to students in the course syllabi, with 13.6% reporting this information as unavailable to students (Table I). A total of 94% reported policies and procedures informing students how to participate in an academic appeals process made available in the student/college handbook, while only 1.8% did not include any of this content in their course materials (Table II). Since many of the responses regarding the location of the written remediation program policies were left unanswered (47%), perhaps the respondents were unsure as to where the policies were actually located. Lack of familiarity with policies presents an important difficulty in clinical remediation.

Identification of Need for Remediation: The preclinical semester in the curriculum was where the majority of respondents reported identifying the student in need of remediation (67.8%). Following closely behind at 62% was the first year clinical semester, while 59% indicated that the need for remediation was not identified until the second year.

Utilizing poor performance on clinical skills assessment was reported by 97%, while 96% utilized faculty observation to determine the need for formal clinical remediation. Faculty meetings and conversations as guided measures of determining a clinical deficiency were used by 73%, while 56.7% utilized a review of daily evaluations. Many respondents commented on using a combination of several of these methods in determining the need for clinical remediation.

Presentation of Remediation Plan: The need for clinical skill remediation is most often communicated to the student by both written and verbal notice, according to 85.5% of the respondents. Communication with the student using only verbal notice was not as popular (11.7%), and the least popular method was written notice (less than 1%). Almost 57% of respondents reported remediation exercises to begin within the same week of the initial identification. Almost 20% reported initiating the remediation process immediately upon identification. Formal remediation plans or contracts with students occurred in 62% of the represented institutions, while 27% reported sometimes and 11% reported none.

In 43% of the programs who do prepare a remediation plan or contract, the clinical coordinator both writes and presents the contract to the student. In the remainder of the programs who do prepare a written plan, 23% are prepared by the program director and the other 23% are prepared by a full time clinical instructor.

Instructional Methods: Clinical remediation for instrumentation skills seemed to be the most common need for students (80%). Other less common themes were critical thinking and problem-solving skills (11%), and respondents did not heavily indicate that these were the primary causes for lack of student progress. A variety of instructional methods were utilized when performing the clinical remediation, with the most common method being one-on-one faculty instruction. Typodont practice in a laboratory setting was utilized by 88%, and approximately 71% gave additional clinic time under one-on-one supervision to their students. A clinical faculty member was identified in 62.9% of the programs as the person responsible for performing the clinical remediation (Table III).

Compensation for Faculty: Of the involved faculty

Table III: Person Responsible for Performing Clinical Remediation (n=111)

Clinical faculty member	62.9%
Clinical coordinator	26.8%
Dental hygiene program director	7.4%
Person most closely working with the student at that particular time	28.7%

*Sum is greater than 100% due to multiple answers allowed

members, 69% were uncompensated for remediating the students, while 18.9% were compensated and 10% were given release time from other program responsibilities. Overall, 35% reported having to exceed their contract hours in order to fulfill these academic obligations (Table IV). Other respondents reported that remediation was considered part of their contract responsibilities, was to be planned during faculty office hours or sometimes allocated to part-time clinical instructors.

Challenges: Two factors were reported as posing the greatest challenge in regards to clinical skill remediation. A total of 25% reported the necessity of identifying the student's deficiency in a timely fashion as a challenging issue, and the same number reported faculty availability to facilitate the remediation as being an issue. Selecting the most beneficial instructional tool to facilitate remediation was reported as the greatest challenge by 17% (Table V).

Three questions were analyzed using Chi-square to determine if a relationship existed between the type of degree awarded and the response given. There was no statistical relationship between the type of degree awarded and the location of written policy, greatest remediation challenge and method of faculty compensation.

Discussion

Remediation is a necessary function within dental hygiene clinical education. Factors associated with this process can hinder or facilitate a student's progress and overall success in a program if remediation is needed. Per accreditation standards, dental hygiene programs must ensure mechanisms are available for students who require remediation. This study sought to examine the various methods schools use to address this need, realizing there were multiple challenges associated with remediation. Results indicate there are multiple factors which can affect the presence, preparation and presentation of remediation policies in entry-level dental hygiene programs, including timing of the identification of the deficiency and methods utilized to remediate the student, as well as the barriers associated with the educational process.

Table IV: How Faculty Members Accommodate Extra Remediation Responsibilities (n=111)

Exceed contract hours	35.1%
Released from other contract responsibilities	20.7%
Additional faculty hired	5.4%
Interaction with non-faculty professionals, i.e. private practice observation	0%
Other	36%
No responses	2.7%

Table V: Factor Which Poses Greatest Remediation Challenge (n=111)

Identification of remediation need in a timely fashion	25.2%
Notifying the student of the need for clinical remediation	0%
Preparing student plan or contract	5.4%
Selection of the most beneficial instructional methods	17.1%
Student availability	8.1%
Faculty availability	25.2%
Faculty compensation	7.2%
Lack of clinic access	9.9%
No responses	1.8%

Presence, Preparation and Presentation of the Remediation Policies

Since only 62.1% of the program respondents reported having a definite remediation plan or contract prepared and presented to the student, this may be a factor in the communication process involved in the notification. Of that number, 57.6% reported incorporating any of the student's input in the plan or contract. Acquisition of a dental skill is facilitated when students know the criteria that define the acceptable product and performance, and when students and faculty can actively and precisely evaluate product and performance.[8] Incorporation of the student's thoughts would not only help to create an awareness of the need, but also the essential criteria for a successful solution. Of the 43% of programs who do prepare a remediation plan or contract, the clinical coordinator both writes and presents the contract to the student. In the remainder of the programs who do prepare a written plan, 23% are prepared by the program director and the other 23% are prepared by a full time clinical instructor. In these cases, the presentation to the student can occur by the clinical faculty member or the program director.

Notification, Timing and Identification of the Clinical Deficiency

As the Branson et al study found, 98% of faculty members communicated with each other at some time during the program regarding the need for clinical skill remediation, however, it was stated that student notification was not always top priority.[9] This study revealed that, while slightly over half of the programs were identifying and notifying students of their clinical deficiencies in the first or second semester of their first year, the remainder were being identified during their second clinical year. This presents a problem, as many clinical instrumentation skills are built one upon another. Late student identification and notification can put a student at risk, adding to the development of incorrect habits coupled with the possibility of a graduation delay. Since advanced instrumentation skills are introduced during the second year of the program, it is possible that some students may acquire instrumentation deficits during the same year as the anticipated graduation. However, if proper habits were attained initially, these instrumentation weaknesses should not be difficult to correct. Extreme cases of student failure to successfully remediate have resulted in dismissal from the program. Methods utilized to determine the deficit were faculty observations in clinical performance, poor performance on clinical skills assessment, review of daily evaluations and faculty meetings and conversations. Since these measures are all part of the clinical process, other barriers become factors intertwined with the clarity of this process, thus resulting in further possible delay of the student's progression in the clinical process.

Instructional Methods Utilized in the Remediation Process

The instructional methods utilized today in the student remediation process are the same as in the Branson study.[9] The most common form of instruction is working one-on-one with a dental hygiene faculty member, due to the complex nature of clinical skills acquisition.[2] This can occur either in a laboratory or clinical setting. The second most common instructional method used involves typodont practice in a laboratory setting. The third most popular type of instructional method used is extra clinic time under one-on-one faculty supervision. Various other methods were utilized in a small number of cases. These all have a common thread in that they require the undivided attention of an instructor and/or additional student clinic time and availability. This instructor participation can add to the faculty workload which is often a barrier in conducting successful remediation plans.[2]

Barriers with the Remediation Process

The greatest challenges associated with the remediation process according to the survey respondents were identifying the student's need in a timely fashion and having the faculty availability to meet the remediation needs of that student. Other barriers identified from the survey were selecting the most beneficial instructional method to be utilized and the issue with faculty compensation regarding the extra time associated with the remediation process. Composing and presenting student-engaged remediation plans is a difficult process, but these plans reinforce necessary performance criteria designed for student completion and success. A study performed by Hinshaw et al reported a significant amount of faculty stress already accompanying the academic and clinical responsibilities of dental hygiene educators.[20] As one of the respondents stated, "Student remediation exercises fall under the umbrella of 'office hours', which is already overbooked!" Faculty collaboration to institute a specific policy and procedure regime could decrease the amount of time spent in the overall faculty involvement of the remediation process. Faculty compensation was nonexistent in 69.3% of the programs who responded. Many schools have experienced a decrease in funding, resulting in a shortage of faculty salary funds.[21]

Conclusion

This study was based on concepts presented in a 1998 report on clinical skill remediation. It appears that little has changed in this area of remediation in the past 15 years. A greater depth of investigation into the field of specific remediation methods utilized, barriers to implementation and methods demonstrating the most successful outcomes would be useful.

The faculty involvement in the remediation policy development and presentation would be interesting. Training programs, including topics such as early identification of students needing clinical remediation, methods for delivery of remediation and preparation of remediation documents and legal issues, need to be developed. In summary, the topic of clinical skill remediation is one that offers multiple avenues for further research, as is demonstrated above.

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Evaluating Meaningful Learning Using Concept Mapping in Dental Hygiene Education: A Pilot Study

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Abstract

Purpose: Concept mapping, as a teaching strategy, has been shown to promote critical thinking and problem solving in educational settings. Dental clinicians must distinguish between critical and irrelevant characteristics in the delivery of care, thus necessitating reasoning skills to do so. One of the aims of the American Dental Education Association Commission on Change and Innovation (ADEA-CCI) is to identify deficiencies in curriculum which were meant to improve critical thinking and problem solving skills necessary in clinical practice. The purpose of this study was to compare 2 teaching strategies, traditional lecture and lecture supported by concept mapping exercises within collaborative working groups, to determine if there is a beneficial effect on meaningful learning.

Methods: For this pilot study, the study population consisted of students from 2 geographically separated associate level dental hygiene programs in the southeastern U.S. A quasi-experimental control group pre- and post-test design was used. The degree of meaningful learning achieved by both programs was assessed by comparing pre- and post-test results.

Results: Both programs experienced a significant degree of meaningful learning from pre- to post-test. However, there was no statistically significant difference between the programs on the post-test. These results were in direct contrast to research in other disciplines on concept mapping and its effect on promoting meaningful learning. Further investigation into the study's outcome was obtained through a follow-up focus group.

Conclusion: In spite of careful attention to methodology in the development of this research project, the focus group illuminated methodological failings that potentially impacted the outcome of the study. Recommendations are underscored for future conduct of educational research of this kind.

Keywords: concept mapping, critical thinking, meaningful learning, faculty development

This study supports the NDHRA priority area, **Professional Education and Development:** Validate and test measures that evaluate student critical thinking and decision-making skills.

Introduction

In 2006, repeated calls for change in the way dental hygiene education is delivered from both outside and within dentistry led to the formation of the American Dental Education Association Commission on Change and Innovation in Dental Education (ADEA CCI). ADEA CCI issued a white paper that outlined 8 core principles that the CCI felt should characterize dental education and inform curricula.[1] Two of the ADEA CCI core principles are central to this research study: critical thinking as the cornerstone of the dental education experience, and faculty development.

The ADEA-CCI identified deficiencies in curriculum which were meant to improve critical thinking and problem solving skills necessary in clinical practice.[2] This issue is not unique to dentistry, as educators across the country are struggling with how to promote critical thinking and problem solving in the educational environment where students often focus on memorization to learn, and fail to fully engage in critical thinking and problem solving for meaningful learning.[3] Haden et al posit that a dental educational environment characterized by the discipline of critical thinking develops self-directed, self-disciplined and self-corrective learners.[1] A teaching strategy, concept mapping, has been shown to promote critical thinking and problem solving in educational settings.[4-5] This study compared 2 teaching strategies, traditional lecture and lecture supported by concept mapping exercises within collaborative work groups, to determine if there was a beneficial effect on meaningful learning and promotion of critical thinking and problem solving.

Dental educators acknowledge the need to improve critical thinking strategies to encourage good clinical judgment.[6,7] Since the vast majority of dental hygiene students will spend their careers in clinical settings, it is important to consider how educational strategies can promote good clinical judgment. Williams et al explored the issue of critical thinking in dental hygiene education and found that the educational experience did little to promote critical think-

ing as assessed by a pre- and post-test.[7] The authors emphasized the need for preparation in critical thinking practices to begin within the first semester of the students' pre-clinical curriculum. By employing teaching strategies that have been theorized to promote higher order thinking, educators can potentially foster skills required for critical thinking and problem solving at the onset of the students' specialized education. Both Wallace et al[6] and Williams et al[7] emphasized the need for faculty development and improvements in pedagogical processes to enhance critical thinking and problem solving.

Critical thinking and problem solving, though related, are distinct concepts. One main distinction between these processes is that critical thinking involves evaluation, whereas problem solving is goal oriented.[8] Skills involved in critical thinking can be defined as locating information appropriate to a purpose, analyzing an argument, differentiating fact from beliefs, and weighing evidence or options. These are quite different from skills utilized in problem solving, which are strategic and organizational in nature. They include recognizing a problem exists, selecting a strategy, implementing a strategy and evaluating the results. Critical thinking and problem solving, though separate entities, coexist in support of each other and share a common foundational base in their development, meaningful learning. Meaningful learning, as opposed to rote memory, requires an in-depth understanding of material where facts are not isolated but rather interrelated and newly learned concepts are directly associated with those previously learned.[9] However, rote learning, while not generally useful by itself, is essential to meaningful learning as it forms the basis/linkage of foundation knowledge to new material. The distinction between rote and meaningful learning is not a simple dichotomy, but rather a continuum of the learning process along with the student's willingness to achieve rich and meaningful learning outcomes.[10] Two main goals in the learning process are the retention and the transfer of information. Retention is remembering previously learned information, whereas transferring involves the application of what one has learned in one situation to another situation. An obvious example would be how students transfer classroom learning to a clinical setting. The accomplishment of this kind of learning transfer has been defined as an indication that meaningful learning has occurred.[11]

Meaningful learning is not a new phenomenon in education. David Ausubel formulated the Assimilation Theory of Meaningful Learning in 1963, in which he hypothesized that complex knowledge requires understanding for conceptual meaning to be achieved and for meaningful learning to occur.[12] His theory has aided in understanding how humans learn by linking old and new knowledge, and can be defined as a cognitive, goal oriented process that is active, constructive and cumulative over time. Knowledge gained through meaningful learning can then be applied or transferred, through the process of critical thinking or problem solving.[10,11] Ausubel's contributions to conceptual learning and knowledge construction are supported by the work of developmental psychologists and constructivist theorists Jean Piaget[13] and Lev Vygotsky.[14] Their work emphasized the conceptual nature of the framework of learning, the need for pre-existing knowledge with which to construct one's own understanding and meaning of new knowledge (constructivism), and the influence of social interactions on the learning process (social constructivism).

Research has identified concept mapping as an effective educational strategy that is supported by cognitive constructivism and cognitive neuroscience theories for the promotion of meaningful learning.[15-18] Concept mapping builds on the science of constructivism in that the act of mapping provides the venue for students to process information and organize knowledge. Further, by working within peer groups, the student not only presents their own pre-existing knowledge but is given the opportunity to hear their peers process the information by each bringing their own unique pre-existing knowledge to the exercise.[15] The mapping exercise concentrates on a main subject or discipline and the linking of interrelated concepts establishes and/or builds a knowledge base for students to reflect upon. They are designed in two-dimensional formats to illustrate hierarchical and interconnection of concepts. The explicit mapping exercises involve strengthening links between various properties as ideas, text, etc., to create meaningful conceptual associations. Informed through the works of Vygotsky, Piaget, Ausubel and recent brain-based research in the neurosciences, McKay and Gibson conclude that curriculum development that proceeds from a constructivist and cognitive neuroscience perspective should recognize the centrality of the following 4 doctrines: visual representation, active learner involvement, the use of new and previous learned knowledge and social interactions to facilitate the learning process.[15]

This study was designed based on the intersection of educational theory, cognitive science and neuroscience research. The purpose of this study was to compare 2 teaching strategies, traditional lecture and lecture supported by concept mapping exercises within collaborative groups, to determine if there is a beneficial effect of concept mapping and social learning on meaningful learning. This study was approved by the institutional review boards of all participating institutions.

Methods and Materials

For this pilot study, the study population consisted of students from 2 geographically separated associate level dental hygiene programs in the southeastern U.S. A quasi-experimental control group pre- and post-test design was used to examine the effects of concept mapping on meaningful learning. In educational settings it is often impossible to have a true control group which would involve random assignment. The test group (Dental Hygiene Program 1) received the new method of instruction (for purposes of this study this included concept mapping in collaborative groups). The control group (Dental Hygiene Program 2), sometimes called the quasi-control group, received the traditional method of instruction (for purposes of this study lecture alone). Applying strict scientific methods to educational research which would involve randomization and a true control group is not easily accomplished. A quasi-experimental control group pre- and post-test design was used to examine the effects of concept mapping on meaningful learning, followed by a focus group of participants from Dental Hygiene Program 1.

Educational researchers must incorporate several steps to ensure the validity and reliability of outcomes. First, threats to internal validity were minimized by the following design measures. A control and test group study design using 2 different dental hygiene educational programs for data collection was employed to address the internal validity threat of diffusion of treatment. Using 2 geographically separated dental hygiene educational programs with no known relationship eliminated interaction of compensatory rivalry, compensatory equalization of treatment and/or resentful demoralization should this have occurred within the study. Second, internal threats to validity involving history and maturation were minimized by the use of a comparison group. Finally, testing threats were minimized by using different but equivalent forms of pre- and post-test instruments.

The statistical design reflected in this study is one of a two-factor, repeated measure. Analyses include comparisons of treatment and control groups at pre- and post-instruction periods as well as differences within each student group. The Ryan-Einot-Gabriel-Welsch Multiple Comparison Procedure was used with the appropriate error terms taken from the designs' repeated measures ANOVA. A Bonferonni adjustment for the 4 comparisons was made.

Subjects

First year, entry level dental hygiene students from Dental Hygiene Program 1 (test group) and Dental Hygiene Program 2 (control group) were recruited during the first week of the 2010 fall semester. The entering classes from Dental Hygiene Program 1 (test group, n=36) and Dental Hygiene Program 2 (control group, n=42) were offered the option to participate in the study while taking the course Dental Radiology. Course selection for this study was based on applying concept mapping to a foundational course within the dental hygiene curriculum to assist in the development of the students' knowledge base. A total of 33 students from Dental Hygiene Program 1 (test group) and 26 from Dental Hygiene Program 2 (control group) chose to participate in the study.

Table I: Demographics of Study Participants

Characteristics	Program 1 (test group) n=33	Program 2 (control group) n=26
	n (%)	n (%)
Gender		
Female	32 (97)	24 (92)
Male	1 (3)	2 (8)
Ethnicity*		
Hispanic or Latino	3 (10)	17 (65)
Non Hispanic or Latino	30 (90)	9 (35)
Age		
20 to 22	8 (24)	8 (31)
23 to 25	4 (12)	10 (38)
26 to 30	13 (39)	3 (12)
30+	8 (24)	5 (19)
Education		
1 year	2 (6)	5 (19)
2 years	19 (58)	11 (42)
3 years	5 (15)	6 (23)
4 years	2 (6)	4 (15)
More than 5 years	5 (15)	-
Experience		
No experience	19 (58)	20 (77)
1 year experience	8 (24)	3 (12)
2 years experience	3 (9)	2 (8)
Did not respond	3 (9)	1 (4)
GPA		
4.0 to 3.75	8 (24)	3 (12)
3.74 to 3.5	10 (30)	5 (19)
3.49 to 3.0	14 (42)	16 (62)
2.99 to 2.5	1 (3)	2 (8)

*p<0.001 (significant difference between programs)
Numbers may not equal 100 percent due to rounding and non-response

Table II: Pre- and Post-Test Question Analysis

Subject Categories	Percent clock hours (27) spent on lecture to number of test questions corresponding to percent clock hours	Dental Hygiene Program 1 (test group) Clock Hours/ Percent	Dental Hygiene Program 2 (control group) Clock Hours/ Percent
1. Foundational Knowledge: Radiation basics and production/equipment, Radiobiology, Infection Control, Safety and protection, prescribing radiographs, patient education and management	28% 14 questions	7.5 28%	7 26%
2. Application an d Procedural Knowledge: Film handling, processing ,image characteristics and diagnostic quality, techniques, ethics and quality assurance	33% 17 questions	9 33%	9.5 35%
3. Assessment Knowledge: Anatomy and interpretation	24%/ 2 questions	6.5/24%	6.5/24%
4. Panoramic/Extraoral radiology, Digital Supplemental procedures	15% 7 questions	4 15%	4 15%
New course content presented	-	27	27
Review for exams	-	2	3
Exams	-	3	2

Participation in the study was completely voluntary. Demographics were gathered on all students participating in the study to include gender, ethnicity, age, years of undergraduate education prior to admission to dental hygiene, prior experience in the dental field and grade point average at the initiation of the study (Table I).

Procedures

The material and content taught in each course were independently analyzed by the primary and co-investigator to ensure comparability. Using the course syllabi, comparability was determined through a thorough examination of course similarities and content. A total of 4 subject categories were mutually agreed upon:

- Subject Category 1: Foundational Knowledge (this included radiation basics, production and equipment, radiobiology, infection control, safety and protection, prescribing dental radiographs, patient education and patient management)
- Subject Category 2: Application and Procedural Knowledge
- Subject Category 3: Assessment Knowledge
- Subject Category 4: Panoramic/Extraoral Imaging, Digital Radiology and Supplemental Procedures

The identified subject categories (1 through 4) were analyzed to determine amount of class time devoted to each (Table II). This information was then used when determining the proportion of test questions to include for each subject area on the pre- and post-test.

In an effort to categorize outcomes and, thereby, provide structure to objective evaluation by the expert reviewers in this study, a cognitive taxonomy was employed. One of the best recognized cognitive taxonomies is that of Bloom's.[19] In this taxonomy, Bloom attempted to organize learning into levels according to the sophistication of mental effort necessary to meet a given goal. In 2001, a revision of Bloom's original taxonomy was published.[20]

Test questions were constructed by the primary investigator to represent levels of meaningful learning as defined by Bloom's Original Taxonomy of Learning Domains (application, analysis, synthesis and evaluation), and were similar in content and form to questions found in national dental hygiene board review books.[19] To establish content validity of the test questions, 3 expert reviewers were selected to evaluate test questions for content accuracy and to independently determine levels of Bloom's taxonomy. All of the expert reviewers are authors of currently used dental radiology textbooks in dental hygiene programs across the U.S. Test questions determined by the content experts to be accurate and that were representative of Bloom's ratings of application and above were considered valid for capturing meaningful learning and thus used in the study.

For the pre- and post-test, 50 test questions were

randomly selected for each from the pre- and post-test banks using a procedure that randomly selected a representative number of questions, as described above, from each subject category. Each test question was of equal weight when calculating scores and averages. This study assumed that test questions selected from the same set would produce equivalent instruments (pre- and post-test). During the first week of the 16 week fall semester 2010, all students from both participating institutions were given a sealed packet from their course instructor containing a consent form, a demographic survey and a pre-test.

Students at Dental Hygiene Program 1 (test group) who agreed to participate received traditional lecture with the use of PowerPoint assisted instruction and concept mapping teaching strategies designed to support corresponding lecture content. Prior knowledge in how to concept map is a requirement for successful mapping and consideration was taken within the study to introduce the fundamentals of concept mapping to students. A session was conducted at the beginning of the semester to provided information on the nature of concept mapping and instruction in how to construct concept maps through visual imaging, hands-on mapping exercises, open discussions and group activities for social learning. Four collaborative concept mapping sessions were scheduled and delivered throughout the semester. Collaborative learning groups were established for concept mapping exercises, and consisted of 4 randomly assigned students each. Student groups changed for each of the 4 concept map sessions to allow students to work with different members of their class. It was the design of this study to vary the groups to eliminate student pairings and maximize heterogeneity and diversity within the study. Each group was randomly assigned a facilitator from within each group of participating members to initiate discussions and concept mapping strategies. In contrast, students at Dental Hygiene Program 2 (control group) were taught via traditional lecture with the use of PowerPoint assisted instruction.

Each collaborative concept mapping exercise was initiated by a definitive task as a question obtained from course content presented during the 3 weeks of lectures held prior to each mapping session. For the first concept mapping exercise a template was provided by the primary investigator for students to complete in their assigned groups. This template guided the students through the initial mapping exercise by providing necessary nodes, links and phrases for map completion using pen and paper. For the second concept mapping exercise, a template was also provided, with fewer cues in the forms of nodes, links and phrases. Concept mapping requires an understanding in fundamental processes of linking information; these templates provided an illustration to assist students through the initial mapping exercises. Students worked collaboratively to complete this map within their groups. Subsequent concept mapping exercises required students to create free-formed concept maps within their collaborative groups without any assistance or cues from the investigator. After each concept map assignment, several student groups were selected to share their maps with the entire class describing their experiences regarding the exercises and use of concept mapping on meaningful learning. Each concept mapping session lasted approximately 25 to 30 minutes, and was held every 3 weeks over the 16 week semester. A relaxed, discussion friendly environment was established during these sessions. During the sixteenth week of the study, a post-test was administered by the course directors to all study participants (n=59).

Results

The demographic differences between the programs were limited to age, ethnicity and experience. However, when analyses were conducted only ethnicity was found to be statistically significant ($p<0.001$, Table I). Dental Hygiene Program 1 (test group) students were overall older, less ethnically diverse and possessed more experience in the dental field prior to entering the program than Dental Hygiene Program 2 (control group). There was a 9% dropout rate (three participants) for Dental Hygiene Program 1 (test group). Two of the subjects left the program prior to the end of the semester due to personal reasons, and 1 subject chose not to participate in the post-test. Pre-test scores of the 3 students who dropped out of the study ranged from 11 to 21. Dental Hygiene Program 2 (control group) did not experience any subjects dropping from the study, thus analyses were performed using pre- and post-test scores from those students who remained in the study throughout the entire duration of the semester (56 of 59, 95% participation rate).

There was a significant difference between the 2 programs on the pre-test ($p<0.05$). Dental Hygiene Program 1 (test group) demonstrated an average pre-test score of 19.33 with a 5.5 standard deviation compared to Dental Hygiene Program 2 (control group) which scored an average of 14.15 and a standard deviation of 3.0. The degree of meaningful learning achieved by those in Dental Hygiene Program 1 (test) and Dental Hygiene Program 2 (control) was assessed by comparing pre- and post-test results. Both programs experienced a significant degree of meaningful learning from pre- to post-test. However, there was no statistically significant difference between the programs on the post-test (Table III).

Final test results were analyzed for internal consistency reliability estimates within each of the subject categories using Cronbach's Alpha. Reliability estimates were as follows:

- 0.54 for Domain 1: Foundational Knowledge
- 0.65 for Domain 2: Application and Procedural Knowledge
- 0.39 for Domain 3: Assessment Knowledge
- -0.01 for Domain 4: Panoramic/Extraoral Imaging, Digital Radiology, and Supplemental Procedures

As a result of the erratic reliability estimates on the pre- and post-test, and the considerably larger variability in the scores of Dental Hygiene Program 1's pre- and post-test scores, a small focus group consisting of 6 students from Dental Hygiene Program 1 (test group) were gathered in an attempt to gain additional insight into the study results. A series of questions were developed - student feedback to the questions can be found in Table IV. Of those, 5 reported being interested in the study; however, only 4 expressed an interest in taking the post-test. Five of the students felt the post-test was much more difficult than the final examination developed and administered by their course director. All 6 students felt the concept maps assignments should have counted toward the final course grade. All students expressed feelings of being overwhelmed, tired and rushed the day the post-test was administered. Five of the students felt strongly that concept mapping was a useful tool for meaningful learning, and 2 felt they would use it for future applications.

Discussion

Research has shown that constructing one's own knowledge by engaging in active learning (constructivism) and the positive role of social interaction through group work (social constructivism) results in deeper learning.[15] Yet in this pilot study designed to empirically examine these relationships, the results did not support the literature. This study utilized concept mapping as an instructional strategy. Every 3 weeks within the test group throughout the 16 week semester, students participated in concept mapping exercises. A total of 4 mapping exercise sessions took place. Logic and previous research would suggest that students in the test group would have gained greater levels of meaningful learning than the control group as a result of implementation of the instructional strategy of concept mapping and group work.

Explanation of the pre-test difference between programs is problematic since academic and/or demographic factors (i.e. GPA, experience, education, age) that might have offered insight for the difference between programs actually did not discern between schools. Using the only academic/demographic factor (experience) that correlated substantially with pre-test scores for each program (0.77 for Program 1 and 0.35 for Program 2) in an exploratory covariance analysis resulted in essentially identical outcomes as compared to results without the use of this covariate. Even more confounding is the finding of no significant difference between the programs on the post-test, and the fact that Dental Hygiene Program 2 (control group) scored approximately a point higher on the post-test than Dental Hygiene Program 1 (test group). A difference in teaching style, years of experience and/or subject knowledge are a few inconsistencies that may exist among course directors, and would provide additional insight as to the varying results on the post-test. It is the recommendation of the authors that in future studies the course directors be assessed for similarities or differences in an effort to establish differences in subject delivery.

Table III: Pre- and Post-Test Mean Scores and Standard Deviations as a Function of Instructional Strategy

	Pre (sd)	Post $\bar{X}$ (sd)	$\lvert\Delta\rvert$
Test Group: Program 1 (n=30) (received additional concept mapping instruction)	19.33 (5.5)	36.77 (6.3)	17.44*
Control Group: Program 2 (n=23) (received traditional lecture)	14.15 (3.0)	37.73 (3.0)	23.58*
$\lvert\Delta\rvert$	5.16*	0.96	-

*$p<0.05$

As previously reported, there is a large body of literature to suggest the positive impact of concept mapping and group work on meaningful learning.[4,5] This prompted the researchers to gather additional data through the use of a focus group. What was learned from the focus group provides some insight into the outcomes of this study. The actual concept map development and subsequent class discussion served as a review of the course content and therefore was perceived as worthwhile. This did not prevail in the post-test results. Stress, lack of time or interest, and post-test difficulty were identified by the focus group as variables that may have played a role in their performance on the post-test. As a result of the focus group discussion, the investigators requested and were given a copy of the final ex-

Table IV: Dental Hygiene Program 1 (test group) Student Focus Group Responses (n=6)

Questions	Responses
1. When was the post-test for the study administered?	"at the same time of the final exam" (5) "immediately following the 2 hour final exam" (1)
2. How did you feel when taking the post-test to the study?	"overwhelmed" (3) "tired" (4) "uninterested" (2) "rushed" (4) "panic to complete" (1) "pressured" (2) "stressed" (1) "exhausted" (3)
3. How much time did you devote to taking the post-test?	"10 minutes" (2) "15 minutes" (2) "20 minutes" (2)
4. How interested where you in taking the post-test?	"not very interested in taking the test" (3) "interested in taking but rushed" (1) "interested" (1) "was not interested in the study at all" (1)
5. How would you compare the post-test to your final exam?	"post-test was much harder than course final exam" (3) "questions not written the same as they are used to answering" (1) "questions more difficult to understand because it caused us to think" (2)
6. Do you feel the study needed additional incentives to encourage participation?	"yes" (6)
7. If so, what suggestions would you have?	"extra credit" (6) "grade" (2)
8. Where do you feel the study lacked in design and structure?	"concept mapping needed to be done more often" (2) "mapping exercises added into weekly lectures" (2) "would rather of have more concept maps instead of PowerPoint for lectures" (1) "course instructor needed to be more involved in the mapping exercises" (1)
9. Do you feel concept mapping is a useful tool for improving meaningful learning?	"yes, it was easy to see how information connected" (3) "yes, easier to follow the material with the use of concept maps" (1) "yes, but I can see where the maps could be hard to understand with too much information" (1) "somewhat, but they would have to stay simple" (1)
10. Will you apply concept mapping in the future? If so, how?	"yes, I like the concept and have already used it in my other dental hygiene courses" (1) "yes, I will use it to make review maps for studying for the DHNBE" (1) "not sure, but like the concept" (1) "would like to see instructors use the maps more, so I can learn from them" (2) no response (1)

amination by the course directors at each of the participating schools. In comparing the post-test to the final examination, the investigators noted that the post-test developed for this study was indeed more difficult than the instructor developed final exams. The design of the study was to capture meaningful learning, thereby requiring that post-test questions to be written at a level of application and above as determined by Bloom's taxonomy.[20] The instructor developed final exams were written predominantly at the knowledge and comprehension levels of Bloom's taxonomy. These

Table V: Results of Dental Hygiene Program 1 (Test Group) Final Course Examination Scores Over a 3 Year Period

Final Exam Grade	Class 2008 (no concept mapping) (n=33)	Class 2009 (no concept mapping) (n=36)	Class 2010 (concept mapping instruction) (n=36)
	n (%)	n (%)	n (%)
A (93 to 100)	2 (6)	2 (6)	3 (8)
B (92 to 84)	11 (33)	9 (25)	13 (36)
C (83 to 75)	13 (39)	17 (47)	16 (44)
D (74 to 65)*	5 (16)	6 (17)	3 (8)
F (<64)*	2 (6)	3 (8)	1 (3)

*Considered failing grades

levels (knowledge and comprehension) provide the foundation for meaningful learning but are achieved through memorization and rote learning. This is an important finding given the ADEA-CCI identification of deficiencies in curriculum development when it comes to improving critical thinking and problem solving.[1] To fully visualize the higher rankings of meaningful learning as defined by Bloom's Taxonomy within concept mapping, it is the recommendation of the authors that the use of concept mapping be employed more aggressively throughout the entire course. More mapping exercises would allow for additional mapping experience, which may provide a better illustration of the meaningful learning that has transpired through the linking of interrelated concepts by the development of more complex maps. This could potentially affect post-test results.

Perhaps even more impactful was the fact that both course directors chose to administer the post-test immediately following the course's 2 hour final examination. The researchers gained valuable insight through the focus group discussion where students acknowledged that time spent on the post-test ranged from 5 to 20 minutes. This provided greater understanding into the large degree of variability in the data for the post-test (36.77, SD 6.3) where students would have answered 50 questions in a time period of 20 minutes or less. Clearly there had to be a degree of students "guessing" to answer the questions in order to complete the post-test in the time frame indicated in the focus group. Based on what was determined in the focus group and the data results for Dental Hygiene Program 1 (test group), this leaves the investigators somewhat suspect of data from Dental Hygiene Program 2 (control group) where the degree of variability in both the pre- and post-test scores was half that of Dental Hygiene Program 1 (test group).

The majority of students within the focus group agreed that the use of concept mapping was a beneficial learning tool, which aided in the delivery of complex material for processing and retaining and ultimately meaningful learning. Of the students from Dental Hygiene Program 1 (test group) asked to take part in a small focus group, 2 stated how concept mapping was helpful to them in their other dental hygiene courses and felt they would use the concept mapping in the future to help them study for their National Board Dental Hygiene Exam (NBDHE). The course director for Dental Hygiene Program 1 (test group), which received concept map training, verified that overall grades on the final examination for the 2010 fall course were higher than the previous 2 years (Table V). Failures on the course final exam was reduced by 14% from the previous 2 years, accompanied by overall improvements in final exam scores by 17%. This is an important finding and suggests that concept mapping could have contributed to this outcome. The authors recommend the application of concept mapping in other dental hygiene courses to visualize the transfer of knowledge from one subject to another.

The use of experts for establishing the validity of the pre- and post-test, and an extensive analysis of class structure to ensure comparability across the 2 programs, ultimately did not overcome the lack of attention to a few design details that ultimately led to confounding outcomes. Because this was designed as a pilot study the authors are able to offer several recommendations for improving the research design for future studies:

1. Students need to be incentivized to participate in research given the high demands placed on them with their normal coursework. Lack of an adequate incentive resulted in student's giving limited attention to the study and to the concept mapping exercises. It is the recommendation of the authors that the concept mapping exercise carry some weight on the

students' grade, either through extra credit or as an assignment towards their final course grade.

2. One methodological approach might have been to administer the post-test one week prior to the final exam under the guise of a review to avoid competing with the students impending final examination schedule.

3. The research design called for the course directors to administer the post-test during the last week of the semester. Unfortunately in both instances (Dental Hygiene Program 1 and 2) the course directors chose to administer the post-test following the course final examination. This resulted in student's giving limited time and attention to the post-test, as determined from the Dental Hygiene Program 1 (test group) focus group discussion, resulting in data that was unreliable. In retrospect, it would be the recommendation of the authors that the principle investigator or a co-investigator should have personally administered the pre- and post-tests as a measure of control. As stated above, the post-test should have been administered the week before the final examination. Minimizing contact between the course directors and the primary investigator was a part of this research design as a method for better ensuring the integrity (absence of investigator bias) of the "treatment" in each classroom. Particularly in the instance of Dental Hygiene Program 2 (control group), it was the intent of the investigators that this research be as non-invasive as possible. Students who were interviewed from Dental Hygiene Program 1 (test group) felt the course director needed a more active role in the study to support the use of concept mapping on a weekly basis. It is the recommendation of the authors that in future studies the course director be more actively engaged in the introduction to and application of concept mapping throughout the entire study. This may increase the test validity and reinforce concept mapping as an instructional method and teaching strategy.

Conclusion

Educational research is problematic in that the researcher is challenged with trying to minimize disruption to the delivery of the course for both faculty and students. However, this study illustrates the importance of balancing intrusiveness with detail. In this instance the primary investigator should have been the administrator of the pre- and post-test, included a means for reward or incentives for student participation and/or improved interest in the study, and involved the course instructor in the test group to reinforce concept mapping on a more consistent basis. Faculty development is necessary if the teaching and learning environment in dental education is to move beyond passive teaching strategies such as lecture and incorporate strategies that have been shown to promote critical thinking and problem solving.

Future studies are needed to empirically examine the educational strategy of concept mapping in collaborative working groups to determine what effect it has on critical thinking and problem solving. Examination of students' improvement in concept mapping over time would be interesting to explore. Findings from this study related to methodology should be helpful in the design and implementation of future research in this area.

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Dental Hygiene Students' Perceptions of Distance Learning: Do They Change Over Time?

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Abstract

Purpose: The University of Arkansas for Medical Sciences dental hygiene program established a distant site where the didactic curriculum was broadcast via interactive video from the main campus to the distant site, supplemented with on-line learning via Blackboard. This study compared the perceptions of students towards distance learning as they progressed through the 21 month curriculum. Specifically, the study sought to answer the following questions: Is there a difference in the initial perceptions of students on the main campus and at the distant site toward distance learning? Do students' perceptions change over time with exposure to synchronous distance learning over the course of the curriculum?

Methods: All 39 subjects were women between the ages of 20 and 35 years. Of the 39 subjects, 37 were Caucasian and 2 were African-American. A 15-question Likert scale survey was administered at 4 different periods during the 21 month program to compare changes in perceptions toward distance learning as students progressed through the program. An independent sample t-test and ANOVA were utilized for statistical analysis.

Results: At the beginning of the program, independent samples t-test revealed that students at the main campus (n=34) perceived statistically significantly higher effectiveness of distance learning than students at the distant site (n=5). Repeated measures of ANOVA revealed that perceptions of students at the main campus on effectiveness and advantages of distance learning statistically significantly decreased whereas perceptions of students at distant site statistically significantly increased over time. Distance learning in the dental hygiene program was discussed, and replication of the study with larger samples of students was recommended.

Keywords: dental hygiene, education, distance learning, distance education, perceptions

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

The concepts implicit in distance education are not a new phenomenon as they are rooted in correspondence study that originated in the U.S. more than 100 years ago, and in Europe more than 150 years ago.[1] Distance education through correspondence study grew through the mid-twentieth century and evolved from the original format of telecommunicating through the medium of the post to electronic communications through radio in the 1920s then to broadcast television in the 1950s.[1] The tremendous growth of distance education over the past few decades can be attributed to technological advances in computer-mediated communications and the Internet.[2] The Department of Dental Hygiene at the University of Arkansas for Medical Sciences experienced this growth and technological advancement when the dental hygiene program added a distant site in the 2009 fall semester. To serve those students at the distant site the didactic courses are delivered via interactive video network (IVN). As this was a new situation for the department, the opportunity presented itself to evaluate students' perceptions of distance learning over time as they progressed through the program and experienced the delivery method.

Evidence of the growth of distance education can be found in public and private surveys of institutions of higher education. The National Center for Education Statistics (NCES) is the primary Federal entity for collecting, analyzing and reporting data related to education in the U.S. and other nations. Per the NCES 2008 report on distance education, 65% of 2 year and 4 year Title IV degree-granting postsecondary institutions reported college-level credit-granting distance education courses during the 2006 to 2007 academic year.[3] The Sloan Consortium, a nonprofit organization, is an institutional and professional leadership organization dedicated to integrating online education into the mainstream of higher education.[4] The 2011 Sloan Consortium report states online education has grown to 6.1 million students enrolled in at least one online course at degree-granting postsecondary institutions as of the fall of 2010. The increase in online enrollments from 1.6 million in the fall of 2002 to 6.1 million in the fall of 2010 equates to a compound an-

nual growth rate of 18.3% as compared to the overall higher education student body annual growth rate of just over 2% in that same time period from 16.6 million in the fall of 2002 to 19.6 million in the fall of 2010.[5]

Distance Education Methods and Delivery Systems

Numerous definitions of distance education can be found in the literature and through an internet search. The U.S. Distance Learning Association defines it as, "the acquisition of knowledge and skills through mediated information and instruction."[6] The NCES has defined it as "a formal education process in which the student and instructor are not in the same place. Thus, instruction may be synchronous or asynchronous, and it may involve communication through the use of video, audio, or computer technologies, or by correspondence (which may include both written correspondence and the use of technology such as CD-ROM)."[3] Simonson defines distance education as "institution-based, formal education where the learning group is separated, and where interactive telecommunications systems are used to connect learners, resources and instructors."[1] The definition will likely continue to evolve with technological advancements. The terms distance education and distance learning have been used interchangeably in the literature, and for purposes of this discussion the terms will be considered to be synonymous.[3]

The delivery systems used to support distance education are divided into 2 categories: synchronous and asynchronous. Synchronous delivery involves the simultaneous participation of students and instructor in instruction that is provided in "real time." Examples include IVN, teleconferencing and web conferencing, and Internet chats. Conversely, asynchronous delivery, such as through e-mail, listservs, CDs, correspondence and the Internet, does not require the simultaneous participation of students and instructor and allows for students to determine their own time frame for learning.

In addition to the synchronous or asynchronous delivery method, distance education can be qualified as online, blended/hybrid, Web facilitated or traditional. Schlosser et al defined blended learning as "A class that is conducted both by face-to-face classroom meetings and distance learning activities."[1] Therefore, blended learning integrates the strengths of synchronous and asynchronous delivery through the combination of traditional classroom face-to-face learning experiences with online learning experiences. The Sloan Consortium report provides descriptions of online, blended/hybrid, Web facilitated and traditional course delivery:

- An online course delivers all or most (80% or more) of the course content online with no face-to-face meetings
- A blended/hybrid course delivers a substantial proportion (30 to 79%) of the content online and typically has a reduced number of face-to-face meetings
- The web facilitated course is essentially a traditional face-to-face course that uses web-based technology e.g. a learning management system or web pages to post the course syllabus and assignments
- The traditional course delivers content orally or in writing and uses no online technology[5]

Distance Education Methods and Student Performance

Little difference has been demonstrated between program outcomes and undergraduate dental hygiene student performance when utilizing distance education methods in the delivery of didactic courses in the dental hygiene curriculum. Whether the delivery method is synchronous via interactive video to multiple sites or online, studies found no significant difference between students' scores on the national board examination or grade point averages (GPAs).[7-10] In contrast, Gallagher et al found better performance in the distance education group as compared to a traditional group.[11] A statistically significant difference was observed in student performance between the web-based and traditional formats, with the web-based students scoring higher total final points. Conclusions of the study suggest student characteristics, such as age and previous experience with online coursework, influenced the outcomes.[11]

Students' Perceptions of Distance Learning Methods

While many dental hygiene programs offer some form of distance education in their curriculum, such as web-based, interactive video, and blended or hybrid courses, most programs utilize some combination of traditional classroom and distance education methodologies.[12] In undergraduate dental hygiene education, the development of clinical skills typically requires face to face instruction which precludes the use of asynchronous distance education methodologies. However, clinical skill sets have already been achieved by the degree completion or graduate dental hygiene student, thus making asynchronous delivery of distance education viable for these groups of students.[13] Blended or hybrid courses are commonly found in undergraduate dental hygiene curricula while asynchronous courses offered completely online are typically offered as bachelor degree completion programs and master's degree programs in dental hygiene.[14,15]

Much of the early literature on the use of distance education in dental hygiene programs highlighted students' perceptions of the advantages of the methodology, such as convenience, accommodation with personal and family needs, and overall program flexibility.[16] Grimes found the overall satisfaction level of students enrolled in an online dental terminology course to be positive. While students found the online course to provide convenience and access, they also cited technical issues and isolationism as drawbacks.[17] In a qualitative study of bachelor degree completion students, Tsokris found no difference between students who had taken all their coursework online and those who had taken a combination of online and traditional classroom courses in regards to their perceived quality of the learning experience.[18] Evaluations for undergraduate dental hygiene and dental students' attitudes and opinions towards and preferences for blended or online courses indicate student satisfaction with distance methods.[19-21] However, students did comment on the need for faculty training in distance learning methods.[19]

Student perceptions have been evaluated in other fields of study, such as criminal justice and business. Dobbs et al analyzed differences in perceptions between criminal justice students who had taken online courses and those who had not and found significant differences in perceptions between the 2 groups but only in their strength of agreement/disagreement.[2] O'Malley et al surveyed students enrolled in business, finance, accounting and information science courses on their perceptions of distance education courses and the traditional classroom.[22] They found that students did not perceive online (asynchronous, online) and distance learning (synchronous, interactive video) courses to be similar. While online courses were perceived as time saving, convenient and flexible, students did not report learning more in online courses compared to traditional courses and reported concerns in regards to being able to contribute to discussions. Overall, students preferred the traditional classroom but wanted more online courses. Students were much less complimentary of distance learning and did not perceive it to be as effective as the traditional classroom and did not prefer to take additional distance learning courses.

As technological variations in the delivery of education continue to become more prevalent, little research has been done specifically on the change in undergraduate dental hygiene student perceptions to the delivery method over time. In the fall of 2009, the Department of Dental Hygiene at the University of Arkansas for Medical Sciences (UAMS) in Little Rock, Arkansas established a distant site approximately 180 miles from UAMS in Mountain Home, Arkansas allowing 5 students at the distant site to receive the same classroom instruction, at the same time, and by the same faculty, as the students at the main campus. Synchronous delivery was accomplished using an IVN to broadcast didactic courses from the main campus to the distant site. The didactic courses were traditional or web facilitated through the utilization of a learning management system. In May 2011, those 5 students in Mountain Home received Bachelor of Science degrees along with the 34 graduates who attended the dental hygiene program in Little Rock. The newly created distant site presented the opportunity to study student perceptions as they progressed through the curriculum.

The purpose of this study was to compare the perceptions of the students at both program locations towards distance learning as they progressed through the 21 month curriculum. The study sought to answer the following research questions:

1. Is there a difference in the initial perceptions of students on the main campus and at the distant site toward distance learning?
2. Do students' perceptions change over time with exposure to synchronous distance learning over the course of the curriculum?

Methods and Materials

The study was approved by the UAMS Institutional Review Board. A total of 39 dental hygiene students participated in the study: 34 students at the main campus and 5 at the distant site. All students were women with a mean age of 23.10 years. The mean age of the 34 students at the main campus was 23 years and that of the 5 students at the distant site was 23.8 years. Thirty-seven were Caucasian, and 2 African-American. The distance education program employed synchronous delivery using an IVN to present the traditional classroom instruction supplemented by online learning via Blackboard, a learning management system. A paper survey was administered at both sites at 4 different periods during the 21 month program: matriculation, end of the first semester, end of the second semester and program completion (fourth semester). Students signed informed consents before taking the survey. The survey assessed dental hygiene students' perceptions on effectiveness and advantages of distance education.

Survey Instrument

The survey was developed and validated by O'Malley and McCraw, and adapted for this study.[22] According to O'Malley and McCraw, questionnaire items were developed based on the work of Moore and Benbasat.[22,23] After revision of items by 2 inde-

pendent experts, items that were ambiguous were reworded or eliminated and items that did not tap the construct were eliminated from their survey.[22] Five items that were related to effectiveness and 9 items that were related to advantages of distance education in comparison to traditional learning were applied in the O'Malley and McCraw study and in this study.[22] Additionally, in this study a new item was added to the items related to effectiveness: "Distance learning requires the instructor to teach differently." The survey included 15 questions on the Likert scale (1-strongly disagree, 2-disagree, 3-not sure, 4-agree, 5-strongly agree). The survey was not previously used with dental hygiene students. However, Cronbach's alpha for questions that assessed effectiveness (questions 1 to 5) was 0.81 and advantages of distance education (questions 6 to 15) was 0.79 which indicated a high level of internal consistency for each group of items in this study.

Statistical Analysis

An independent sample t-test was conducted to assess initial differences between students' perceptions of distance learning in the traditional class on the main campus and those of students at the distant site. Repeated measures of ANOVA were conducted to assess differences in students' perceptions about distance learning over the course of the dental hygiene curriculum.

Results

At the beginning of the program, students at the main campus perceived statistically significantly higher effectiveness of distance learning than students at the distant site, but not advantages of distance learning. Over time students' perceptions of effectiveness and advantages of distance learning statistically significantly decreased at the main campus whereas at the distant site students' perceptions of these statistically significantly increased.

According to tests of normality, Kolmogorov-Smirnov and Shapiro Willk, assumptions of normality were met for both groups on effectiveness and advantages of distance learning ($p>0.05$). According to Levene's test, assumptions of equality of variances were also met ($p>0.05$). Independent sample t-tests revealed a statistically significant difference between students on the main campus ($M=2.42$, $SD=0.57$, $n=34$) and at the distant site ($M=3.04$, $SD=0.43$, $n=5$) in their initial perceptions on effectiveness ($t(37)=-2.35$, $d=1.23$, $p<0.05$), but not on advantages of distance learning ($p>0.05$). According to the Mauchly's test of sphericity, assumptions of sphericity for both groups were met ($p>0.05$). Results of repeated measures of ANOVA showed that students' perceptions on the main campus statistically significantly decreased over time on effectiveness ($F(3)=28.96$, $\eta^2=0.47$, $p<0.05$), and advantages of distance learning ($F(3)=14.80$, $p<0.05$, $\eta^2=0.31$, $p<0.05$). Students at the distant site statistically significantly increased their perceptions over time on effectiveness ($F(3)=3.51$, $\eta^2=0.47$, $p<0.05$), and advantages of distance learning ($F(3)=5.12$, $\eta^2=0.56$, $p<0.05$). Tables I and II provide addition information on means, standard deviations and confidence intervals of students' scores on the survey at the main campus on four occasions.

Discussion

The start of a new distant site of the UAMS Department of Dental Hygiene presented the opportunity to investigate students' perceptions of distance education. A review of the literature revealed that little research comparing students' perceptions of effectiveness and advantages of distance learning initially and over time in the distance education setting has been done.

Initially, the study showed there was a difference between students' perceptions of effectiveness of distance learning at the distant site and main campus, but no difference between the 2 groups' perceptions of advantages of distance learning. In the study by Dobbs et al, differences in perceptions were in the strength of agreement/disagreement, not in the direction of agreement/disagreement between the two groups.[2] However, the UAMS Department of Dental Hygiene study revealed that over time students' perceptions at the main campus and distant site did change but in opposite directions - as the distant site students' perceptions of distance learning became more positive, the main campus students' perceptions became more negative. It can be hypothesized that because students in Mountain Home chose to attend the program at the distant site, they were a self-selecting group with positive perceptions toward distance delivery of education. The opportunity to earn a degree closer to their home could have influenced their more positive perceptions toward the end of the fourth semester. Accordingly, students in Little Rock did not select distance delivery and, on occasion, found technical issues with the IVN as distracting. Further research needs to be conducted to ascertain why the perceptions of these 2 groups moved in opposite directions. The study should be replicated on a new cohort of students to evaluate/compare the perceptions between cohorts of students but, if possible, with larger sample sizes than in the present study. The addition of focus group interviews of students at the 2 sites could provide insight into the differing attitudes and perceptions.

Table I: Means, Standard Deviations and Confidence Intervals for Scores of Students on the Main Campus (n=34)

	Effectiveness of distance learning			Advantages of distance learning		
Occasion	M	SD	95% CI	M	SD	95 % CI
1	2.42	0.57	2.2 to 2.6	2.93	0.53	2.7 to 3.1
2	1.94	0.55	1.7 to 2.1	2.53	0.46	2.4 to 2.7
3	1.71	0.66	1.5 to 1.9	2.46	0.66	2.2 to 2.7
4	1.53	0.49	1.4 to 1.7	2.32	0.49	2.1 to 2.5

Table II: Means, Standard Deviations and Confidence Intervals for Scores of Students on the Distant Campus (n=5)

	Effectiveness of distance learning			Advantages of distance learning		
Occasion	M	SD	95% CI	M	SD	95 % CI
1	3.04	0.43	2.5 to 3.6	3.26	0.42	2.7 to 3.8
2	3.28	0.46	2.7 to 3.8	3.68	0.53	3.0 to 4.3
3	3.28	0.23	3.0 to 3.6	3.64	0.32	3.2 to 4.0
4	3.56	0.50	2.9 to 4.2	3.78	0.41	3.3 to 4.3

A factor that was not examined in this initial research was faculty familiarity with the technology, specifically the IVN. As suggested in the research conducted by McCann et al, students expect faculty to perform well in this area.[19] Faculty did have introductory training on the use of IVN but were by no means experts at the time synchronous distance education started. Did faculty's lack of experience with IVN impact students' perceptions? If this study is conducted again, the fact that faculty now has experience utilizing an interactive video network should be considered when evaluating results.

Further research could include retrospective analysis of other data sets collected by the department compared to the information gained through this research which may give a better understanding of how distance education could be improved in the Department of Dental Hygiene at the University of Arkansas for Medical Sciences. Specifically, the department administers student course evaluations at mid-semester for most courses. There are several questions in the assessment that could be analyzed in comparison to students' perceptions of distance education.

Limitations of the Study

Results of the present study should be interpreted in light of study limitations. First, the sample size at the distant site was small. The maximum number of students enrolled per class at the distant site was 5, whereas the maximum number of students enrolled at the main campus is 34, which limited the estimates of population values for the small group in comparison to the larger group of students. Another limitation is the lack of randomization because the students in Mountain Home self-selected for distance education whereas the students in Little Rock did not.

Conclusion

The study has implications for improvement of teaching and learning in distance learning courses. A literature review revealed that little research has been done on the change in students' perceptions of the distance education delivery methodology over time and what factors might influence that change.

Because distance education methodologies are utilized at many undergraduate dental hygiene programs,[12] the study could be replicated at other institutions to increase the understanding of students' perceptions over time of distance education and improve teaching and learning in education. Similar research could be conducted in other allied health education settings as well and in other different education settings.

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Musculoskeletal Disorders in a 3 Year Longitudinal Cohort of Dental Hygiene Students

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Abstract

Purpose: Musculoskeletal disorders (MSDs) are a significant occupational health issue for the dental hygiene profession. There is increasing evidence that these problems commence during undergraduate training; however, there is a surprising lack of studies investigating how MSD develops in student groups over the course of their study. The aim of this study was to determine the longitudinal MSD trends among a cohort of undergraduate dental hygiene students at an Australian university.

Methods: A previously validated self-reporting questionnaire was distributed to dental hygiene students in 3 consecutive years from 2008 to 2010.

Results: MSDs were most commonly reported in the neck (ranging from 66 to 68%) and lower back (ranging from 61 to 68%), with a marked increase in reported lower back pain by the final year of study.

Conclusion: This study not only supports mounting evidence that MSDs are a common problem for dental hygiene students, but further demonstrates the magnitude of this occupational health issue across the training program. These findings are concerning for a group yet to embark on their professional careers, given that it raises some serious questions about career longevity and the efficacy of preventive measures.

Keywords: musculoskeletal disorders, dental hygiene, students, occupational health

This study supports the NDHRA priority area, **Occupational Health and Safety:** Investigate the impact of exposure to environmental stressors on the health of the dental hygienist (aerosols, chemicals, latex, nitrous oxide, handpiece/instrument noise).

Introduction

Musculoskeletal disorders (MSDs) are usually defined as injuries to the soft and hard tissues of the body, and may occur after a single event or due to cumulative trauma.[1] Work related MSDs are considered a global health and financial burden, costing millions of dollars annually.[2,3] For example, in Australia, work related MSDs were reported in over 76,000 workers' compensation claims.[4] Reduced work hours and increased sick leave are a significant burden not only for the individual, but also on the economy.

Research has demonstrated that MSDs are a significant occupational health issue for the dental profession, especially for dentists and dental hygienists.[5-7] A number of unique risk factors have been documented among these professionals, including a limited working field, static postures, fine movements and repetitive tasks. A recent review, for example, identified that over half of dental hygienists report MSDs in any body region.[7] More specifically, MSDs in the neck, shoulder, wrist/hand and lower back regions is frequently reported across a number of studies.[8-11] Despite this fact, there is a distinct lack of evidence regarding the efficacy of preventive measures for MSDs in the dental hygiene profession.

In recent years, there is mounting evidence that undergraduate students are burdened by MSDs.[12] In particular, health sciences students have been identified as suffering MSDs at considerable rates.[13-15] Computer usage and desk based study have been shown to increase the report of MSDs among cohorts of university students, while psychosocial stress has been suggested as another possible risk factor.[14,16-19] Despite this fact, a surprising lack of research has investigated MSDs among dental hygiene student populations.

Dental hygiene is a rapidly growing profession in Australia, as elsewhere, with a number of new baccalaureate programs established within the last decade. Dental hygiene education and training in Australia involves the completion of a 2 year advanced diploma or a 3 year bachelor's degree program. Given that dental hygiene students are undergraduate students working towards a career that has a high incidence of MSDs, it is of great concern that

this particular group may be at an increased risk of developing MSDs.

The focus of the current study was to collect epidemiological data, such as the prevalence, and determine predictors of MSDs over a period of time to allow insight into patterns and trends of risky behaviors or disease. Ascertaining patterns of MSDs among dental hygiene students is essential for employing sound ergonomic principles in the dental hygiene curriculum, as well as influencing how and when preventive strategies should be employed to best effect. As such, the aim of the present study was to determine the longitudinal MSD trends in a cohort of dental hygiene students at an Australian University, across the 3 years of their education and training.

Methods and Materials

This study was carried out as descriptive and exploratory research, using a longitudinal approach. It is an extension of a cross-sectional study that was completed in 2008. As such, the methodology has been published in detail elsewhere.[14] An institutional review board approval to collect data over a 3 year period was sought and obtained from the University of Newcastle Human Research and Ethics Committee. All dental hygiene students commencing the Bachelor of Oral Health at the University of Newcastle in 2008 (n=75) were invited to participate in this study. For 3 consecutive years, in the first week of semester 2, students were approached during a scheduled lecture or clinical session and invited to participate in the study. They were invited by a staff member not involved with the research project, and were clearly advised that there were no penalties or rewards for participation. An anonymous, 2 page modified version of the Standardized Nordic Questionnaire was completed by students agreeing to participate.[20] This questionnaire is a valid tool that has demonstrated a high level of reliability (k=0.73 to 0.82) and sensitivity (0.9 to 1.0).[21] Completing the survey involved answering 17 tickbox questions, covering items such as age, gender, weekly clinical hours, regular exercise and study habits. Participants were asked to indicate whether they had experienced any ache, pain or discomfort in specific body regions in the previous 12 months, whether it lasted longer than 2 days, affected their daily life or required medical attention. An anatomical diagram was included to aid participants in identifying various regions of the body. The survey has been used among a variety of health science student groups in various countries.[15,16,22-24]

All data collected was entered into a spreadsheet and analyzed using the STATA statistical software package. Descriptive statistics were calculated, with direct logistic regression performed to elucidate potential risk factors for MSD.

Table I: Demographic Data

	2008		2009		2010	
	n	%	n	%	n	%
Gender						
Female	45	90	50	98	38	93
Male	5	10	1	2	3	7
Have children						
Yes	4	8	6	12	11	27
No	46	92	43	88	27	65
Experience as a dental assistant						
Yes	41	82	42	82	28	68
No	9	18	9	18	13	32
Age						
Mean	25.8	-	26.8	-	28.1	-

*Percentages may not total 100% where some values are missing

Results

Across the 3 years, response rates ranged from 54 to 68%. From a cohort of 75 students commencing in 2008, 50 students participated in the first year (2008), 51 students in the second year (2009) and 41 students in their final year of study (2010). Demographic data is presented in Table I. The cohort was predominately female non-smokers, who had prior experience working as a dental assistant.

The 12 month prevalence of MSDs by body region for the 3 year period between 2008 to 2010 is presented in Table II. Neck pain was the most commonly reported MSD, and its prevalence rate increased steadily over the 3 year period (the prevalence rates ranging from 66% in 2008, to 68.3% in 2010). Lower back pain was also commonly reported by students, with the results showing a noticeable increase in the final year of study (rising from 60.8% in 2009, to 68.3% in 2010). Wrist/hand pain was reported by over one-third of respondents in the first year of study; however, this increased noticeably in the second year, and even further in the final year (34%, 41.2% and 43.9%, respectively). The prevalence of upper back pain lasting longer than 2 days (22%, 27.5%, 34.1%) increased steadily across the 3 years of training, while pain lasting longer than 2 days in the neck, shoulders and wrist/hand regions peaked in the second year of study.

All students who reported feelings of extreme stress associated with the clinical requirements of the dental hygiene course indicated that they had experienced pain in the neck, shoulder, upper back and lower back, a finding that was consistent for all 3 years of the study. Logistic regression analysis did not elucidate any statistically significant correlations between year of study, number of clinic hours or prior experience as a dental assistant with MSD.

A comparison of 12 month prevalence of MSDs in the neck, shoulder, wrist/hand and lower back regions among student cohorts is displayed in Table III. All studies utilized the Standardised Nordic questionnaire anatomical diagram for investigating the 12 month prevalence of MSD.

Discussion

This study investigated the prevalence of MSDs among a group of dental hygiene students, over the 3 year duration of their education and training program. The results suggest that MSD is a common problem, in particular at the neck, shoulder, wrist/hand and lower back regions, which were reported frequently across the 3 years from 2008 to 2010. The cohort of students in this study closely resembles those in other studies of dental hygiene students, which were also predominantly female with an average age in the mid-twenties.[25,26] A study from the U.S. found that second year dental hygiene students were more likely to report any MSD (70%) than their first year counterparts (62%).[26]

Compared with students undertaking other health science studies, dental hygiene students appear to suffer from MSDs at considerably higher rates.[14,16,22,27,28] A comparison of 12 month prevalence of MSD in the neck, shoulder, wrist/hand and lower back regions among student cohorts suggests that dental hygiene students are more likely to suffer from wrist/hand pain and lower back pain than other health science students. Clinical tasks carried out by hygiene students are very repetitive and require static postures - these risk factors may not be as common for other health sciences students, which may explain the differences in reported MSD rates. Perhaps the most comparable group to dental hygiene students are occupational therapy students, whose reports of neck and shoulder pain appear to be related more to computer usage and increasing age rather than occupational risks.[16] Higher prevalence rates documented in the current study may also be influenced by the relatively high proportion of females in dental hygiene cohorts, given that previous research has indicated that females are more likely to report MSDs than their male counterparts.[29]

Table II: Prevalence of MSD by Body Region

	Reported MSD (% students)		
	2008	2009	2010
Neck			
Any symptoms	66.0	66.7	68.3
Persisted >2 Days	44.0	54.9	46.3
Affected daily life	28.0	39.2	24.4
Needed treatment	18.0	25.5	14.6
Shoulders			
Any symptoms	44.0	52.9	46.3
Persisted >2 Days	32.0	39.2	29.3
Affected daily life	22.0	23.5	12.2
Needed treatment	16.0	15.7	1.0
Upper Back			
Any symptoms	42.0	35.3	43.9
Persisted >2 Days	22.0	27.5	34.1
Affected daily life	8.0	13.7	14.6
Needed treatment	12.0	15.7	12.2
Wrists/Hands			
Any symptoms	34.0	41.2	43.9
Persisted >2 Days	26.0	25.5	26.8
Affected daily life	14.0	19.6	14.6
Needed treatment	4.0	7.8	4.9
Lower Back			
Any symptoms	62.0	60.8	68.3
Persisted >2 Days	46.0	43.1	39.0
Affected daily life	26.0	25.5	31.7
Needed treatment	26.0	13.7	22.0

It is interesting that the current study did not find any statistically significant correlations between MSDs and previous experience as a dental assistant, number of clinical hours or year of study. Previous research among dental hygiene students suggests that those with a dental assisting background self-reported neck and shoulder pain more than their inexperienced student counterparts.[30] Furthermore, studies of nursing students in both Australia and Japan have found an association between reported MSD and previous experience working in a hospital.[22,31] It may be that as the clinical requirements of the course increase, students spent less hours working in paid employment - this may have minimized the effect of dental assisting on reported MSD. Practicing dental professionals may be at an increased risk of developing MSD over time, with a study of Swedish dentists, hygienists and assistants reporting increased pain levels after 5 years when compared to baseline measures.[8]

Table III: Comparison of 12 Month Prevalence (%) of MSD Among Student Cohorts, by Body Region

Student group		Body region (%)				Reference
Country	Field	Neck	Shoulder	Wrist/hand	Lower back	-
Australia	Dental Hygiene	66	44	34	62	14
Australia	Nursing	35	24	13	59	22
Italy	Radiography	16	11	5	27	28
Australia	Occupational Therapy	67	46	-	-	13
Korea	Nursing	36	46	22	39	27

A number of studies have also reported increasing age to be correlated with increased MSD symptoms, in both student groups[14] and practicing hygienists.[10,32,33] It may be that a combination of factors, such as increased time practicing in clinical settings and one's natural increase in age, contributes to MSD, however, neither correlated individually with reported MSD in the current study.

Based on the findings of the current and previous studies, it is important that dental hygiene students undertake comprehensive occupational health and ergonomics modules during their education and training. Contemporary research has found that among practicing hygienists, education on patient and operator positioning can help reduce the risk of MSD.[34] Despite this fact, there is limited research published on this topic.[35] Future studies should investigate the educational component of ergonomics in the curriculum, along with the expertise of faculty in this area.

The results of this study are concerning for a group yet to embark on their professional careers, and this raises some serious questions about career longevity and the efficacy of preventive measures. Further investigations into the epidemiological patterns of MSD among larger cohorts of dental hygiene students are necessary. Also, longitudinal studies following students into their employment would also be extremely valuable. It has also been established elsewhere that there is very limited research investigating the effectiveness of preventions or interventions for MSD.[7]

The present study required careful design to ensure that the students invited to participate did not feel as though they were coerced, or that there was any perceived benefit or disadvantage to their education if they chose to participate. As such, the privacy and anonymity of the students was vital, and for this reason the follow-up of individual students was not possible. Another perceived limitation of the study may be the use of a self-reporting survey, as possible response bias may limit the generalizability of the results. However, while there is a plethora of research involving MSD, little research has investigated this occupational health issues among dental hygiene students. Given that this study appears to be the first to follow a cohort of dental hygiene students across their 3 years of training, the findings are nevertheless valuable, adding to the small body of research and facilitating an increasing understanding of MSD in our profession.

Conclusion

The results of this study provide valuable insight into the epidemiological patterns of this occupational health issue. Dental hygiene students are reporting MSDs at considerably higher rates than students in other health science disciplines. What continues to remain unclear is the risk factors involved and, therefore, how to instigate appropriate preventive strategies.

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Point-of-Care HbA1c Screening Predicts Diabetic Status of Dental Patients

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Abstract

Purpose: Mutual production of proinflammatory cytokines causes a deleterious cyclic relationship between uncontrolled diabetes and periodontal disease. The prevalence of diabetes is escalating out of control. Early detection of pre-diabetes and diabetes may respectively prevent or delay disease onset and eliminate or decrease complications. The dental office offers an opportune site for diabetes screening. This study investigated the ability to precisely screen previously unidentified dental patients for diabetes and pre-diabetes.

Methods: In this predictive correlational study, participants were chosen by convenience sampling, and were included based on self-proclaimed risk factors. A point-of-care (POC) fingerstick HbA1c screening identified participants for confirming venous HbA1c laboratory screenings. Kendall's tau analyzed the relationship between POC HbA1c results and classification as diabetic or pre-diabetic based on laboratory HbA1c results. Chi Square, Likelihood Ratio, Cramer's V and Lambda compared the expected and observed results.

Results: Of the 104 diabetes risk questionnaires completed, 75 participants were included in the POC screening. Of these, 34 (71% female and 29% male) had HbA1c levels at or above the American Diabetes Association's (ADA) recommended 5.7% cut-point for pre-diabetes. Three participants were less than age 44, 10 were 44 to 57, and 21 were over 57. Laboratory results categorized 6 participants as normoglycemic and 28 with HbA1c greater than or equal to 5.7%. Kendall's tau ($p=0.004$) determined POC results can predict diabetic or pre-diabetic laboratory group assignment. Pearson's chi-square ($p=0.004$), Likelihood ratio ($p=0.004$) and Cramer's V ($p<0.001$) concluded a relationship existed between group assignment based on POC HbA1c results and those of subsequent laboratory HbA1c results; Lambda ($p=0.145$) did not.

Conclusion: Within the limits of this study, it was established that a safe and minimally invasive dental chair-side POC HbA1c screening unveiled previously unidentified diabetic and pre-diabetic patients.

Keywords: diabetes mellitus type 2, periodontal diseases, diagnosis, diabetes complications, periodontal atrophy

This study supports the NDHRA priority area, **Clinical Dental Hygiene Care:** Develop and test interventions to reduce the incidence of oral disease in special at-risk populations (diabetics, tobacco users, cardiac patients and genetically susceptible).

Introduction

Disease Prevalence

In 2010, the Centers for Disease Control and Prevention (CDC) reported that 25.6 million (11.3%) of all Americans aged 20 or older were diabetic or undiagnosed diabetic and 79 million were pre-diabetic.[1] A recently composed model based on U.S. Census projections, current diabetes and pre-diabetes prevalence, and predicted diabetes incidence calculates that the prevalence of diabetes in 2050 may be as high as 33% of the population.[2] Diabetes is a chronic disease with no cure. As the seventh leading cause of death in the U.S., a major cause of heart disease and stroke, and an estimated $174 billion annual cost, diabetes is one of the most deadly and costly diseases affecting Americans.[1]

Bio Mechanism of Diabetes

Diabetes is a disease characterized by an abnormal level of glucose in the blood.[3] This is caused by the lack of insulin production or an inability of the body to utilize insulin, also known as insulin resistance.[3] Ideally insulin, a hormone that is only produced in the pancreas, transports glucose from the bloodstream into muscles for energy production.[3]

Historical Perspective

As early as 1983, research involving the Pima Indians of Arizona determined the deleterious effect of diabetes mellitus on periodontal tissues.[4] By 1991, it was determined that not only were diabetics 3-times more likely to develop periodontal

disease, but that diabetes mellitus was a risk factor for periodontal disease independently of age and gender.[5] By the mid-1990s, studies had determined that the oral flora was the same for diabetics as non-diabetics, so research turned to biological mechanisms of host response.[6] First hypothesized in 1992, then confirmed by several studies between 1996 and 2010, proinflammatory cytokines as a result of periodontal infections were found to be positively correlated with hyperglycemia in diabetics.[7-16]

Today, after years of research, it is known that the relationship between diabetes and periodontal disease is bidirectional, affected by risk factors and promoted by a biochemical cascade of events (Figure 1).[3,7-16] Blood accumulations of advanced glycation end products (AGEs) in persons with prolonged hyperglycemia and of lipopolysaccharides (LPS) from the lyses of periodontal bacteria, stimulate macrophages to secrete the proinflammatory cytokines tumor necrosis factor-alpha (TNF-α), interleukin-1 (IL-1), and interleukin-6 (IL-6).[10] These cytokines lead to the destruction and retarded healing of periodontal tissues and to insulin resistance.[10] Either disease is less likely to be well controlled if the other one is not.

Purpose of Screening

Early detection of pre-diabetes or diabetes may slow or prevent the complications of diabetes, including periodontal disease.[17,18] National organizations and initiatives emphasize that infrequent screening limits diabetes prevention and treatment, while general population screenings have been shown to reduce the prevalence of diabetes and its adverse outcomes.[19-25] This relationship between screenings and diabetes demonstrates the need for an increase in screening strategies, approaches and locations. According to the Centers for Disease Control and Prevention (CDC), 61% of U.S. citizens aged 18 to 64 visited a dentist in 2010.[23] Using a predictive equation, dental patients who had never been diagnosed as diabetic, yet reported diabetic risk factors in the NHANES III study had a 27 to 63% chance of being diabetic.[26] Borrell's primary conclusion was that the dental office could be a prime location to identify diabetes.[26]

Screening Methods

In a comparison of diabetes diagnostic tests, the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) reports that diabetes is traditionally diagnosed by a fasting plasma glucose test (FPG), a random plasma glucose test (RPG) or an oral glucose tolerance test (OGTT).[27] All require a confirmation test at a later date.[20,27] The FPG and OGTT diagnose diabetes and pre-diabetes but require fasting.[28] The RPG test does not require fasting, but it is only diagnostic in symptomatic individuals.[27] The OGTT requires 2 measurements of plasma glucose levels, the first after a minimum 8 hour fast and immediately before ingestion of a liquid glucose solution, and the second measurement is taken 2 hours post-glucose ingestion.[27] It has been known as the gold standard even though it is less convenient than the FPG.[29]

Figure 1: Diabetes Risk Factors

- Impaired Glucose Metabolism
- Age over 45
- Family History of Diabetes
- Obesity
- Physical Inactivity
- Low HDL Cholesterol
- High Triglycerides
- High Blood Pressure
- Periodontal Disease
- History of Gestational Diabetes
- Race/Ethnicity
  - African American
  - Hispanic
  - American Indian
  - Pacific Islander
  - Asian Americans

Another diabetes diagnostic tool is glycosylated hemoglobin, commonly referred to as HbA1c, which is an irreversible complex which forms when glucose binds to the hemoglobin in red blood cells in an overabundance of glucose and an absence (or reduction) of insulin.[30] The concentration of HbA1c in the blood is a marker of glucose control over the previous 2 to 3 month period, which is the lifespan of the red blood cell. Point-of-care (POC) and laboratory HbA1c screenings do not require fasting and they are not affected by diet or exercise.[31]

Periodically, international diabetes experts appointed by the American Diabetes Association (ADA), the European Association for the Study of Diabetes and the International Diabetes Federation meet to make recommendations for the diagnosis and treatment of diabetes. The 1997 committee recommended against the use of the HbA1c assay for diabetes diagnosis based on a lack of instrument standardization and calibration techniques.[30] The 2003 committee conceded standardization, but upheld this recommendation based on other disadvantages.[30] The 2008 committee was the first to recommend the use of laboratory HbA1c to diagnose diabetes because it reliably captures the chronic glucose exposure, is a better biological marker for diabetes, relates well to the risk for vascular com-

plications, has superior stability over blood glucose assays and has several technical advantages over other diagnostic methods.[30]

Purpose of Study

This study investigated the ability to accurately screen previously unidentified dental patients for diabetes and pre-diabetes using a chair-side HbA1c screening method compared to a laboratory HbA1c screening method. The hypothesis tested was: A POC HbA1c screening will reliably identify dental clients who have self-proclaimed diabetes risk factors, as diabetic or pre-diabetic when compared to a laboratory HbA1c screening method.

Methods and Materials

Participants were chosen from a dental hygiene school (site #1) and a private practice (site #2) in this 2-armed, predictive correlational study. Protocol approval was obtained from the Eastern Washington University Institutional Review Board (IRB) for Human Subjects Research committee. The investigators were held to stringent ethics, procedures and confidentiality. The Washington State Department of Health Office of Laboratory Quality Assurance issued a medical test site certificate of waiver license for use of the POC HbA1c screening kit (A1CNow+®, Bayer Healthcare, LLC), because it is a Food and Drug Administration (FDA) waived test as determined by the Clinical Laboratory Improvement Act (CLIA) of 1988.

To achieve statistical significance, a power analysis determined that a minimum of 21 laboratory results were required for valid research. Consequently, a goal to obtain 30 participants with elevated POC HbA1c results was established. Based on this goal and results of previous self-proclaimed diabetes risk factor research,[32] it was expected that between 95 and 112 at-will participants would need to complete the diabetes risk questionnaire in order to obtain sufficient numbers of participants meeting inclusion criteria (Table I).

The diabetes risk questionnaire was developed by the researcher based on Heikes[32] validated diabetes risk algorithm and used with permission (Bowman, personal communication, August 2010). Participants were excluded from screening if they had previous positive blood glucose tests, hemoglobin traits or conditions that would potentially produce aberrant HbA1c results, insufficient diabetes risk, or factors that increase screening risk to the participant or the researcher (Figure 2).

A total of 75 participants met the inclusion criteria and subsequently signed an IRB approved informed consent. Age, gender and ethnicity data were collected

Table I: Comparison of Expected and Observed Sample Numbers

	Expected (Average)	Observed (% of expected)
Questionnaires completed	95 to 112 (103.5)	104 (100)
POC screenings	57 to 111 (84)	75 (89)
POC results ≥5.7%	30	34 (113)
Lab results ≥5.7%	30	28 (93)
Normoglycemic	0	6
Drop Out	0	0 (100)

Figure 2: Questionnaire Exclusion Criteria

1. Previous diagnosis of diabetes or pre-diabetes
2. Previous abnormal blood glucose tests
3. Abnormal hemoglobin traits
4. Rx use of corticosteroids
5. Age less than 44 years old with a waist size less than 38.4 inches
6. Between the ages of 44 and 57 with a waist size less than 38.4 inches and no first degree blood relatives with diabetes.
7. History of blood borne infections or blood disorders
8. Rx or OTC use of blood thinners including aspirin

Table II: ADA's HbA1c Recommended Cut Points

Status	% HbA1c
Normoglycemic	< 5.7
Pre-diabetes	5.7 - 6.4
Diabetes	> 6.4

to describe the sample and determine generalization of the research results in relationship to demographics published by the ADA. The participant's blood pressure was measured and recorded since elevated blood pressure is common in diabetics. With good laboratory practices and standard precautions, calibrated co-investigators obtained a fingerstick blood droplet using a single-use, sterile, retractable lancet (Figures 3A-3C). Trained in the proper storage, handling and technique for using the POC HbA1c screening kit, co-investigators acquired POC HbA1c results (Figure 4A-D) and made laboratory screening referrals for those with results at, or above, the ADA's recommended pre-diabetes cut point (Table II). POC and laboratory results were assigned to diabetic categories according to the ADA's

Figure 3A: POC Fingerstick Preparation

Figure 3B: Use of the Disposable, Sterile, Retractable Lancet

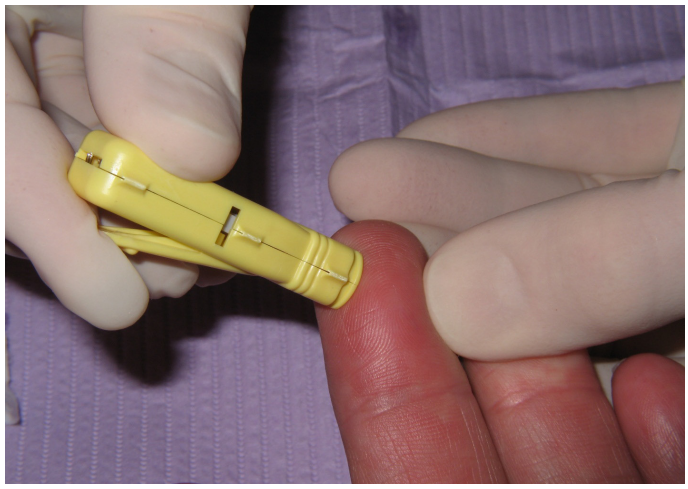

Figure 3C: Capillary Blood Droplet

standard of clinical care cut points (Table II). Laboratory results were delivered to participants concurrent with nutritional and diabetes educational counseling and referral to a licensed medical professional.

Two rounds of statistical tests were conducted in SPSS software (Version 19) following suggested guidelines.[33] In the first round, Kendall's tau, a nonparametric statistical test, evaluated whether the POC results could predict laboratory result group assignment, i.e. diabetes or pre-diabetes, because it measures the association between values of rank order and group membership when data is ranked and the results are not normally distributed. In the second round, 4 additional statistical tests evaluated the results for significance ($p \leq 0.05$). The Chi Square statistical tests measured the differences between the expected and observed laboratory groups - the Likelihood ratio compared the frequencies of expected and observed groups, Cramer's V measured the strength of association between the expected and the observed groups and Lambda measured the proportional reduction in error when one group predicts the other, i.e. POC diabetic category predicting the laboratory diabetic category.

Results

From the 104 diabetes risk questionnaires completed, 75 individuals were identified for inclusion in the study (Table III), who were predominately Caucasian, female, older than 57 years, having a waist size larger than 38.4 inches and weighing over 168 pounds. Few were shorter than 5 foot 3 inches and slightly less than one-third of the participants had diabetic first degree blood relatives. The POC screening better identified participants with more notable diabetes characteristics than the diabetes risk questionnaire (Table III). Study results mirrored national statistics for the percentage of diabetics by age group and for the blood pressure of diabetics.

As shown in Table I, laboratory screening results confirmed POC screening results for 28 of the 34 participants at or above the cut point between normal glycemic and pre-diabetic blood levels. Those participants were directed to seek medical evaluation and consultation. Researchers made up to 3 attempts to obtain details of medical follow-ups. Of referred participants, 82% responded to these attempts. One respondent with a laboratory result greater than 6.5% (the cut point between diabetes and pre-diabetes) and one with a laboratory result in the pre-diabetes category reported that the medical provider recommended lifestyle changes and a re-evaluation in 4 and 6 months, respectively. Another participant with laboratory results in the diabetic range was encouraged to make lifestyle changes and was prescribed Metformin, a drug that decreases the amount of glucose absorbed from food and increases the body's response to insulin.

Figure 4A: Filling the Blood Collector

Figure 4B: Placing the Blood Collector into the Sampler Body

Figure 4D: POC Screening Result Digitally Displayed on the Test Monitor after 5 Undisturbed Minutes

Figure 4C: Transfer of the Blood Solution to the Test Cartridge in the Test Monitor

A total of 45% of respondents did not follow up with a medical provider. The remaining 45% were reassured by a medical provider that the laboratory results were of no consequence (Table IV).

Statistical analysis was completed with data combined from the 2 research sites because they were not found to be statistically different. Table V illustrates the abnormal distribution in the association between the POC ranked values and the laboratory result assignment into its respective diabetes category. In the first round of statistical analysis (Table VI), the result value (0.439) and significance ($p<0.05$) of Kendall's tau indicate that the POC HbA1c screening result prediction is statistically significant for the subsequent laboratory diabetes category assignment.

More POC results in the diabetic and pre-diabetic range were observed than expected, but fewer laboratory results in the diabetic and pre-diabetic range were observed than expected (Table I). In the second round of statistical analyses (Table VII), 3 of the 4 tests executed to analyze an association between the POC and the laboratory screening results demonstrated statistical significance: Chi Square ($p=0.004$), Likelihood ratio ($p=0.004$) and Cramer's V ($p<0.001$). Lambda ($p=0.145$) was the exception and did not show statistical significance. The study found that POC screening results could predict normal, pre-diabetic or diabetic group membership as confirmed by subsequent laboratory HbA1c screenings.

Discussion

Data from NHANES III public use files reveals that self-reported diabetes risk factors determines diabetes in 27 to 53% (40% average) of the cases.[26] Of the 75 at-will research participants who demonstrated sufficient self-reported risk factors, 28 (37%) were confirmed as diabetic or pre-di-

Table III: Percent of Questionnaire vs. POC Result Qualified Participants with Diabetes

	Questionnaire Qualified			POC Qualified		
	Total	Site #1	Site #2	Total	Site #1	Site #2
No. of Participants	75	33	42	34	16	18
% Male	28	18	36	29	12.5	44
% Female	69	76	64	71	87.5	56
% Unknown	3	6	-	-	-	-
% Caucasian	93	91	95	94	87.5	100
% Hispanic	4	3	5	3	6	-
% Native American	1	3	-	3	6	-
% African American	1	3	-	-	-	-
% <44 years	13	15	12	9	6	11
% 44 to 57 years	32	18	43	29	25	33
% >57 years	56	67	45	62	69	56
% Waist >38.4"	59	52	64	68	50	83
% Unknown waist	3	6	-	3	6	-
% Weight >168 lbs.	73	70	76	68	62.5	72
% Height <5'3"	15	12	17	26	19	33
% Increased Activity						
<1/month	9	9	10	12	6	17
1/month	7	9	5	9	12.5	6
2 to 3x/month	7	6	7	6	6	6
1 to 2x/week	21	18	24	29	25	33
3 to 4x/week	24	15	31	26	19	33
5 to 7x/week	16	9	21	3	-	6
No response	16	34	2	-	-	-
% Family History DM	31	30	31	35	25	44

Table IV: Follow-Up Results

				Physician's Recommendation		
Lab Results	Number of Participants	No Response	No Follow–Up	Rx & Lifestyle Modification	Lifestyle Modification and 4 to 6 month Evaluation	No Concern
Site #1 5.7 to 6.4	12	1	3	-	-	8
Site #1 >6.4	-	-	-	-	-	-
Site5#2 5.7 to 6.4	14	5	7	-	-	2
Site #2 >6.4	2	-	-	1	1	-
Total 5.7 to 6.4	26	6	10	-	-	10
Total >6.4	2	-	-	1	1	-

abetic by POC screening followed by subsequent laboratory screenings.

Inclusion criteria involved age, weight, height, waist size, ethnicity and family history. To improve the sample, the inclusion criteria could have been significantly tightened to contain only those at or over 45 years of age, especially if body mass index (BMI) was equal to or greater than 25 kg/m and/or either treated or untreated sustained blood pressure was greater than 135/80 mm Hg.[21] BMI and weight gain are good inclusion criteria - according to Mokdad, they are major risk factors with an unfortunate prolonged delay between them and the onset of diabetes.[34] Including socioeconomic status would have been advantageous since Link et

al found that it may be more indicative of undiagnosed diabetes than ethnicity.[35]

Exclusion criteria included previous diabetes or pre-diabetes diagnosis, pregnancy, abnormal hemoglobin traits, history of blood-borne infections, use of corticosteroids, or over-the-counter (OTC) or prescription blood thinners, such as aspirin or Coumadin, respectively. Staying true to exclusion criteria utilized in previous research, such as only previous diabetes or pre-diabetes diagnosis, pregnancy or abnormal hemoglobin traits, would also improve the sample.[17,21,25,26] To the knowledge of the researchers, no other research excluded participants with a history of blood-borne infections or the use of blood thinners. The IRB required these exclusions. The researchers assume that the exclusion of those with a history of blood-borne infections was to protect research participants and researchers from cross contamination. According to the CDC's 2011 Diabetes Fact Sheet, in 2004 heart disease and stroke were respectively listed on 68% and 16% of diabetes-related death certificates of those age 65 and older,[1] and blood thinners are frequently recommended for a history of vascular disease, which is often concurrent with diabetes.[36,37] An assumption could be drawn that there exists a likelihood that undiagnosed diabetic and pre-diabetic individuals may be self-medicating with OTC blood thinners or may be taking a prescription blood thinner for vascular disease under the direction of a physician. Excluding these individuals from screening decreases the sample size, therefore decreasing the power of the study and, furthermore, allows for the possibility of not identifying previously undiagnosed diabetes and pre-diabetes.

Using the HbA1c assay for diabetes status has limitations including conditions that reduce the red blood cell turnover rate like hemolytic anemia, chronic malaria, major blood loss and blood transfusions, all of which give false results, or abnormal hemoglobin traits (i.e., sickle cell anemia) that interfere with some HbA1c assay methods.[30] Because the POC kit used in this study had been shown to be 99.3% accurate,[38] it was anticipated that the same number of participants would be categorized as pre-diabetic and diabetic from both the POC and laboratory assays; however, in this study only 28 of the 34 (82.4%) positive POC results were confirmed by laboratory results. One explanation might be that the kit used in this study was standardized to the Diabetes Control and Complications Trial (DCCT) assay in a National Glycohemoglobin Standardization Program (NGSP) certified laboratory[39] and the laboratory processing the confirming screenings was not.

Table V: Cross Tabulation of POC and Laboratory Results

Count	Lab HbA1c			Totals
	<5.7%	5.7 to 6.4%	>6.4%	
POC HbA1c				
5.6	0	1	0	1
5.7	4	4	0	8
5.8	1	3	0	4
5.9	0	8	0	8
6.0	1	3	0	4
6.1	0	2	0	2
6.2	0	2	0	2
6.3	0	0	0	0
6.4	0	1	0	1
6.5	0	2	0	2
6.6	0	0	0	0
6.7	0	0	1	1
6.8	0	0	0	0
6.9	0	0	1	1
Total	6	26	2	34

Table VI: Round 1 Statistical Analysis

	Value	Std. Error	CV	p–Value
Kendall tau	0.439	0.120	2.842	0.004
Number of valid cases	34	-	-	-

National statistics indicate that 67% of diabetics, as defined with laboratory screening results of HbA1c of 6.4% or greater, have blood pressure equal to or greater than 140/90 or are taking hypertensive medications.[40] Similarly, 2 participants in this study having laboratory screening results of 6.4% or greater had systolic measurements of 130 or more, while only 1 had diastolic measurements greater than 80. The participant with elevated systolic and diastolic blood pressure was also taking hypertensive medication.

The prevalence of diagnosed and undiagnosed diabetes is low until age 40, when it increases to 10.8%, through age 59, and is 23.1% in those aged 60 and older.[1] That is a ratio of 2.14 diabetics over the age of 59 for every one between the ages of 40 and 59. Of the 34 participants identified as diabetic or pre-diabetic in this study, 3 were less than age 44, 10 were aged 44 to 57, and 21 were over the age of 57. This study identified a ratio of 2.11 diabetic and pre-diabetic participants over the age of 57 for every one between the ages of 44 and 57. While this study's age categories were different than those of the national statistics, the ratio of diabetics in the highest age range compared to those in the mid-range of ages was very similar.

Table VII: Round 2 Statistical Analysis

	Value	DF	Std. Error	CV	p–Value
Number of valid cases	34	-	-	-	-
Chi Square	34.253	4	-	-	0.004
Likelihood Ratio	15.635	4	-	-	0.004
Cramer's V	0.710	-	-	-	<0.001
Lambda Average POC HbA1c dependent Lab HbA1c dependent	 0.364 0.667 0.250	-	 0.186 0.272 0.153	 1.458 1.458 1.458	 0.145 0.145 0.145

Table VIII: Population Statistics: Percentages of Ethnicities at Greatest Risk of Diabetes

	U.S. Census Bureau	County Census Site #1	County Census Site #2	Site #1 Study Results	Site #2 Study Results
Non-Hispanic Black	12.32	1.7	1.1	0.03	-
Hispanic/Latino American	12.55	4.5	38.3	0.03	0.05
Asian Americans	3.64	2.1	0.9	-	-
Pacific Islanders	0.14	0.4	0.1	-	-
American Indian/Alaska Native	0.88	1.5	1.2	0.03	-

This study agreed with Ealovega et al that an increase in opportune screening does not improve the rate of preventive and therapeutic diabetic treatments; although, the reason in each study had vast differences.[41] Ealovega et al found physicians are unlikely to follow up with a person who has abnormal results whereas this study discovered that either patients did not seek early medical intervention or most physicians did not uphold the ADA's recently revised diabetes cut points as listed in (Table II).[41]

This study addresses the Healthy People 2020 diabetes objective D-15: Increase the proportion of persons with diabetes whose condition has been diagnosed.[22] It also fosters a collaborative foundation among health care providers as suggested by Jahn who stressed the importance of diabetes-sensitive quality care of dental patients by way of collaboration with other dental and medical providers.[42] Jahn also feels this collaboration may lead to an improved understanding of the perio-systemic relationship - as indicated in the Institute of Medicine's report: Health Professions Education: A Bridge to Quality, collaboration brings out the strengths of each discipline.[43]

This study paves the way for additional research to evaluate time and cost effectiveness, sources of remuneration for screening services, and surveys of patients and physicians to assess desire and appreciation of diabetes screening in the dental office. Replicating this study with a larger sample size and/or a more culturally diverse sample would increase the ability to generalize the results to the entire population (Table VIII). Using periodontal disease indicators and more standard inclusion and exclusion criteria, in addition to a POC HbA1c screening as in a study by Lalla et al would improve the percentage of correctly identified dental patients with pre-diabetes and diabetes.[44]

As early as 1999, the Agency for Healthcare Research and Quality (AHRQ) began investing in strategies to improve the translation of research findings into clinical practice grounded on the fact that it takes up to 2 decades for research to become the everyday norm.[45] Translation of research into dental practice may be a limitation of this study if responses are similar to those given by dentists surveyed by Kunzel et al, who not only lacked knowledge but also lacked desire, responsibility or confidence to change practice and address diabetes in the dental office.[46] If this research is translated into dental practices, a limitation may result from individuals not pursuing follow-up care or physicians not translating the most current ADA standards of medical care in diabetes into their practices.[20]

The practical implication of this research is that it answers a call to action by increasing screening strategies, approaches and locations and, in turn, decreases the prevalence of diabetes and its adverse outcomes.[41] Phillips et al stated "diabetes prevention and care are limited by lack of screen-

ing."[25] The screening in this study, if adopted universally, could lead to early detection of pre-diabetes or diabetes and consequently slow or prevent the complications of diabetes.[17,18] Theoretically, this study implies that any office, in any location, with any population could include diabetes screening in their daily routines.

Conclusion

The POC diabetes screening used in this study is quick, easy and welcomed by dental patients. Because diabetes is a risk to the oral and systemic health of an individual, the Standards for Clinical Dental Hygiene Practice recommends the evaluation of diabetes in the systematic collection, analysis and documentation of patient assessments.[47]

The purpose of screening in the dental office is not to diagnose diabetes, but to refer for medical diagnoses and treatment to improve systemic and oral outcomes.[48] Medical and dental professionals are challenged to stay abreast of the ever changing flood of evidence in the literature regarding the severity of diabetes and the bidirectional relationship between diabetes and periodontal disease. Medical-dental education and collaborations for improved systemic and oral health of the population can be fostered via diabetes screening in the dental office.

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Iatro-Compliance: An Unintended Consequence of Excessive Autonomy in Long Term Care Facilities

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Abstract

Purpose: Periodontal disease and caries remain the most prevalent preventable chronic diseases for seniors. Seniors transitioning into long term care facilities (LTCFs) often present with oral health challenges linked to systemic diseases, plaque control, psychomotor skills and oral health literacy. Many retain a discernible level of physical and cognitive ability, establishing considerable autonomy. This study examines the effect of autonomy on residents' ability to perform oral hygiene.

Methods: Descriptive data were developed utilizing mixed methodology on a convenience sample of 12 residents and 7 care staff of a LTCF. One-on-one interviews consisted of questions about demographics, and exploration of the influence of ageism, respect and time constraints on resident autonomy in oral care practices.

Results: Data suggests shortcomings, such as failure of the staff to ensure oral hygiene oversight and failure of the resident to ask for assistance. Autonomy, while laudable, was used by residents to resist staff assistance, partially motivated by residents' lack of confidence in care staff oral hygiene literacy and skills. In turn, by honoring resident's independence, the staff enabled excessive autonomy to occur creating an environment of iatro-compliance.

Conclusion: While it is beneficial to encourage autonomy, oversight and education must remain an integral component of oral hygiene care in this population. Improved oral hygiene skills can be fostered in LTCFs by utilizing the current oral health care workforce. Registered dental hygienists (RDHs), under indirect supervision of a dentist, can fulfill the role of an oral health care director (OHCD) in LTCFs. A director's presence in a facility can decrease staff caused iatro-compliance and increase oral hygiene skills and literacy of the residents, while enhancing their autonomy through education and support.

Keywords: Autonomy, Oral Hygiene, Long Care, Term Care Facilities, Health Promotion, Disease Prevention, Oral Health Care Director

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

Introduction

By 2030, Americans over 65 will represent 19% of the entire U.S. population.[1] Today's 65 year old will have a 25% chance of reaching 90. This will rise to 40% by 2050.[2] The "older-old" category (those 85 and older) will account for 4.3% of the population and represent the group most likely to require long term care services.[2,3] This longevity has been attributed to discoveries in prevention, control and eradication of chronic adult diseases.[4] However, medicine does not stand alone in such advancements.

It is well known that oral health has seen advancements, such as reducing tooth loss from dental caries and periodontal disease. Introduction of stannous fluoride in dentifrices (Crest® Toothpaste) in 1955 and fluoridation of municipal water systems in 1962 reduced the incidence of caries hence tooth loss.[4,5] Discoveries and applications in dental science have improved diagnosis, treatment and prevention of periodontal disease.[6] Therefore, the overall numbers of edentulous elders (no retained natural teeth) decreased from over 45% of the population in 1974, to nearly 25% in the most current survey dated 1999 to 2002.[4,6] Despite these advancements, dental caries and periodontal disease remained the most prevalent preventable chronic diseases for seniors. Of dentate elders (retaining at least one tooth), 23% had untreated dental caries. Of those, greater than 14% had moderate to severe periodontal disease.[7]

Challenges for oral care providers will increase as the senior population transitions into long term care facilities (LTCFs).[8] Such challenges include:

- Medically complex residents presenting with oral health issues linked to systemic diseases (e.g., diabetes, pulmonary and cardiovascular disease)[8,9]
- Environmental factors, such as tobacco and alcohol use, poor diet and nutrition, reduced sali-

vary flow, history of fluoride exposure, and limitations to activities of daily living[10,11]
- Oral health literacy and skills of care staff[12-14]
- Oral health literacy and skills of residents[15-17]
- Understanding residents' autonomy in performing oral hygiene[15,18]
- Residents willingness to report oral hygiene needs[18,19]

Many residents entering LTCFs retained a discernible level of physical and cognitive ability. These residents represented the autonomous segment of the LTCF population who exerted control over their care staff interactions. Yet few studies within literature specifically addressed how LTCF resident autonomy impacted oral hygiene skills.[15,18] Autonomy, defined as an ability to govern ones-self and have independence of will, seemed out of reach to the LTCF resident. One way to engender autonomy was through an individual's capacity to self-advocate or enlist the aid of an advocate.[19] Successful self-advocacy was dependent on a resident's ability and willingness to be heard, matched by staffs' willingness to listen and act as an advocate. Therefore, the purpose of this study is to explore the influence of resident autonomy on their oral hygiene care.

LTCFs originated in 1954 with an amendment to the Hospital Survey and Construction Act.[20] This legislation funded construction of facilities that extended the medical model of treatment from hospitals to new care environments.[21] The medical model, based on biomedicine, assumed that "disease could be fully accounted for by deviation from the norm of measurable biological variables."[22] It required that disease was treated separately from psychosocial influences. Thus health outcomes desired and expected were less related to psychosocial influences such quality of life (QoL) than medical outcomes.[22]

Since 1997, new care models and trends, exemplified by The Greenhouse concept and The Eden Alternative, focused on resident centered care and QoL issues.[21,23] These models introduced a philosophy of care and practice focused on resident-directed and consumer-driven health promotion.[21,23-25] This new focus emphasized the importance of resident autonomy and its influence on resident QoL.[23,26] As theoretical frameworks grew, newer guidelines addressed insufficient oral health care practices for LTCF residents. Resulting federal regulations outlined by the Health Care Financing Administration (HCFA) mandated all nursing homes receiving federal reimbursement improve resident oral health by providing routine and emergency oral health care services.[27] These regulations became effective April 1, 1992 and required LTCFs to:

- Assist patients in obtaining routine and emergency dental care
- Provide dental care internally or obtain care from an external source
- Assist in scheduling appointments for dental care and arrange transportation
- Develop an oral health program that includes annual staff in-service training, oral examinations within 45 days of admission, repeated annually for each resident and a daily oral hygiene preventive care plan for each resident[27]

Despite these mandates, LTCFs apparently did not consider oral health an institutional priority.

More recently objectives were developed from governmental initiatives, such as Healthy People 2010 and 2020 and ongoing Centers for Disease Control (CDC) funding,[27,28] in conjunction with the Association of State and Territorial Dental Directors, which assisted in promoting and monitoring oral health behaviors nationwide. One objective of Health People 2020 was to increase the proportion of dentists with geriatric certification from 20% in 2007, to 22% by 2020.[27] While this targeted increase addressed geriatric oral health, the majority of the Healthy People 2020 objectives addressed children and adults less than 64 years of age.

In 2003, 40% of ambulatory institutionalized older adults had gingivitis and 33 to 60% had some degree of attachment loss due to periodontal disease.[29] A seminal study by Yoneyama et al reported links between periodontal pathogens and pneumonia, the leading cause of death in elderly long term and hospitalized patients.[30] Further studies reported improved oral hygiene practices reduced morbidity and mortality related to new pneumonia cases and number of febrile days not associated with urinary tract infections in LTCFs.[31-33]

Physiological changes in the oral cavity occur with age. Xerostomia, the most common adverse effect of medications commonly prescribed in LTCFs, exacerbated age related epithelial alterations.[31] Therefore, xerostomia increased plaque control challenges for residents and care staff alike. Plaque control was an important preventive measure to reduce bacterial propagation, periodontal pathogens and systemic complications of oral inflammatory processes.[34] Many autonomous residents developed poor oral care practices in the absence of care staff assistance.[31] Further barriers were created when LTCFs, as organizations, did not place a priority on oral health or develop oral health policies for care staff compliance.[35]

Effects of Oral Hygiene Autonomy

In a study authored by Bytheway, ageism was defined as "discrimination against older people on the grounds of age."[36] Residents in LTCFs were presumed inflexible in their beliefs with old fashioned morality and skills.[37] Residents perceived oral hygiene as forceful encounters performed by staff. Care staffs had opportunities to change these perceptions if they understood the level of hygiene residents could perform for themselves and when to assist.[26,37]

Ageism, while discriminatory, was not entirely negative. Under the influence of ageism, staff and residents formed "fictive kin" relationships similar to those of family members.[38] These relationships fostered protectionism and devotion toward the resident and allowed autonomy to develop.[19]

Respect involved demonstrations of consideration and regard for one another. Care routines thus became key factors in developing relationships.[39] Respect demonstrated by staff was influenced by the leadership style within the LTCF. In a facility where the priority was a home-like environment, respect was displayed by informal communications and kind gestures that represented an understanding of resident desires.[39] In an effort to demonstrate respect for the resident, staff acceded to their wishes. If care staffs determined a resident did not wish or require assistance in oral hygiene tasks, they would leave them alone.[40] Autonomous residents required less care staff time. Therefore, it was beneficial to care staff when residents were autonomous.[41,42]

Of the 3 effects explored in this study, time constraints was unique because it involved a directly measurable quantity, that of time. Time's value was most appreciated when "time has run out." Nevertheless, constraints placed upon time available were not consistently quantifiable. For instance, all of the following contributed to the concept of time constraints:[43]

- Imposed limits of an eight hour work shift
- Number of mandated and non-mandated tasks
- Medical and personal complexities of residents
- Number of residents assigned to a staff member
- Relationships between staff and resident

Thus, it was gathered from the findings of a 2007 study, where 92% of LTCFs lacked adequate care staff to provide the level of care mandated. Time constraints represented a significant impact on the staff-resident relationship.[43] Time constraints were reduced using positive relationship skills and demonstrations of respect.[38,39] Demonstrations of oral hygiene autonomy by residents were considered beneficial even though they contributed to the lack of oversight by care staff.[41]

Methods and Materials

This study used a mixed study design on a convenience sample of 12 residents and 7 care staffs that resided or were employed in a LTCF. Resident inclusion criteria limited participation to those who could speak and understand English, were able to participate in a 30 minute face-to-face structured interview, could understand questions and make reasonable responses. Care staff inclusion criteria limited participation to those who could speak and understand English, had direct contact with residents, and were currently employed by the facility.

One-on-one interviews were conducted, formatted as Likert Scale fixed answer questions about demographics and oral hygiene care practices. Open-ended narrative interviews explored influences of ageism, respect and time constraints on autonomy in oral hygiene tasks. Narrative answers were analyzed to describe resident experiences, supplemented by salient points derived from Likert Scale questions. All interview data was digitally recorded and detailed field notes were taken. Interviews were transcribed into Microsoft Word 2010 and entered into NVIVO 9 for analysis in the constructivist tradition. Fixed data were analyzed using descriptive statistics. Measures of central tendency were normalized using a convenience sample into percentages to supplement qualitative findings. Responses from residents and care staff were aggregated to develop non-biased results.

Limitations of Study

Purposeful limitations placed on this study included a single LTCF and resident participants who were not intubated or ventilated, or unable cognitively to partake in the interview process. This study was designed to explore residents with partial or complete autonomy in performing oral hygiene tasks. Due to the use of a single LTCF, these findings could not be generalized to other facilities. The instrument used to gather data was developed specifically for this study and is in process of validation.

Results

Care staff spent 2 hours and 44 minutes with patients per patient/day. This figure was slightly better than the national average of 2 hours and 28 minutes per patient/day.[44] Within that time frame CNAs were responsible for the majority of direct care tasks: waking and dressing, bathing, assisting with meals, light housekeeping, transporting, lifting, and oral hygiene

care. These care tasks were performed for numerous residents with a variety of needs.

While all participants agreed oral health was important for general health, it remained a low priority for all in the facility. Oral health priority was evaluated by interviewing administrative staff, direct care staff and residents. At the administrative level federal guidelines were adhered to and resident oral care plans developed. However, care plans were directed solely towards dietary planning. There were no comprehensive dental examinations for plaque, caries or oral disease to establish comprehensive oral hygiene care. Any concerns that required referrals were directed to the family, yet there were no guidelines that assured appointments were made.

The facility's administration required that care staff perform oral hygiene care yet did not promote oral hygiene care plans that included oversight. The administrator stated oral hygiene care was based primarily on resident input: "A lot of our patients are alert and do not need a lot of help." Those comments were contradicted by residents with the noteworthy (83%) negative response when asked if care staff monitored their oral hygiene care. Additionally, one third of residents perceived care staff had little time or desire to perform oral hygiene care.

Care staffs' oral hygiene education conformed to federal guidelines consisting of bi-annual in-service training provided by the facility's contracted dentist. However, this infrequent level of educational intervention without constant reinforcement did not maintain oral health literacy.[45] Significantly, several residents reported they lacked confidence in care staffs' oral hygiene care skills. A sample quote from one report read: "I don't know what kind of course they give but I figured the course they gave them any fifth grader would pass."

While the facility's administration made basic armamentarium available for daily oral hygiene care, it did not emphasize the importance of daily or professional oral care. One half of residents reported having no dentist and more than half had not had a professional scaling since entering the facility. Of those who stated they had a dentist, nearly 67% had not made a professional dental or dental hygiene appointment. Therefore, in the protective supportive environment of a LTCF, the majority of residents were not provided access to a dental home or a source of oral health education.

The priority residents placed on oral hygiene care was evaluated, in part, by exploring their oral hygiene care practices. The majority of residents brushed their teeth and half reportedly brushed twice daily for 3 minutes or more. Therefore, minimal oral hygiene literacy was inferred from these responses. However, with no oversight or professional care, resident oral hygiene literacy or care practices could not be confirmed.

Ageism and respect appeared inter-woven as effects of poor oral hygiene care oversight. Relationships that developed between resident and care staff, fostered by ageism and respect, were beneficial and improved resident QoL. Care staff commented:

"We know this is their home. We have to respect their privacy. We have to respect their wishes."

However, this respect developed into a routine where care staff was encouraged to avoid interjecting oral hygiene care assistance. Residents contributed to this routine by refusing assistance. Residents noted: "No, not for my teeth, they just never ask. They probably think it would aggravate me if they did (ask me) and it would. That's a task that's not difficult," and "I usually do everything for myself. "Add to these comments the residents' lack of confidence in care staff, and oral hygiene care oversight was virtually non-existent.

Resident responses regarding access to a dental home revealed their complicity since they did not partake in available oral health services. One-half of residents had not seen a dentist and 58% had not had professional oral care while in the facility. While 42% of residents self-reported having a dentist, 67% reported never visiting a dentist while in the facility. Only 33% of residents interviewed reported having had professional cleanings. Two residents participated in community rotations with the Health Science Center Dental School's Division of Dental Hygiene senior students. These dental hygiene seniors provided oral hygiene services including assessment, treatment and education free of charge for residents who had a dental exam within the previous year.

Discussion

The purpose of this study was to examine the effect autonomy had on the ability of residents to perform personal oral hygiene care. As data was collected a cause and effect relationship became apparent between the influences of ageism, respect and time constraints on resident autonomy, generating compelling findings.

Ageism was found beneficial and even preferred by residents. "They treat me better because I'm older." Thus ageism was an important component of respectful relationships and facilitated task completion. These findings were supported in literature that described

"fictive kin" relationships and established that residents ultimately exerted control over day to day relationships through manipulation.[19,38] Care staffs comments of "Because it depends on the person and their mood at that time" reflected this.

Respect was directly affected by ageism and based upon affection. Care staffs were reluctant to intervene if assistance was not requested. Residents stated: "There are certain things I should be able to do by myself. But if not, I'll ask for help." An unintended consequence of this respect was excessive autonomy, leaving the resident without assistance or oversight in their daily oral hygiene care. These findings were supported by Cook, who found that residents were active in how they responded to institutional processes.[15] Cook also found that residents lived as "active biographical agents" instrumental in shaping their life in a facility. This challenged an initial assumption that residents were inactive or passive recipients of care.[19,42]

Time constraints were initially considered to be the exclusive domain of care staffs. Within an 8 hour work shift, care staffs had limited time to devote to each resident. Time distributions could not be normalized for any individual - any given task could take an unspecified, and often unexpected, amount of time. Residents were aware of this work load, commenting: "Well, I think they need more (employees), particularly the CNA's. You can sit here and wait and wait and wait."

Significant data from this study described autonomy in oral hygiene care as initiated by residents. Residents, while aware of time constraints, were motivated to be autonomous largely due to a lack of confidence in care staffs' oral hygiene care skills. Thus they presented themselves fully capable of performing their own oral hygiene care and resisted care staffs' offerings of assistance.

Care staff, because they were less involved in oral care, had additional time to devote to other residents. They respected resident autonomy but also exploited it as an excuse not to intervene in a task they were uncomfortable performing. As a member of care staff indicated: "I mean like I'm not against it. I would say though if I were super-duper crunched for time it's not a priority."

These care staff, similar to those discussed in the literature, would rather perform any task than oral hygiene care.[37] Tasks such as transporting, lifting, bathing, eating and toileting were caring tasks, while oral hygiene care was directly related to the health of the resident. Thus, residents' autonomy was a welcomed respite for staff, yet resulted in benign neglect. This resulted in iatro-compliance by care staff when they shifted oral care responsibility fully to the resident.

While this facility administration, care staffs and residents all indicated oral health was important to general health, none appeared to place a priority on oral hygiene care. Residents felt it was too simple a task to require assistance. Without consistent care staff oversight or record of professional oral care, there was no way to monitor proficiency. Therefore, there existed the potential for substandard oral hygiene care practices.

This facility monitored and managed residents' general health, while specific oral health was marginalized. Daily oral hygiene care plans were based on limited intake oral evaluations and resident feedback, not professional oral health examinations. Oral diseases were under diagnosed if there was no institutional oral care plan. Resulting oral diseases could impact a residents' ability to masticate, swallow, speak, consume food and remain pain and infection free.[12,28,31,32]

Even though this facility contracted with a dentist as required by mandate, this contract did not ensure provision of a dental home. Because residents reported few or no visits for professional oral care it could be surmised there was little in the way of professional oral hygiene education provided. There would have been little change in residents' approach to their oral hygiene care as their oral environment changed with age. Therefore federal mandates provided little oversight or funding to insure compliance. Residents bore responsibility, along with the facility, by not placing a priority on their own oral health.

Due to the study's small sample size and single facility, the results cannot be generalized. However, by sampling autonomous residents, this data gives oral health providers in LTCFs added information about effects on oral health. This study provides new insight about how autonomy affects the ability of a resident to perform acceptable oral hygiene by demonstrating the unintended consequence of iatro-compliance by staff and resident alike.

Conclusion

Many LTCF residents retain a discernible level of physical and cognitive ability enabling them to establish considerable oral hygiene care autonomy. This autonomy, while laudable, is a mechanism used to rebuff care staff's assistance when residents lack confidence in their skills. By conforming to resident autonomy, care staffs miss opportunities to engage in improved oral hygiene care. This relationship is instrumental in fostering a facility-wide complacency about resident oral health. The unintended consequence of this relationship is iatro-compliance.

This phenomenon could be ameliorated by developing the role of an Oral Health Care Director (OHCD). This director, a registered dental hygienist could coordinate patient evaluations, treatment, and referrals. The OHCD would train and supervise staff, collaborate with medical professionals, and gather data to support funding for continued care.

To determine if iatro-compliance is evident throughout the industry, this study should be expanded to multiple facilities with different organizational environments. Further research about the impact of resident autonomy on oral hygiene care in these varied environments could inform oral health care providers of ways to enlist residents to capitalize on their autonomy to reduce the benign neglect of iatro-compliance.

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