

Source: Journal of Dental Hygiene, Vol. 81, No. 3, July 2007
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The Branding Campaign, the Journal, and our Editorial Review Board

Rebecca S Wilder, RDH, BS, MS

Rebecca S. Wilder is an associate professor at the University of North Carolina Chapel Hill School of Dentistry and Director of the Master of Science Degree Program in Dental Hygiene Education. She is the current editor-in-chief of the Journal of Dental Hygiene.



I recently returned from the American Dental Hygienists' Association (ADHA) Annual Session in New Orleans. It was quite exciting to see the new branding campaign unfold. "Unleashing your potential" says it all. ADHA is committing to empowering, developing, and supporting every dental hygienist. Through my many years in academia, I have had the privilege of seeing many graduate students enter as one person and leave quite differently-empowered, developed, and supported by his/her faculty and peers to go out and make many contributions to the dental hygiene profession. Each of us has the ability to become the person we envision. It takes perseverance and a network of caring mentors and peers. Each of you can have the support you need to become the professional you desire through the American Dental Hygienists' Association-if you take advantage of it.

My role as editor-in-chief of the *Journal of Dental Hygiene* is to envision and implement what we should look like to the scientific community. The *Journal* is a public symbol of our theoretical base in dental hygiene and it represents our unique body of knowledge. **In the entire world, there are only 3 peer-reviewed, scientific research journals for dental hygienists.** To give you something to compare that to, nurse practitioners have somewhere between 4-5 times the numbers of peer-reviewed research journals to represent their profession. The entire nursing profession has many more than that!

The 3 peer-reviewed, scientific research journals in dental hygiene are the *Canadian Journal of Dental Hygiene* (CJDH), the *International Journal of Dental Hygiene* (IJDH), and the *Journal of Dental Hygiene* (JDH). The CJDH is published 6 times per year; the IFDH and JDH are published 4 times per year. The CJDH is in print version only; the IFDH is in print and online versions, and the JDH has been online-only since the summer of 2004. In response to our members' requests to bring the print version of the JDH back to ADHA members, ADHA staff developed, pilot tested and conducted a randomized sample of members with the consultation of a statistician. The entire results will be published in a future issue of *Access*. The bottom line is that 89% of respondents want a print or print and online version of the Journal. Only 11% wanted the online version only. Since ADHA is committed to data-driven decisions, the Board of Trustees were presented with the results of the survey and they made a recommendation to the House of Delegates to increase dues by \$5 per year to bring back the print version of the JDH. In a close vote, the House narrowly defeated the dues increase. What that means to you is that the JDH will remain in an online format. Although the House did not feel it is financially feasible at this point in time to raise dues, the move to bring the print edition of the JDH is not being ruled out. For now, ADHA staff is committed to improving the online version of the Journal as we investigate other strategies to move ahead as the ADHA membership desires.

As we strive to make our Journal the best it can be to empower, develop, and support you, I would like to take this opportunity to thank several people. Staff at ADHA who make my job pleasant and innovative are Jeff Mitchell, director of communications, and Katie Barge, staff editor. Thanks for all of the hard work that you do every day!

The JDH Editorial Review Board is fantastic! All reviewers to the Journal have a tremendous responsibility to evaluate manuscripts critically but constructively. They prepare a summary of comments to help authors improve their writing ability. In addition, they make recommendations to me about the quality of the paper and whether it is suitable for the *Journal of Dental Hygiene*. The reviews have to be accomplished in a certain time frame so they are adding this job on to the many other tasks they have to do. The JDH could not function without the time, expertise and commitment of the following people. Thank you for loving your profession and lending **support** to others so they may become **empowered** in their careers and **developed** in their writing abilities.

Have a wonderful summer!

Sincerely,

Rebecca Wilder, RDH, BS, MS

Editor-in-Chief, *Journal of Dental Hygiene*

2007 Editorial Review Board

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Upfront

Katie Barge

Katie S. Barge is staff editor of the Journal of Dental Hygiene and staff writer for Access

Antibiotic Use in Infants May Boost Asthma Risk

Infants who are exposed to even one course of antibiotics during their first year of life may be at increased risk for developing childhood asthma, reported Canadian researchers from the University of Manitoba and McGill University. The study, which was published in the June issue of *CHEST*, the peer-reviewed journal of the American College of Chest Physicians, reports that children who received antibiotics before their first birthday were at greater risk for developing asthma by age 7 than those who did not receive antibiotics. The risk for asthma doubled in children receiving antibiotics for nonrespiratory infections, as well as in children who received multiple antibiotic courses and who did not live with a dog during their first year of life.

"Antibiotics are prescribed mostly for respiratory tract infections, yet respiratory symptoms can be a sign of future asthma. This may make it difficult to attribute antibiotic use to asthma development," said lead study author Anita Kozyrskyj, PhD, University of Manitoba, Winnipeg, MB. "Our study reported on antibiotic use in children being treated for nonrespiratory tract infections, which distinguishes the effect of the antibiotic."

Using a prescription database, Kozyrskyj and her colleagues assessed the association between antibiotic prescription use during an infant's first year of life and asthma at age 7 in a 1995 birth cohort of 13 116 children. The reason for antibiotic use was categorized by lower respiratory tract infection (bronchitis, pneumonia), upper respiratory tract infection (otitis media, sinusitis), and nonrespiratory tract infection (urinary infections, impetigo).

The researchers found that the risk was highest for the infants who received multiple courses of antibiotics. Children who received 1 to 2 courses of antibiotics had a 21% increased risk of asthma; those given 3 to 4 courses had a 30% increased risk; and kids who were given more than 4 courses had a 46% increased risk. The researchers also found that those who received prescriptions for broad-spectrum antibiotics, which kill both bad and good bacteria, were at higher risk than those who received narrow-spectrum antibiotics.

"It may be that you need the presence of good bacteria during the first year of life for the immune system to develop normally, and the antibiotics are killing off some of the natural microflora in the gut," said Kozyrskyj.

Within the study group, 6% of children had current asthma at age 7, while 65% of children had received at least one antibiotic prescription during their first year of life. When researchers compared the reason for antibiotic use, their analysis indicated that asthma at age 7 was almost twice as likely in children receiving an antibiotic for nonrespiratory tract infections compared with children who did not receive antibiotics.

Other factors that increased the risk of asthma included maternal asthma, living in an urban area, and being male. The presence of a dog during the first year of life was associated with a decreased asthma risk. Absence of a dog during the first year doubled asthma risk among children who received multiple courses of antibiotics. However, the protective effect of living with a dog was not present among children who received fewer antibiotic courses.

"Dogs bring germs into the home, and it is thought that this exposure is required for the infant's immune system to develop normally. Other research has shown that the presence of a dog in early life protects against the development of asthma," said Kozyrskyj. "Exposure to germs is lower in the absence of a dog. The administration of an antibiotic may further reduce this exposure and increase the likelihood of asthma development."

The researchers recommend that when treating infants, physicians start by prescribing narrow-spectrum antibiotics, such as amoxicillin, and then if necessary, try a broad-spectrum medication.

"Antibiotics are frequently prescribed for young children for both respiratory and nonrespiratory infections," said Mark J. Rosen, MD, FCCP, president of the American College of Chest Physicians. "Understanding the relationship between antibiotic use and asthma can help clinicians make more informed decisions about treatment options for children."

More than 18 million Americans have asthma. About 4 million American children have active asthma, which results in about 14 million missed school days a year, according to the American Lung Association. Asthma cannot be cured-only controlled-which has lead researchers to focus on factors that may play a role in the development of the lung disease.

Periodontitis Increases Tongue Cancer Risk in Men

Whether he smokes or not, periodontitis could boost a man's risk for tongue cancer, reported US researchers in the May issue of *Archives of Otolaryngology-Head & Neck Surgery*.

Researchers at the State University of New York at Buffalo and the Roswell Park Cancer Institute in Buffalo compared 51 non-Hispanic white men with tongue cancer and 54 non-Hispanic white men without tongue cancer. The case-controlled study used preexisting data from patients admitted between June 15, 1999, and November 17, 2005.

Using panoramic radiographs, one examiner blind to cancer status assessed periodontitis in the men by measuring alveolar bone loss. Men with tongue cancer had significantly greater bone loss than those without tongue cancer-4.21 mm versus 2.74 mm.

"After adjusting for the effects of age, smoking status, and the number of teeth, each millimeter of bone loss was significantly associated with a 5.23-fold increase in the risk of tongue cancer," wrote the study authors. "Other oral variables (the number of dental decays, fillings, crowns and root canal treatments) were not significantly associated with the risk of tongue cancer."

This preliminary data suggests an association between periodontitis and tongue cancer, but larger studies that include women and different racial/ethnic groups need to be conducted to confirm this association, said the researchers. If this association is confirmed, it has a potential impact on understanding the etiology of oral cancer as well as on its prevention and control.

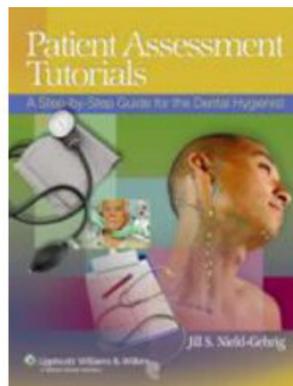
According to the Oral Cancer Foundation, roughly 7500 Americans are diagnosed with tongue cancer each year, with men accounting for nearly two-thirds of the cases.

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Review of: Patient Assessment Tutorials: A Step-by-Step Guide for the Dental Hygienist

Patricia A Frese, RDH, MEd

Reviewed by Patricia A. Frese, RDH, MEd, professor, University of Cincinnati, Raymond Walters College, Department of Dental Hygiene, Cincinnati, Ohio.



Patient Assessment Tutorials: A Step-by-Step Guide for the Dental Hygienist

Nield-Gehrig JS, RDH, MA

Lippincott Williams & Wilkins

Philadelphia, Pa, 2006

571 pages, illustrated, indexed, softcover

ISBN: 0-781-77516-7

\$55.95

Patient Assessment Tutorials: A Step-by-Step Guide for the Dental Hygienist readily accomplishes its goal of providing step-by-step instruction for patient assessment procedures in 2 settings: first, for students in preclinical and clinical settings and second, as a reference during patient treatment.

The text is divided into 3 parts containing a total of 14 modules. Part I focuses on communication techniques and Part II on assessment skills. Part III contains 6 comprehensive patient cases for practice. The User's Guide takes time to point out the many unique features available to the reader in this user-friendly text. A glossary is provided at the end of the text.

There may be an inclination to skip the communication techniques presented in Part I but it reinforces the concept that dental hygiene procedures are rendered with a special level of care. Dental hygienists practice patient-centered, empathetic communication, and in doing so, create a trusting relationship.

The modules contain several beneficial features. Each module begins with an overview and skill goals to set the stage for learning and teaching. Ready References are designed to be removed from the text and laminated/page protected for chairside use. These References support module content with module references, internet sources, drug references, diagnostic test result ranges, descriptor worksheets, eruption and occlusion charts, self-evaluation worksheets, and other helpful information as well as suggestions for additional reading. A feature entitled 'The Human Element' uses observations from patients, reflections from students, and comments from experienced clinicians to reinforce the positive impact of caregiving. In an effort to increase cultural competence, English to Spanish Phrase Lists are provided. The Quick Questions allow the learner to quickly review the content of the module. Skill Checks can be used by both the student and instructor to assess skill performance and can be used as part of a student's grade. Information on the skill performance as well as communication with the patient is included in the Skill Checks. Practice with patient cases is provided in many modules and is the focus of Part III. For each patient assessment procedure, Peak Procedures are provided. This feature provides step-by-step instructions necessary for mastering each skill. The Peak Procedures can be used independently by the students in a self-instruction format and incorporated into consistent demonstrations to instruct students and calibrate supervising faculty.

An Instructor's Resource CD-ROM is available as a valuable adjunct to the text. It contains the answers to the Quick Questions sections of the modules, additional discussion/role playing scenarios, possible student assignments, PowerPoint slides, and a testbank.

The content is up-to-date and presented in a concise, organized format. Techniques are clearly explained and supported with appropriate illustrations. In the module on head and neck examination, photographs are overlaid with anatomical diagrams to demonstrate the technique of, as well as the anatomy of, the examination. In the charting module, color coding of text and diagrams clarifies eruption dates of teeth. In the radiology module, radiographs are provided for practice identifying anatomical structures in addition to radiographic errors.

This text will assist the dental hygiene student to learn assessment skills and knowledge, provide the practicing dental hygienist with easy-to-use references at chairside, and refresh the dental hygienist returning to clinical practice.

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Review of: Fundamentals of the Extra and Intra Oral Examination: An Assessment Tool for Dental Hygienists and Other Allied Health Professionals (DVD)

Margaret Fehrenbach, RDH, MS

Reviewed by Margaret J. Fehrenbach, RDH, MS, oral biologist and educational consultant, Seattle, Wash.

Fundamentals of the Extra and Intra Oral Examination: An Assessment Tool for Dental Hygienists and Other Allied Health Professionals.

Electronic Media Communications, University of Cincinnati, Raymond Walters College

Cincinnati, Ohio, 2005-2006

\$35 for student copy; \$40 for instructor copy with instructional material; \$155 for instructor package (5 licenses). The DVD can be purchased from Electronic Media Communications by emailing rwcmmedia@uc.edu

This DVD on the basics of examination of patients has an easy-to-use layout and design. Even in the intraoral areas, lighting generally was well done and the music overlay and voice-over were not too distracting to the clearly seen visuals. The use of color was well done. References are included for completeness.

Not only does the DVD provide video with voice-over of the extraoral and intraoral examination procedures in each of its 2 main chapters, it also has a interactive chapter of still photographs with an index of common oral lesions and basic anatomy encountered during the procedure. There is also appropriate emphasis that this is a "life-saving procedure."

Importantly, voice-over of pronunciation is included for these stills with sidebar information. The font could have been larger for easier reading. The stills could have been left on the screen a little longer to allow for reading of the important sidebar information on each one. The use of close-up with some of the still photographs really added more information and could have been used more often with the still photographs, such as with the palatine tonsils.

The DVD is geared toward dental care providers in one chapter as well as health care providers in its second chapter, which is an interesting concept for this examination procedure. However, not much is different between the presentations for these two health providers. Possibly, more explanation could be provided for the latter group so that they would feel more comfortable outside their normal practice purview. The DVD includes a discussion on how this procedure could vary according to the setting.

The information presented is technically accurate but in some cases could use further exploration. The cervical lymph nodes are categorized as one entity and at some point could have used further demarcation. Most of the examination took place with the clinician behind the patient and information can be missed, such as symmetry that could be seen from the front of the patient as during the examination of the TMJ and thyroid gland. Also, palpation of the masseter muscle should not take place with the patient having their head back on the head rest. The palpation of the frontal and nasal region and sinuses seems to have been left out. There was emphasis on the vermilion border of the lips, which added depth to the

procedure. Using a *damp* gauze square when examining the tongue was one hint that they provided that will make patients feel more comfortable!

Possibly in the next edition, to further knowledge of the viewer, one additional chapter in the DVD could have correlated the anatomical still photographs with the video for an expanded view of the procedure, possibly with an overlay drawing of the anatomy on the patient. And a section on oral cancer would have made a strong impact of the importance of the procedure but it may be beyond the fundamental level of this video.

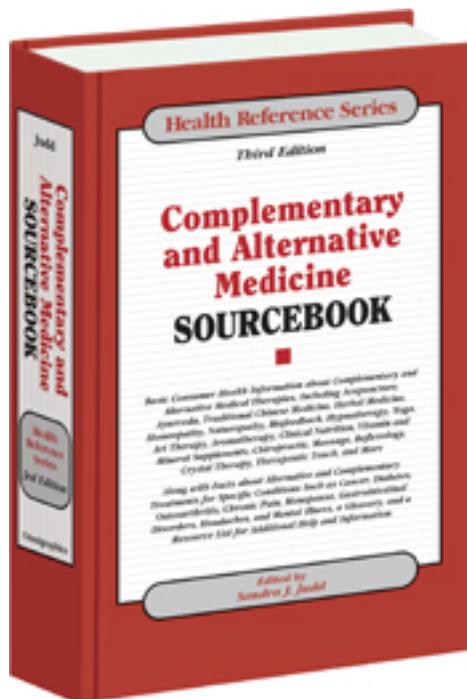
This well done DVD would be very useful in education of first-year dental hygiene students as well as other health care providers that deal with patient oral care. An Instructor's Copy with a CD is available; it has objectives, homework, checklist, and test bank. It could also be used in a study club environment or within large dental clinics for the review of the procedure.

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Review of: Complementary and Alternative Medicine Sourcebook

Jackie Carpenter, DA, RDH

Reviewed by Jackie Carpenter, DA, RDH



Complementary and Alternative Medicine Sourcebook

Third Edition

Judd S

Omnigraphics Health Reference Series

Detroit, Mich, 2006

657 pages, indexed, hardcover

ISBN: 0-780-80864-9

\$78.00

In the present state of health care in America, many people suffering from chronic or debilitating illnesses are searching for alternate therapies. Considering the cost of medications and the side effects that are becoming more evident, Americans are educating themselves about unconventional treatments for disease, which have actually been practiced for hundreds of years. The *Complementary and Alternative Medicine Sourcebook* is a quality, indexed, referenced guideline for many alternative practices that are quite popular around the world and have had unbelievable results. It is neatly organized to find facts quickly, is peer-reviewed, and stays current with the most recent advances.

As a registered dental hygienist, I am continually asking/being asked health history questions from patients. I hear their frustrations, their suffering, their longing for not a new drug, but for new hope. They are reaching out, they are reading alternative health articles and books, yet they know little about how to begin, what to expect, what has been tested safe, and who to trust. In my quest for answers, contrary to what the book has advised, I have found that traditional family medical doctors and professionals know little about these alternative therapies themselves. I do believe this trend is changing as more and more Americans are demanding it. I also believe that we still must ask our medical doctor before deciding on some alternative medicines because there could be interactions with your current medications or health issues. As health professionals, we have the responsibility to be aware of some of the more popular complementary and alternative medicines and practices so when our patients ask if their oral health or overall health could be affected or improved by these factors, we can give them an educated response or at least guide them to that information. If your medical doctor isn't familiar with complementary and alternative medicine, find someone who is qualified to advise you. One of those popular therapies is auricular acupuncture, which aids in smoking cessation, an oral health issue for many.

In reviewing the 80 chapters in this book, I was overwhelmed with information, although I know I can always reference information as needed. As our awareness develops, we will be ready to learn about new alternative medicines and this book will be the best resource. A few of the chapters that stand out are Chapter 6, Whole Medical Systems, and Chapter 7, Traditional Chinese Medicine. These chapters are interesting because we are slowly integrating these complementary and alternative medicines into our culture. Traditional Chinese Medicine dates back to 200 B.C., with variations that have grown from that. Acupuncture, herbal medicines, nutrition, and exercises like tai chi and qi gong are all becoming commonplace among chiropractic offices, vitamin stores, and even our own community centers. People suffering from arthritis and other chronic conditions are now being advised by their medical doctors to practice yoga, another popular form of complementary therapy.

We need guidance in order to better understand and utilize these complementary and alternative medicines. This sourcebook gives definitions, questions to ask, studies done, how they work, finding practitioners, costs, insurance coverage, how to read labels, benefits, drawbacks, tables for comparing, the future outlook, and even a glossary for medical terminology. What I found encouraging is that every chapter gives supporting research.

The goal of this particular edition was to be a sourcebook for Complementary and Alternative Medicine ranging from Mind-Body Medicine like prayer and spirituality, to Biologically Based Therapies, as in Aromatherapy. It also has alternative treatments for specific diseases such as cancer, diabetes, and osteoarthritis.

These are real issues that affect our daily lives. I enthusiastically recommend this sourcebook to anybody: my fellow dental hygienists, my patients, and anyone who cares for them. There are no illustrations in here, just facts, supporting research, detailed questions and answers, and hope for our renewed mind-body connection that our fast-paced lives have made it difficult to attain.

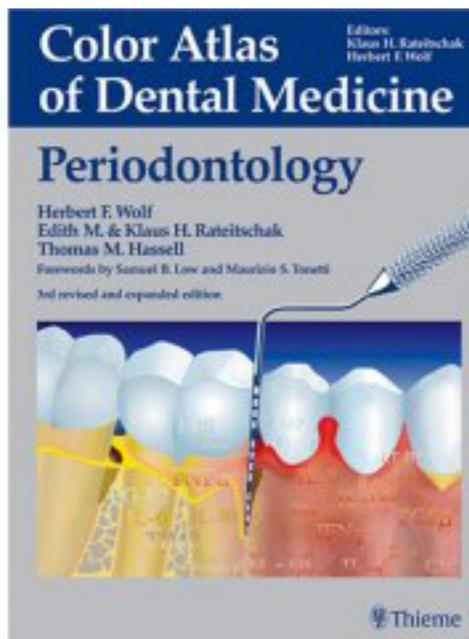
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Review of: Color Atlas of Dental Hygiene: Periodontology

Cathryn L Frere, BSDH, MSED

Reviewed by Cathryn L. Frere, BSDH, MSED, associate professor, Division of Dental Hygiene, West Virginia University School of Dentistry, Morgantown, WVa.



Color Atlas of Dental Hygiene: Periodontology

Wolf HF and Hassell TM

Thieme Medical Publishers

Stuttgart, Germany, 2006

339 pages, illustrated, indexed, softcover

ISBN: 1-588-90440-7

\$61.95

The first edition of the *Color Atlas of Dental Hygiene: Periodontology* is a welcomed addition to the library of periodontology. Wolf and Hassell have compiled this brilliantly illustrated text exclusively for the dental hygienists in clinical practice, dental hygiene students, and dental hygiene educators. This is a very concise but inclusive text meant to

prepare the dental hygienist for their responsibility in clinical periodontal practice that is rapidly expanding beyond their present role in mechanical therapy. The primary means of presenting the latest concepts of dental hygiene practice is through clear color clinical pictures and instructional diagrams.

The text begins typically with the fundamentals of structural biology, microbiology, the host's reaction in disease pathogenesis, the classification of the periodontal diseases, periodontal indices, and epidemiology. The second section describes the latest laboratory microbiologic and host susceptibility tests available to diagnose the periodontal disease entities in addition to the standard methods of clinical assessment. The next section covers mechanical periodontal therapy, anti-infectious supportive therapy, host modulation, and maintenance therapy. Surgical procedures are only briefly summarized; however implant therapy is thoroughly covered.

Topics unique to this new book include the following: the procedure for full mouth therapy, periodontal disease risk determination, the clinical management of furcation involvement, and the methods used to correct iatrogenic and natural plaque retentive areas. Complete chapters are devoted to the treatment of the periodontally involved patient with HIV, the clinical significance of gingival recession, geriatric periodontology, and systemic risk considerations in treatment planning.

The beauty of this atlas is the use of clear, color pictures to describe what words cannot. With the before and after photographs, radiographs, and chartings of the various disease types, the cases become real for the reader. The authors use descriptive, artful illustrations and charts to relay information rather than use voluminous text. Some of these illustrations and charts are complex and require careful scrutiny by the reader.

The chapters related to immunology and the host's role in disease progression are very detailed and may need clarification and simplification for the student dental hygienist. Not included with the topic chapters are key word definitions, review exercises, or case studies that are part of many undergraduate textbooks. Although the authors give permission to reproduce the photographs and illustrations in the book, it would be more convenient, especially for the educator, to have this material available online or on a compact disk. A challenge for the reader in this country is the use of the International/FDI system of tooth numbering. The text does, however, give an international perspective of periodontal instruments, products, and clinical procedures.

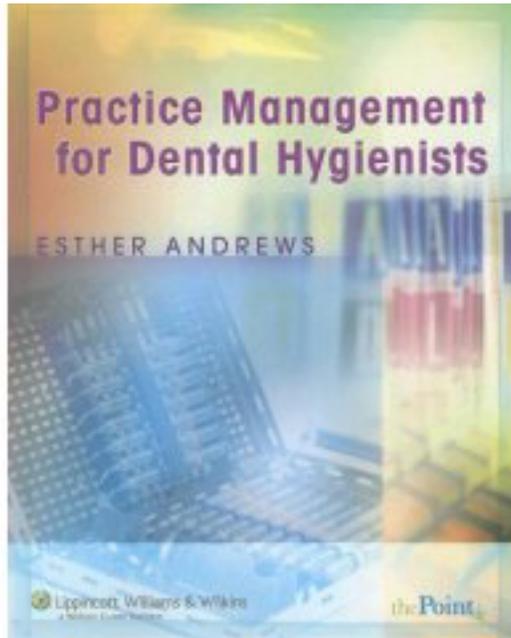
The authors do succeed in their goal of providing the basic knowledge and rationale needed for the dental hygienist of the new century to assume greater responsibility in periodontal therapy and for the total health of the patient by means of a concise, graphic, and pictorial text. The dental hygiene student will be drawn to the subject of periodontology by the inviting photographs and illustrations; however, the educator may need to supplement and clarify some of the material to this first edition if used as a course text.

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Review of: Practice Management for Dental Hygienists

Anne Gwozdek, RDH, BA

Reviewed by Anne Gwozdek, RDH, BA, adjunct faculty member, University of Michigan, Ann Arbor, Mich, and Lansing Community College, Lansing, Mich.



Practice Management for Dental Hygienists

Andrews EK

Lippincott Williams & Wilkins

Philadelphia Pa, 2007

372 pages, illustrated, indexed

ISBN: 0-781-75359-7

\$46.95

With limited texts focusing specifically on practice management for dental hygienists, Esther K. Andrews has compiled a resource that is most useful for dental hygiene education and currently licensed practitioners. *Practice Management for Dental Hygienists* covers 4 general topic areas: basics of dentistry and dental law, office management, applied

communications, and employability skills. Included in the chapters within each section are review questions, case studies, and individual and group critical thinking activities. The appendix provides "answers to review questions and selected critical thinking activities."

Each of the 4 sections contains a summary that identifies how content has addressed "Competencies for Entry into the Profession of Dental Hygiene" approved by the American Dental Education Association 2003 House of Delegates. Also included in the section summary are a wealth of references and resources, which includes organizations, online resources, pamphlets/dissertations/papers, and articles. There is no accompanying CD-ROM or web site support for this text.

Section III: Office Management includes state-of-the art practice management concepts including the use of "recare" or "continuing care" in lieu of recall. Morning huddles, scheduling for production, and minimizing broken appointments are all key elements within dental hygiene practice and are covered well. Andrews provides important management guidelines for dental hygienists, integrating these appropriately within the umbrella of the dental practice team.

Expanding content in several areas would enhance this comprehensive text. The information related to accurate and comprehensive treatment record keeping was limited. Expanding this subtopic to include examples of good treatment notes and linking this to risk management would have been useful in Section III. Within Section IV: Employability Skills, information regarding overall practice health (including dental hygiene production) as a component of a job performance evaluation was missing.

Practice Management for Dental Hygienists serves as a valuable text for integration in dental hygiene curriculum. It is also a fine resource for practicing dental hygienists who are looking to improve their value and effectiveness within a dental practice team.

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One Dental Hygienist's Role in Clinical Research

Mary Gilson Layher, RDH, BSDH, CCRP

Mary Gilson Layher, RDH, BSDH, CCRP, research laboratory specialist senior, University of Michigan, Ann Arbor, Mich.

After graduation from a dental hygiene program, dental hygienists are faced with a multitude of professional pathways to pursue beyond the private practice scenario. The dental hygiene education and licensure uniquely qualifies them for a professional career in clinical research.

Clinical research is growing quickly in medicine and dentistry today. Moving research findings from the bench top of a scientific laboratory to the private practitioner's clinical setting is what translational research is all about. The National Institutes of Health (NIH) Roadmap 2002 for biomedical research has highlighted translational research within medicine, and that includes oral health, as part of reengineering the clinical research enterprise in the United States. The National Institute of Dental and Craniofacial Research support this mission, along with their mission, which is "to improve oral, dental and craniofacial health through research, research training, and the dissemination of health information."

I began my dental hygiene career in private practice and about 10 years ago transitioned to working in clinical research settings. I was working full time as a clinical dental hygienist for the University of Michigan (U-M) Faculty Practice when I was recruited as a clinical examiner and coordinator for a clinical research project that was studying a local delivery antimicrobial for the treatment of periodontal disease. It was a large, multi-centered study utilizing 5 private practices in 10 geographically different areas (multi-centered) throughout the United States.

The clinical research study was a hands-on learning experience for me, beginning with the site initiation and investigator meeting. There were drug sponsor meetings, study monitor visits, subject advertising, recruitment and enrollment, case report form development, source documentation guidelines, and adverse event reporting, just to name a few of the responsibilities. Once enrollment of the research subjects was complete, I provided initial scaling and root planing and then followed up with periodontal assessments every 3 months for a year. The site investigator and the drug sponsor company's study monitor were very helpful in mentoring me about my role as a clinician/examiner. Networking with the other coordinators and examiners helped achieve a high quality study with 100% subject compliance.

When my career evolved as a clinical examiner for research clinical trials, the skills I had acquired as a dental hygienist came in to use. I conducted a thorough oral examination, periodontal assessments that included probing pocket depth, measuring attachment levels, grading mobility, and furcations. Studies also may include utilizing various periodontal indices for plaque, gingivitis, and bleeding. The protocols for each individual study direct the type of indices to be used. Measurements for all studies must be standardized to assure validity of the data collected. In order to achieve this standard, examiners must be calibrated for each study. I have participated in numerous calibration exercises all over the United States and with other examiners from as far away as Japan and Italy.

My role in clinical research has since expanded to administration, management, performing quality audits, and coordination of the projects. I saw opportunities for career expansion through my involvement in clinical research organizational groups such as the Society of Clinical Research Associates (SoCRA) and the Association of Clinical Research Professionals. The goal of these organizations, which include almost 30 000 members, is to provide opportunities and certifications that address the distinct educational and networking needs of those working in clinical investigations. I became a Certified

Clinical Research Professional (CCRP) through SoCRA in 2003 by studying, taking coursework, and then passing a certification examination. In order to remain certified, every 3 years she must complete 45 continuing education hours and pass a recertification examination that includes updates to the laws of the FDA and standards that guide quality clinical research. I stay abreast of clinical research education by being part of the U-M's Center for the Advancement of Clinical Research that includes clinical research physicians, nurses, and administrative personnel, and by attending the International SoCRA Annual Conference. Currently, I am co-coordinating efforts to maintain the SoCRA Chapter in the Great Lakes Region.

Wendy Kerschbaum, Director of the U-M Dental Hygiene Program, collaborates with me to provide clinical research experiences for the dental hygiene students within the Graduate Periodontics program and at the Michigan Center for Oral Health Research (MCOHR) facility where I work. The dental hygiene students can be found as work-study students participating on study teams at MCOHR or on required rotations their second and third years within the projects occurring in the U-M Graduate Periodontics Program. This rotational exposure and work experience is a benefit for our dental hygiene students to see how the dental hygienist can play an active role in clinical research. It provides them with another professional avenue they may someday want to pursue.

There are an increasing number of universities and colleges in the United States that provide courses for certifications in clinical research, as well as, bachelor's and master's degree programs in clinical research. The dental hygiene degree qualifies a person for the pursuit of these various certifications or degrees.

Below is a weblink for a list of clinical research training programs in the United States:

<http://www.aamc.org/research/clinicalresearch/training/start.htm>

Additional schools with certification, long distance; and/or degree programs are:

Campbell University

Cornell University

Eastern Michigan University

Ohio State University

University of Arizona Health Science Center

University of North Carolina

University of Texas SW Medical Center

University of Washington

Wake Forest University

There are many online resources for clinical research education, publications and training.

These may be governmental websites:

<http://hhs.gov/ohrp/>

<http://www.fda.gov>

Or professional, educational, or publication websites:

<http://socra.org>

<http://www.acrpnet.org/>

<http://www.barnettinternational.com>

<http://www.diahome.org>

<http://www.centerwatch.com>

<http://www.actmagazine.com/appliedclinicaltrials/>

Currently, I work at U-M as a Research Laboratory Specialist Senior, both in the Graduate Periodontics Clinic, directed by Hom-Lay Wang, DDS, MSD, and the Michigan Center for Oral Health Research, directed by William V. Giannobile, DDS, DMSc. Here, studies are sponsored through NIH, the University of Michigan, industry, and /or pharmaceutical companies. I have been part of clinical research studies that last from 6 months to 3 years and have included local delivery of various antimicrobials, periodontal drug development, various dental implants and implant techniques, different types of tissue grafts, multiple methods to repair bone defects, identification of biomarkers in saliva, and power toothbrushes. For more information about the work that I do, please contact me at maryl@umich.edu.

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Advanced Degree Seeking Students' Satisfaction with Online Courses at UMKC - An Early Investigation

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The use of online instruction is becoming more prevalent and transcends many disciplines. Nursing has been at the forefront of health professions utilizing distance education. Nearly half of all predoctoral dental programs report use of web-based or distance delivery. Comparatively, 22% of dental hygiene programs report use of this somewhat new approach to teaching. Distance learning provides a means for increasing access to and enrollment in dental hygiene programs. Individuals who cannot physically attend courses in dental hygiene benefit from the institutions that offer web-based classes. In today's environment, more individuals seek to advance their educational needs. Advanced dental hygiene degree programs may benefit by providing distance learning. Since 2000, the University of Missouri - Kansas City (UMKC), Division of Dental Hygiene has offered its degree completion program online. Its master's degree online program has been offered since 2001.

Purpose. The purpose of this study is to describe the pre- and post-course graduate and degree completion students' perceptions of web-based courses offered at UMKC.

Method. Over the course of 3 years, all students enrolled in required fall semester online classes were selected and agreed to participate in the study. Students were asked to fill out questionnaires prior to and at the completion of required online courses. There were no identifiers on the questionnaires. The surveys used in the study were derived from an instrument used by Wills and Stommel who examined graduate nursing students' perceptions of web-based courses.

Results. Results indicate that students enjoy this method of learning. All students reported they would enroll in another online course if given the opportunity.

Conclusion. Based on favorable student perceptions, UMKC will continue to provide this method of learning to students seeking advanced degrees in dental hygiene.

Keywords: Dental Hygiene, distance education, student perceptions

Introduction

Distance learning is a method of utilizing technology to teach adult learners.¹ Moore and Kearsley define distance education as learning that takes place in a different location from teaching.² Since many educational institutions attract busy, working adult students with families who live at a distance from the classroom, more and more educators are rethinking the traditional delivery of courses.³ Therefore, online courses are becoming a commonality for reaching students at greater distances.⁴ Since 2000, the University of Missouri - Kansas City (UMKC), Division of Dental Hygiene has offered its degree completion program online. Its master's degree online program has been offered since 2001. This study describes the pre- and post-course graduate and degree completion students' perceptions of web-based courses offered at UMKC. The students' experiences with online courses at UMKC are positive, leading dental hygiene programs to consider whether this method of course delivery is advantageous to their institutions.

Review of the Literature

Distance learning applies to teaching and educational conditions in which the instructor and learners are geographically separated and can rely solely on other means of delivery for course content.¹ Distance education or distance learning can be defined in a variety of ways.⁵ The methods of delivery for courses may include a mixture of computer or web-based technologies, stand-alone instructional programs via television or online, correspondence courses, or a set of videotapes that supplement or extend classroom learning.^{1,5} Although distance learning may be diverse in its form of delivery, all distance education is distinguished by the division of place or time between the learner and teacher, or by the student and learning resources.¹

Many disciplines have taken on distance education in their curriculums. Some, and certainly not all, of those offering courses via the Internet are Business, Education, Pharmacy, Law, English, and Computer Programming. However, nursing has been a leader in offering courses via distance education.⁶ A 1997 study by Reinert and Fryback⁷ surveyed members of the American Association of College of Nursing examining the use of distance education courses. Forty-one percent reported plans for offering distance education courses in the future. In 2001, a report by the American Association of University Women (AAUW) Educational Foundation found that women constitute the majority of distance learning students. This same report found that women enjoy distance education for its flexibility, minimizing costs, and fulfillment. Women reported being able to learn at their own pace, while making time for family commitments. They are able to save money in childcare while fulfilling personal goals.⁸

The American Dental Education Association (ADEA) has encouraged the review of distance learning in the dental school curriculum.⁹ Andrews and Demps⁹ surveyed the associate deans for academic affairs of 64 North American dental schools to assess to what extent distance education was being used in the dental curriculum. Fifty-one percent reported that web-based and distance learning methods were being utilized in predoctoral education. Twenty percent were considering implementing or planning its use, and 27% had no plans for implementation. However, 33.3% reported current usage in graduate dental education, 20.8% were planning or considering implementation, and 45.8% had no plans for implementation. Andrews and Demps concluded in their study that the use of online delivery of content and information in the dental school curriculum has potential.

Distance education is a somewhat innovative approach in dental hygiene education as well.⁶ Grimes surveyed dental hygiene directors of all associate degree and baccalaureate degree dental hygiene programs in the United States to examine their use of distance education. Twenty-two percent (N=255) of those responding to the survey were using distance education in their dental hygiene programs. Thirteen percent reported plans to utilize distance education in the future. Computer-based distance education (or online courses) was the most popular delivery method used by these programs. Six programs reported using only CD-ROM for delivering courses. The 5 most popular courses offered using distance education were Periodontology, Oral Pathology, Dental Anatomy, Nutrition, and Radiography.⁶ Four dental hygiene programs reported offering 76% to 100% of their curriculum via distance education. However, this type of education is

also being offered for those seeking to complete their baccalaureate degree or master's degree in dental hygiene education. This same study found 5 programs that offered distance education in the baccalaureate degree completion program and 2 of the respondents offered master's degrees. These respondents reported their primary reason for offering distance education was to serve special populations. Six percent reported student recruitment and 10% reported dental hygiene manpower as reasons for providing distance education.

Research has been conducted to demonstrate that distance learning can be as effective as classroom teaching.¹ Distance learners have a uniqueness that influence their success in the learning experience. Most distance learners are highly motivated, know when to call upon instructors for assistance, and have a willingness to learn and follow through.¹ There has been some research in outcome assessment with distance education in dental hygiene. Olmsted⁵ examined both onsite and distance learners to determine if those who received onsite instruction performed statistically better on established benchmark assessments (GPA, course averages, and National Board Dental Hygiene Examination) than learners at a distance. She analyzed 5 classes with a total of 221 learners. Results indicated there was no significant difference between the onsite and distance learner performances. Both sets of learners performed uniformly well. Bearden, Robinson, and Deis examined the differences in academic performances (calculated by grades and performance of national exams) of 54 dental hygiene students enrolled in an online and an on-campus nutrition course. They concluded there was no difference in course average and performance on the National Board Dental Hygiene Examination (NDBHE) tests between online and on-campus students.¹⁰ Grimes looked at the success of 13 students in an online and a traditional in-class dental terminology course by comparing final examination results. Students in the online course scored higher on the final examination than students in the traditional in-class setting. Additionally, data confirmed that online students had an equal amount of course instruction of that experience by the traditional in-class students based on the number of times the online students visited the material's website.¹¹

There have been few studies in dental hygiene looking at student perceptions and satisfaction with distance education. In the Grimes study previously mentioned, the perceptions of students in an online dental terminology course were examined. Overall positive perceptions of online learning were found. However, 69% of students reported missing the interaction of a regular classroom setting and had a feeling of being "detached" from faculty and other students.¹²

Distance learning has many potential benefits in a dental hygiene curriculum. Distance learning could be a means for increasing enrollment in dental hygiene programs. Individuals who cannot physically attend courses in dental hygiene benefit from the institutions that do offer web-based classes. Distance technology allows for innovative approaches to teaching where faculty can utilize a hybrid approach to teaching with content available online combined with in class exercises. In today's technology savvy society and more individuals seeking to advance their educational needs, providing distance learning may be beneficial as well for dental hygiene programs.¹¹ Since 2000, the University of Missouri - Kansas City (UMKC), Division of Dental Hygiene has offered its degree completion program online. Its master's degree online program has been offered since 2001. The purpose of this study is to describe the pre- and post-course graduate and degree completion students' perceptions of web-based courses offered at UMKC.

Materials and Methods

Subjects

All students enrolled in required fall online courses were invited to participate in the study. Due to the small number of students enrolled in online courses, it was determined that data would be collected over a 3-year period to increase the number of participants for this study. A total of 27 students participated in the study.

Instrumentation/Measurement

In 2000, Billings published an outcomes evaluation framework for web-based courses in nursing.¹³ From this framework, Wills and Stommel developed an instrument that examined graduate nursing students' perceptions of web-based courses.¹⁴

The instrument from Wills and Stommel was used for this study. The instrument for this study was utilized because it was the best fit for the purpose of the investigation. Both the original research and this study had small numbers of participants. Wills and Stommel analyzed the internal consistency reliability of statistically derived scales. Alpha coefficients met the standard of adequate internal consistency, therefore, providing a good basis for continued use of the instrument.¹⁴ Although the number of participants for this study was not big enough to warrant ideal alpha coefficients for reliability testing (n=27), the instrument was used since it was previously tested and published in a similar study within allied medicine. The questionnaires consisted of rank-scaled items and 2 open-ended questions where respondents were asked to write in explanations or comments (Appendix). This study was reviewed and approved by the Institutional Review Board at the University of Missouri - Kansas City (UMKC) to ensure the safety and rights of human study participants. Participants in survey research give consent to participate when they fill out and return the survey. Therefore, no consent form was required.

Data Collection Procedures

Students were asked to fill out questionnaires prior to and at the completion of required online courses. There were no identifiers on the questionnaires. Anonymity was ensured to the study participants. Participants were asked to not place their name or identify themselves anywhere on the questionnaire. The primary investigator distributed the questionnaires to designated study personnel who in turn, distributed the questionnaires to the study participants. The designated study personnel did not change over the course of the 3 year study. Students were asked to complete the pretest at the conclusion of their orientation session where details on how to utilize Blackboard (a web course platform) and Centra (an electronic conference program) were given. At the conclusion of the courses when all material had been covered, students were asked to complete the posttest. Students returned the completed surveys to designated study personnel. The primary investigator kept the questionnaires in a locked area over the course of data collection.

Statistical Analysis

Data was entered into the SPSS statistical program for analysis. Statistics generated included frequency distributions and measures of central tendency. All narrative data were recorded by a stenographer. The following outcomes were sought: student perceptions of learning, connectedness, preparation for real-world work, and satisfaction.

Results

Over the course of 3 years, 27 students were enrolled in master's or baccalaureate degree completion online courses at the University of Missouri-Kansas City (UMKC). All 27 students filled out the precourse questionnaire as well as the postcourse questionnaire. Therefore, 100% participation was obtained. This can be attributed to the surveys being distributed in person to each student. One condition for each student in both programs is that he/she personally visits the UMKC campus one time per semester in fulfillment of course requirements. Table 1 shows pre and post student responses to Likert scale questions on the questionnaires.

Table I Pre- and Post-course Student Perceptions

Survey Questions	PRE (Mean responses) n=27	POST (Mean Responses) n=27
1. I believe that active learning will take place in the web-based course comparable to the active learning that takes place in a traditional classroom setting.	(3.62) Undecided <i>Likert scale: 1=strongly disagree; 5=strongly agree</i>	(4.59) Agree <i>Likert scale: 1=strongly disagree; 5=strongly agree</i>
2. I expect to learn the same amount of course content in the web-based class that I would if the course were offered in the traditional classroom setting.	(4.03) Agree <i>Likert scale: 1=strongly disagree; 5=strongly agree</i>	(4.44) Agree <i>Likert scale: 1=strongly disagree; 5=strongly agree</i>
3. I expect faculty instruction in the web-based course to be _____ it would be in a traditional classroom setting.	(2.03) The same as <i>Likert scale: 1=worse than; 3=better than</i>	(2.76) The same as <i>Likert scale: 1=worse than; 3=better than</i>
4. I anticipate there being _____ technical difficulties accessing course materials in the web-based class.	(2.11) Some <i>Likert scale: 1=many; 4=no</i>	(2.81) Some <i>Likert scale: 1=many; 4=no</i>
5. I believe there will be _____ issues logging on to the Web for course materials.	(2.29) Some <i>Likert scale: 1=many; 4=no</i>	(3.11) Few <i>Likert scale: 1=many; 4=no</i>
6. I am excited about learning in an online format.	(3.48) To some degree, yes <i>Likert scale: 1=definitely not; 4=definitely yes</i>	(4.74) Positively <i>Likert scale: 1=more negatively; 5=more positively</i>
7. After today's orientation and description of the course, what is your understanding of the course content?	(2.18) Some level <i>Likert scale: 1=none to minimal; 3=very good level</i>	(3.0) Very good level <i>Likert scale: 1=none to minimal; 3=very good level</i>
8. I think the web-based course will be _____ challenging compared to a traditional classroom setting.	(2.37) Somewhat <i>Likert scale: 1=not very; 3=very</i>	(2.55) Somewhat <i>Likert scale: 1=not very; 3=very</i>
9. I expect the amount of interaction between students and faculty to be _____ it would be in a traditional classroom setting.	(1.85) Less than <i>Likert scale: 1=less than; 3=more than</i>	(2.70) As much as <i>Likert scale: 1=less than; 3=more than</i>
10. I believe the course will prepare me for real life experiences.	(4.14) Agree <i>Likert scale: 1=strongly disagree; 5=strongly agree</i>	(4.74) Agree <i>Likert scale: 1=strongly disagree; 5=strongly agree</i>
11. I think I will find this web-based course to be _____ enjoyable.	(2.51) Somewhat <i>Likert scale: 1=not very; 3= very</i>	(2.96) Somewhat <i>Likert scale: 1=not very; 3=very</i>
12. I _____ that academically I will perform well in the web-based course.	(3.96) Undecided <i>Likert scale: 1=strongly disagree; 5=strongly agree</i>	(4.69) Agree <i>Likert scale: 1=strongly disagree; 5=strongly agree</i>
13. I expect to achieve a grade in the web based course similar to grades I have received in the past in traditional classroom settings.	(4.0) Agree <i>Likert scale: 1=strongly disagree; 5=strongly agree</i>	(4.46) Agree <i>Likert scale: 1=strongly disagree; 5=strongly agree</i>
14. I prefer traditional classroom settings over web-based courses.	(3.22) Undecided <i>Likert scale: 1=strongly disagree; 5=strongly agree</i>	(2.11) Disagree <i>Likert scale: 1=strongly disagree; 5=strongly agree</i>
15. I consider myself to be a self-directed learner.	(4.14) Agree <i>Likert scale: 1=strongly disagree; 5=strongly agree</i>	(4.25) Agree <i>Likert scale: 1=strongly disagree; 5=strongly agree</i>
16. It is important for me to feel like I "belong" in a course.	(3.96) Undecided <i>Likert scale: 1=strongly disagree; 5=strongly agree</i>	(4.62) Agree <i>Likert scale: 1=strongly disagree; 5=strongly agree</i>
17. I feel prepared to begin the web-based course.	(3.66) Undecided <i>Likert scale: 1=strongly disagree; 5=strongly agree</i>	(4.51) Agree <i>Likert scale: 1=strongly disagree; 5=strongly agree</i>

In regards to the outcome of learning, at the posttest, students perceived that active learning had taken place in the online courses comparable to a traditional classroom setting and that the same amount of course content was learned in the online courses that would have been in a classroom situation. Feelings towards faculty instruction did not change from pretest and posttest. There were some to almost few technical difficulties in accessing course materials at posttest. Students anticipated issues logging on to the web for course content, but at posttest, there were few problems with this. At the conclusion of the courses, students' attitudes towards learning in an online environment had changed direction in a more

positive way. Students had a very good level of understanding of course content at the end of the classes and found the courses to be somewhat challenging compared to a traditional classroom setting.

Regarding connectedness, preparation for real-world work, and overall satisfaction, students did not expect to have much interaction with their peers, but found at the courses' end to be similar to a regular classroom setting. They found the classes to be enjoyable and felt they served in preparation for real life experiences. Academically, they were happy with their grades. Students were undecided in their preference of online versus traditional classroom settings at the pretest, but preferred the online setting at the completion of the courses. Participants felt they "belonged" in the courses and the feelings of not being prepared for the courses at the pretest changed in a positive way at course end. One question asked the student to rate their computer skills on a scale of 1-10 with 10 being the highest (Table II). At the pretest, the mean was 6 and at posttest 8. Seventy percent of students had not taken online courses prior to enrolling at UMKC. At posttest, 100% of participants responded that given the opportunity, they would take another online course.

Table II
Non Likert Scale Items

Question	Precourse	Postcourse
On a scale of 1-10, with 10 being the highest, how do you rate your computer skills?	6	8
Have you taken other web-based courses in the past? (PRECOURSE ONLY)	70% No 30% Yes	NA
Given the opportunity, would you enroll in another web-based course again? (POSTCOURSE ONLY)	NA	100% Yes

Discussion

Most students report that the convenience of an online program in dental hygiene is advantageous because of the flexibility of the class while fulfilling goals and aspirations in obtaining an advanced degree. The overall perceptions of students in this study were satisfied with the delivery of online courses at UMKC. These findings parallel the students' responses to the original study where nursing students were satisfied with online courses. In order to obtain a meaningful number of participants, data was collected over a 3-year period.

A growing concern in distance education has been that online courses are taught by adjunct faculty.¹⁵ All online courses at UMKC are taught by full-time tenured faculty. The graduate and degree completion programs at UMKC Division of Dental Hygiene have prepared dental hygiene educators for more than 30 years. Preparing the student for advanced degrees in dental hygiene takes place utilizing a variety of asynchronous and synchronous learning including: mixed media, print based, CD-ROM, web-based courses via Blackboard, and internet-based formats such as electronic conferencing, chat rooms, bulletin boards, and email. Prior to being accepted into either program (graduate or degree completion), the student is made aware that one campus visit is required per semester. This is different from other programs where students never meet peers or faculty in person. Students are also required to attend a one-time orientation session in the fall to initially meet other classmates and faculty. This orientation provides the student with a hands-on approach to the web as well as detailed instructions for logging on to the course site.

In a study by Seiler and Billings in 2004, nursing students suggested the use of web cams for their online coursework.¹⁶ The online courses offered through the graduate and degree completion programs at UMKC do just that. UMKC Division of Dental Hygiene courses utilize Centra - a platform that gives the students the opportunity to "see" their faculty and peers during synchronous learning times. At the beginning of the semester, a meeting time is established with all students enrolled in the course as to the time of day the class will "meet" online. All faculty at UMKC that teach graduate courses online also have responsibilities of teaching at the undergraduate level. Therefore, these meeting times are usually at night where the course director may teach from their home after traditional school hours are over. Students who have sought advanced degrees through UMKC include students from California, Iowa, Wisconsin, and Florida, to name a few. This

means that the class may meet at 5 PM California time and 8 PM Florida time. Although there is flexibility in taking an online course, the student is aware that synchronous learning and meeting is a course requirement. This set meeting time is similar to gathering in a traditional classroom setting for a weekly class. It also provides the students "face time" with peers as well as faculty. If a student has a question for faculty, they may choose to ask during the weekly Centra meeting time. More than likely, this plays a role in the students' positive perceptions at post-course in relation to faculty instruction and overall excitement about learning in an online format. Students are able to build relationships with their peers similar to a traditional classroom setting.

Students responded at post-course that the courses were somewhat challenging. This finding is similar to a study by Britt (2006) where the majority of students reported that online courses were more difficult than traditional instruction.¹⁷ Some programs with online courses (not limited to dental hygiene) never require the students to meet or make a campus visit. Students in the UMKC setting are expected to go to class online prepared for the synchronous learning times. Faculty directing the course has the ability to "flash" the camera on an individual student and ask them to share their thoughts on that night's discussion. This, along with the course assignments, could be the determining cause for the online course to be challenging. In a program that does not have synchronous learning requirements, the student may feel less challenged in being prepared for course content.

Respondents had an opportunity to write in comments about the courses. There were no negative comments reported. One student commented "this style of education fills a void most educators or students are unaware exists. Overall, I think distance education is brilliant. It has provided me with an opportunity that otherwise would be unavailable." Another student felt "it was the best instruction I have had in a long time."

The results of this study should be interpreted in light of several limitations. First, the study had a very small number of participants. The 100% participation achieved with the survey responses can be attributed to the questionnaires being distributed in person to each student. This was done when the students visited the campus for their required "on-site" visit within the semester. The designated study personnel who distributed the questionnaires to the study participants was involved in overall course grading, but is not the sole director for online courses at UMKC. More sophisticated data analysis including factor analysis was unable to be performed on the questionnaires. Future research needs to be conducted that looks at outcomes over several years time. These results, although early, are valuable and call for further research. The perceptions of those faculty teaching the advanced education online courses would also be of value.

Conclusion

This is the first study to examine advanced degree seeking students' satisfaction with online courses at UMKC Division of Dental Hygiene. Perceptions wanted to be investigated to have an overall sense of what students' thoughts were to this method of delivery of courses. Students' overall perceptions to online courses were positive. The UMKC Division of Dental Hygiene will continue to provide students seeking advanced degrees the opportunity of learning at a distance. Since this is one of the first studies to report students' perceptions to this method of learning at the UMKC Division of Dental Hygiene, future studies are anticipated to explore outcomes of distance learning.

Acknowledgements

Notes

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Validation of the National Board Dental Hygiene Examination

GA Kramer, PhD and LM Neumann, DDS, MPH

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The National Board Dental Hygiene Examination program is a part of the process for licensing dental hygienists. The examination assesses theoretical and applied knowledge in the basic biomedical, dental, and dental hygiene sciences, as well as community health. Standards for licensure examinations recommend that test publishers demonstrate a relationship between examination content and actual practice.

Method. To this end, a validity study was conducted, which involved the definition of the domain of entry-level dental hygiene practice using 56 competencies; the conduct of a practice analysis survey designed to rate the importance of these competencies; and the linking of competencies to content elements in accordance with the competencies' importance ratings. Of the 3941 surveys distributed, 1841 participants responded and, of these, 1284 were full-time practitioners. The importance ratings for the competencies were translated into numbers of items. The number of items devoted to each competency was distributed across all applicable elements of the existing content specifications based upon the knowledge needed to support the realization of the competency.

Results and Discussion. The findings confirmed the adequacy of the content specifications in effect prior to 2005. However, based on this validity study, 2 sub areas of relatively little significance were eliminated, and 2 new areas were introduced. Specifically, Clinical Testing under Assessing Patient Characteristics (one item) and Professional Methods of Administering Fluorides under Using Preventive Agents (one item) were eliminated, and Dental Hygiene Treatment Strategies was incorporated with 4 items, and Professional Responsibilities was added with a total of 28 items.

Keywords: dental hygiene licensure, National Board Dental Hygiene Examination, practice analysis, professional licensure, Rasch rating scale analysis, validity

Introduction

The Joint Commission on National Dental Examinations is the agency of the American Dental Association that is responsible for the conduct of the National Board Dental Hygiene Examination program. The purpose of this program is to provide state boards with information on the qualifications of individuals who seek licensure to practice dental hygiene¹. In light of this purpose, the content of the Dental Hygiene Examination has been formulated to evaluate the licensure candidates' theoretical and applied knowledge in the basic biomedical, behavioral, dental, and dental hygiene sciences, as well as in community health and research principles, and to evaluate their ability to apply the knowledge in a problem solving context.¹

Validation of their examinations is an important responsibility of testing agencies; it is an ongoing process of gathering evidence from a variety of sources to support the interpretation and use of examination scores for a clearly stated purpose. For examinations involved in the credentialing process, the primary source of validity evidence is related to the appropriateness, ie, representativeness and relevance, of the content of the examination. For the Dental Hygiene Examination, the content is appropriate if it assesses the theoretical and applied knowledge required for the successful entry-level practice of dental hygiene. The overall licensure process is multi-layered. Measures of clinical competency, ie, clinical demonstrations, are beyond the scope of the National Board Dental Hygiene Examination program.

The content of the Dental Hygiene Examination has evolved over time to reflect the ever-changing theoretical knowledge base and nature of practice. Prior to 2005, recommendations regarding the content have come from essentially 2 sources. First, the educators and practitioners who served on the test construction committees recommended modifications to the content specifications based upon their knowledge of developments in the subject matter included on the examination and developments in accepted dental hygiene practice. Second, those professionals attending various regional and national forums focused on dental and dental hygiene issues recommended modifications. Regardless of the source, the Joint Commission is ultimately responsible for evaluating the appropriateness of these recommendations through its standing Committee on Dental Hygiene. While the Joint Commission has successfully used this approach to determining and validating the content of the Dental Hygiene Examination, the *Standards for Educational and Psychological Testing* recommends that to demonstrate validity evidence a strong linkage between examination content and practice be established for credentialing examinations.² The *Standards* indicate that one mechanism for demonstrating this linkage is to base the content of the examination on the findings of a practice analysis. In response to this recommendation, the Joint Commission conducted a validity study, which involved a practice analysis as it relates to entry-level practice, and applied the findings of this practice analysis to confirming the Dental Hygiene Examination content specifications. The purpose of this article is to describe the overall validation process, including the comprehensive definition of the domain of dental hygiene practice, the dental hygiene practice analysis, the procedure used to link the findings of the practice analysis to the content specifications, and the modifications to the content that were indicated by the findings.

Method

National Board Dental Hygiene Examination

The Dental Hygiene Examination is a comprehensive examination that consists of 350, 4 or 5 alternative multiple-choice items contained in 2 components.¹ Component A includes 200 case-independent items, and Component B includes 150 case-dependent items. The case-independent component of the examination also includes 20 items distributed across approximately 4 testlets. For the purposes of the Dental Hygiene Examination, testlets typically consist of brief scenarios describing community health activities. These scenarios consist of a paragraph of less than 100 words, and they contain information that is necessary in order for the candidate to endorse the correct responses to the items associated with the scenarios. The case-dependent component consists of from 12 to 15 dental hygiene patient cases with from 12 to 15 multiple choice items associated with each case. The case material includes patient histories, dental charts, radiographs, and clinical photographs, when appropriate. For each edition, Component B includes at least one case that addresses geriatric, adult-periodontal, pediatric, special needs, and medically compromised patients. The case-independent component addresses the scientific basis for dental hygiene, provision of dental hygiene services, and community health activities, while the case-dependent component addresses only the provision of dental hygiene services.

Phases in the Validation Process

As shown in Table 1, there are a number of phases involved in the overall process of validating the Dental Hygiene Examination. The first step is to define the domain of entry-level dental hygiene practice. For the purposes of this validity study, defining the domain is accomplished through the delineation of competencies. The second phase involves gathering information related to the importance of each of the competencies through the use of a survey of recently licensed dental hygienists. The third phase involves forging a link between the competencies and the content specifications. The link between the competencies and the content is based on the judgments of a panel of experts using a 2-dimension model.

The final phases of the process involve the review and approval of the revised content specifications by the Joint Commission through its standing Committee on Dental Hygiene and the application of the revised content specifications to designing and developing the examination.

Table 1. Phases involved in the National Board Dental Hygiene Examination validity study

Phase	Activity	Responsible Agency
1	Define the domain of entry-level dental hygiene practice based on a synthesis of the competencies included in the <i>Competencies for Entry Into the Profession of Dental Hygiene</i> promulgated by the American Dental Education Association and Competencies described in the <i>Accreditation Standards for Dental Hygiene Programs</i> of the Commission on Dental Accreditation.	Committee on Dental Hygiene and Joint Commission on National Dental Examinations
2	Conduct practice analysis survey of 3,941 dental hygienists to elicit ratings of importance of competencies to patient care within the practice of dental hygiene.	ADA Survey Center
3	Two-dimensional model used to distribute the 350 test items across competencies to the content elements that support the competencies.	Expert Panel – comprised of an educator, four full-time practicing dental hygienists representing the various regions of the country, and the joint commissioner representing the American Dental Hygienists' Association
4	Review and approval of the content specifications.	Committee on Dental Hygiene and Joint Commission on National Dental Examinations [March 2004]
5	Revised examination specifications implemented.	[January 2005]

Domain of Entry-level Dental Hygiene Practice

To conduct a comprehensive validity study that supports the use of Dental Hygiene Examination scores in the licensure process, it is necessary to define the domain of entry-level practice. To lay the ground work for the validity study, 2 committees were convened. One of these was the Committee on Dental Hygiene, which is a standing committee of the Joint Commission, and the other was an ad hoc test construction committee. The Committee on Dental Hygiene was composed of 3 dental practitioners and one dental educator, as well as 3 dental hygienists. The dental practitioners were members of the Joint Commission, and the 3 dental hygienists were appointed to the Joint Commission by the American Dental Hygienists' Association. The members of the Committee on Dental Hygiene were selected to participate in the validity study based on their expertise in the clinical practice of dentistry and dental hygiene. The *ad hoc* test construction committee included 3 dental and 3 dental hygiene educators, as well as one basic scientist. Both committees met together to share information regarding the overall purpose and goals of the examination program relative to dental hygiene practice. The committees defined the broad purpose of entry-level dental hygiene care to be: *Health Promotion and Disease Prevention*.

The Committee on Dental Hygiene then met separately and synthesized 56 competencies important for the recently licensed dental hygienist based upon the Accreditation Standards published by the Commission on Dental Accreditation of the American Dental Association and the *Competencies for Entry into the Profession of Dental Hygiene* promulgated by the American Dental Education Association.^{3,4} The domain of dental hygiene practice was defined in terms of entry-level competencies because the examination content is designed to address the theoretical knowledge that supports successful entry-level clinical practice. These 56 competencies were grouped into 3 categories, which included professionalism, patient/client care, and community health involvement. The competencies are listed in Table 2a, ,2b, 2c

Table 2. The domain of initial dental hygiene practice as defined by 56 competencies in the area of health promotion/disease prevention

Health Promotion and Disease Prevention

	Professionalism	N	\bar{X}	σ
1.	Apply a professional code of ethics to dental hygiene practice.	1238	4.77	0.49
2.	Adhere to state and federal laws.	1237	4.85	0.42
3.	Assume responsibility for dental hygiene care.	1229	4.73	0.52
4.	Provide dental hygiene services based on accepted standards of care.	1238	4.74	0.48
5.	Evaluate scientific literature and other sources of information to make decisions about dental hygiene treatment.	1234	4.09	0.76
6.	Perform self-assessment for life-long learning and professional growth.	1233	4.15	0.86
7.	Participate in professional organizations.	1213	3.14	1.16
8.	Participate in community service activities.	1163	2.80	1.11
9.	Provide quality assurance mechanisms for health services.	1198	4.13	0.85
10.	Provide care to all clients using an individualized approach that is empathetic and caring.	1237	4.71	0.55
11.	Identify career options and practice settings.	1144	3.30	1.23
	Patient/Client Care			
12.	Provide dental hygiene care to promote patient/client health and wellness.	1234	4.81	0.45
13.	Provide evidence-based practice using critical thinking and decision-making skills.	1233	4.58	0.63
14.	Maintain accurate, consistent and complete records.	1235	4.80	0.48
	<i>Collect and analyze data to identify patient needs and oral health problems.</i>			
15.	Obtain medical histories.	1236	4.93	0.29
16.	Obtain dental, psychosocial, and behavioral histories.	1234	4.41	0.70
17.	Perform head and neck examination.	1226	4.44	0.74
18.	Perform intra-oral examination.	1239	4.80	0.47
19.	Measure and record vital signs.	1193	3.80	0.93
20.	Perform periodontal examination.	1235	4.83	0.45
21.	Obtain and interpret radiographs.	1237	4.83	0.44
22.	Perform dental indices.	1179	3.91	0.96
23.	Perform a risk assessment for oral diseases and oral habits.	1219	4.24	0.83

<i>Establish goals and treatment strategies to facilitate optimal oral health.</i>			
24. Determine a dental hygiene diagnosis.	1225	4.64	0.61
25. Develop a dental hygiene treatment plan.	1229	4.66	0.59
26. Obtain informed consent.	1223	4.67	0.67
27. Communicate a dental hygiene case presentation.	1182	4.15	0.98
<i>Provide treatment to achieve and maintain oral health.</i>			
28. Adhere to established infection control protocol.	1241	4.94	0.28
29. Implement and monitor environmental safety programs.	1186	4.34	0.87
30. Perform periodontal debridement and scaling procedures.	1237	4.86	0.40
31. Incorporate pain management techniques.	1226	4.52	0.66
32. Apply chemotherapeutic agents.	1164	4.17	0.79
33. Administer fluoride therapy.	1229	4.35	0.73
34. Apply pit and fissure sealants.	1201	4.34	0.73
35. Perform coronal polishing.	1211	3.83	1.05
36. Provide care of oral prostheses.	1223	4.23	0.79
37. Provide care and maintenance of restorations.	1187	4.23	0.84
38. Provide nutritional counseling.	1197	3.78	0.84
<i>Evaluate the extent to which treatment goals have been achieved.</i>			
39. Use and compare indices.	1148	3.75	0.94
40. Re-evaluate oral and periodontal health status.	1236	4.73	0.53
41. Evaluate treatment needs.	1233	4.69	0.52
42. Establish a recall schedule and determine necessary referrals.	1233	4.75	0.48
43. Evaluate patient satisfaction with treatment outcomes.	1235	4.43	0.68
44. Refer patients/clients who may have a systemic, psychological, and/or social problem for comprehensive patient/client evaluation.	1174	4.30	0.82
45. Perform basic cardiac life support.	1160	4.79	0.58
Community Health Involvement			
46. Promote oral and general health and wellness to the public.	1169	4.14	0.83
47. Communicate effectively both verbally and in writing.	1197	4.51	0.68
48. Assess the oral health needs of the community.	1075	3.71	0.91
49. Identify the availability and quality of community resources and services.	1077	3.72	0.84
50. Develop community-based disease prevention and health maintenance strategies.	1024	3.68	0.93
51. Provide screening, referral, and educational services.	1080	4.01	0.89
52. Provide community oral health services in a variety of settings.	1013	3.78	0.92
53. Evaluate opportunities for improving access to care in a variety of settings.	1013	3.81	0.91
54. Evaluate reimbursement mechanisms and their impact on the patient's/client's access to oral health care.	1024	3.65	0.92
55. Evaluate the outcomes of community-based programs and plan for future activities.	982	3.56	0.94
56. Utilize professional and social networks and resources to increase access to care.	1047	3.82	0.92

1. Examination consists of 350 items: 200 case independent and 150 case dependent items.
2. Demographic notes on the respondents (1,841) to the sample of 3,941.
 Practice: Full Time=1,284 (69.7%), Part Time=491 (26.7%), Not Practicing=61 (3.3%), N=5 (0.3%)
 Award: Certificate=55 (3.0%), Associate Deg=1,456 (79.1%), Bachelor Deg=321 (17.4%), N=9 (0.5%)

The test construction committee convened separately to develop recommendations related to the structure and length of the Dental Hygiene Examination and to develop relevant demographic questions for the practice analysis survey that might prove useful in the interpretation of participants' data. This committee, and subsequently the Joint Commission, deemed the current structure and length of the examination to be appropriate, and, therefore, the overall validation process was based on the examination as it is currently configured.

Practice Analysis Survey

To determine the importance of each competency to the practice of dental hygiene, a survey instrument was developed and distributed to a sample of dental hygienists. The survey included several questions gathering general and personal information along with information on the practice environment. This information was used to guarantee the integrity of the sample parameters, ie, the information was used to ensure the degree to which the sample represents the population. The remainder of the survey listed the competencies. The participants were to rate each competency for its importance to patient care using a 5-level rating scale. The following descriptors define the five levels of the rating scale.

This competency is:

5: critical to patient care. Without this competency, the resulting patient care would be clearly unacceptable.

4: important to patient care. Without this competency, the resulting patient care would be compromised.

3: moderately important to patient care. Without this competency, the resulting patient care would be clinically acceptable but less than ideal.

2: unimportant to patient care. Without this competency, the resulting patient care would only be slightly affected.

1: very unimportant to patient care. Without this competency, the resulting patient care would not be affected.

In some instances, a particular competency might be unrelated to the participants' practice of dental hygiene. For these competencies, the participants were directed to circle N/A, for Not Applicable.

Sample

With regard to sampling procedure, a stratified random sample was drawn so that the number of survey participants from each licensing jurisdiction was proportional to the number of candidates residing in that jurisdiction at the time of application for the examination. The population consisted of those candidates who were enrolled in accredited dental hygiene programs and who passed the Dental Hygiene Examination during the years from 1997 through 2001. The addresses of candidates were drawn from the Joint Commission's electronic application files. The baseline percentage of candidates included in the survey per year was set at 10%, which was deemed appropriate to obtain a reasonable number of returned surveys and stable findings. Because some of the addresses included in the file were likely to be outdated, the size of the sample for each year was expanded, especially for the out years. The numbers of candidates included in the survey sample are given in Table 3. The American Dental Association's Survey Center arranged for the production and distribution of the instrument. There were 5 mailings. A pre-letter was distributed describing the importance of the practice analysis and soliciting participation. The second mailing consisted of the survey, and the subsequent three mailings consisted of reminder notices. Data collection ended on February 21, 2003.

Table 3. Sample for the National Board Dental Hygiene Examination practice analysis

Year	Total Candidates	Percentage Sampled	Sample
2001	5,303	14%	742
2000	4,966	15%	749
1999	4,881	16%	781
1998	4,783	17%	813
1997	4,742	18%	854
Total	24,675	16%	3,939

Rasch Rating Scale Analysis

The ratings provided by the full-time practicing dental hygienists were averaged for each competency. In addition to means, standard deviations were computed. While these means are estimates of the importance of each competency, they are not on an interval scale of measurement, which is important in determining the number of items to devote to each competency. Because of this, the ratings provided by the practicing dental hygienists were submitted to a Rasch model rating scale analysis using the computer program WINSTEPS.⁵ The analysis converted the ratings to Rasch calibrations of importance. These calibrations are on an interval level scale of measurement with a mean of 0.00 and a typical range of from -3.00 to +3.00 logits, ie, log odds units. Using the rating scale analysis, each competency is placed on a measurement scale that is characterized by consistently and uniformly increasing importance to patient care. The relative differences among the importance levels of the competencies are mirrored in the calibrations. Specifically, if the actual difference in importance between 2 competencies is the same as the actual difference between 2 other competencies, the differences in the calibrations between the first and second sets will be the same. The Rasch rating scale model can be expressed as:

where n is the agreeability of the rater, δ_i is the endorsability of the competency, and τ_k is the difficulty of the k th threshold.⁶ For the purpose of this study, agreeability might best be interpreted as the tendency of the participating dental hygienists to provide higher or lower ratings for the competencies, and endorsability might best be interpreted as the relative importance of the dental hygiene competencies. The difficulty of the threshold provides information on the viability of each of the 5 levels of the rating scale.⁴

As observed above, the calibrations resulting from the rating scale analysis are on an interval scale of measurement. This characteristic of the calibrations is crucial to this study because it allows for the transformation of calibrations to percentages of examination items using the linear transformation $y = ax + b$, where a and b are constants, x is the importance calibration associated with each competency, and y is the percentage of items devoted to each competency.^{7,8} Using simultaneous equations, it is possible to determine the 2 constants. In order to solve the equations, it is necessary to set, *a priori*, the maximum and minimum percentages of items devoted to each competency. For the purposes of this practice analysis, the maximum and minimum were set at 5.0% and 0.0%, respectively. The selection of these particular maximum and minimum percentages was based on the 2-fold principle that the greatest number of competencies should be represented in the examination specifications and that the important competencies should be adequately supported by relevant content.⁷

As observed by Lunz, Stahl, and James, the total of the transformed percentages typically will not be 100%.⁷ Because of this, it is necessary to adjust the percentages using a correction factor of the form: $R = 1 / \sum y$ where R is the correction factor and y is the percentage of items devoted to each competency.⁷ Finally, it was necessary to determine the number of items to devote to each competency. This was accomplished by multiplying the percentage associated with each competency by 350, which is the approved number of items on the Dental Hygiene Examination.

Two-dimensional Model Linking Competencies and Content

A 2-dimensional model was used as the framework for demonstrating the linkage between the examination content and clinical practice.^{7,9} This model is depicted in Figure 1. The horizontal dimension of the model consisted of competencies underlying the initial practice of dental hygiene, and the vertical dimension consisted of the current list of content elements assessed by the examination. There are 2 aspects of this model that are important to successfully validating the examination. First, the importance of each competency to patient care determines the number of items devoted to that competency. Second, the number of items devoted to each competency is distributed across the existing content elements in accordance with the extent to which the theoretical and applied knowledge associated with the content support the competency.

Content	Competency					
	1	2	3	4	...	56
	†	†	†	†		†
Scientific Basis for Dental Hygiene Practice (60)	‡					
1.0. Anatomic Sciences (17)						
1.1. Anatomy (12)						
1.2. Histology & Embryology (5)						
2.0. Physiology (5)						
3.0. Biochemistry and Nutrition (6)						
4.0. Microbiology and Immunology (10)						
5.0. Pathology (12)						
5.1. General (5)						
5.2. Oral (7)						
6.0. Pharmacology (10)						
Provision of Clinical Dental Hygiene Services (120)						
Community Health/Research Principles (20)						

† Number of items devoted to each competency, which is based on the practice analysis survey findings.
 ‡ Each cell shows the number of items devoted to each content element that supports each competency.

Figure 1. Two-dimensional model underlying the validity study

Once it was determined how many items were required to support each competency, it was necessary to distribute these items across the existing content specifications. Relating competencies to examination content is difficult, at best. To overcome this difficulty, a panel of experts was convened, and this panel used the 2-dimensional model described above to forge the appropriate links. Essentially, the panel distributed the items devoted to individual competencies to the content elements that involve the theoretical and applied knowledge that support that competency. The number of items devoted to existing content elements, ie, elements in effect prior to 2005, could be increased or decreased depending on the competencies, and content elements could be added or removed.

The Joint Commission determined the qualifications of the panel members when it directed that a validity study be conducted. The members included 4 full-time practicing dental hygienists, 1 dental hygiene educator/test constructor, and the Joint Commissioner representing the American Dental Hygienists' Association. The Joint Commission selected the members based on geographic distribution and practice experience. As shown in Table 1, the final phases of the validation process involved the review of the revised content specifications by the Joint Commission through its standing Committee on Dental Hygiene.

Results

Using the outcomes of the committees' deliberations and synthesis of competencies, the practice analysis survey was developed and distributed. Of the 3941 surveys distributed, responses were received from 1841 participants. Of these 1841, 1284 or 69.7% were involved in full-time practice, 491 or 26.7% were involved in part time practice, 61 or 3.3% were not currently practicing, and 5 or 0.3% did not respond to this question. The 1284 full-time responding practitioners were distributed across licensing jurisdictions in proportion to the number of practicing dental hygienists in those

jurisdictions. With regard to the educational attainments of the dental hygienists in the sample of full-time practitioners 38 or 3.0% held a certificate, 1013 or 78.9% held an associate degree, and 232 or 18.1% held a bachelor's degree. One respondent did not indicate his/her award. The Committee on Research and Development, which had responsibility for advising the conduct of the practice analysis and overall validity study, considered this distribution of awards for the dental hygienists in the sample reflective of the educational attainments of the population of dental hygienists. Because the respondent sub-sample was representative of the population, it was deemed unnecessary to explore nonresponse bias.

The range in mean ratings for the competencies was from a low of 2.80 to a high of 4.94, with an overall mean of 4.27. The mean ratings were found to be 4.13, 4.46, and 3.85 for the categories Professionalism, Patient/Client Care, and Community Health Involvement, respectively. The lowest mean rating was associated with the competency "Participate in community service activities," and the highest mean rating was associated with the competency "Adhere to established infection control protocol." The number of practicing dental hygienists providing ratings, the mean ratings, and the associated standard deviations appear in Table 2a, 2b, 2c.

The ratings provided by the practicing dental hygienists were submitted to the Rasch calibration program WINSTEPS.⁵ The results of the analysis showed the relative value or contribution of the 5 levels of the rating scale as well as the calibrations, or endorsability, for each of the 56 competencies. The curves shown in Figure 2 indicate the probability of endorsing each of the levels of the rating scale for each difference estimate.⁶ Each of the 5 levels shown in Figure 2 should peak in an orderly fashion along the continuum of ever-increasing rater agreeability. Rating scale level 4 overlaps with the 2 adjacent levels, and it does not show a clear peak indicating that it has a relatively low probability of occurrence. While not severe in this instance, this structure suggests that participants are experiencing some difficulty in distinguishing between levels 3 and 4 and between levels 4 and 5. In severe instances, ie, where the probability of a particular level of the rating scale is flat, the rating scale should be collapsed and data reanalyzed.⁶ However, this rating scale structure clearly indicates that the 5 levels are functioning in an acceptable manner.

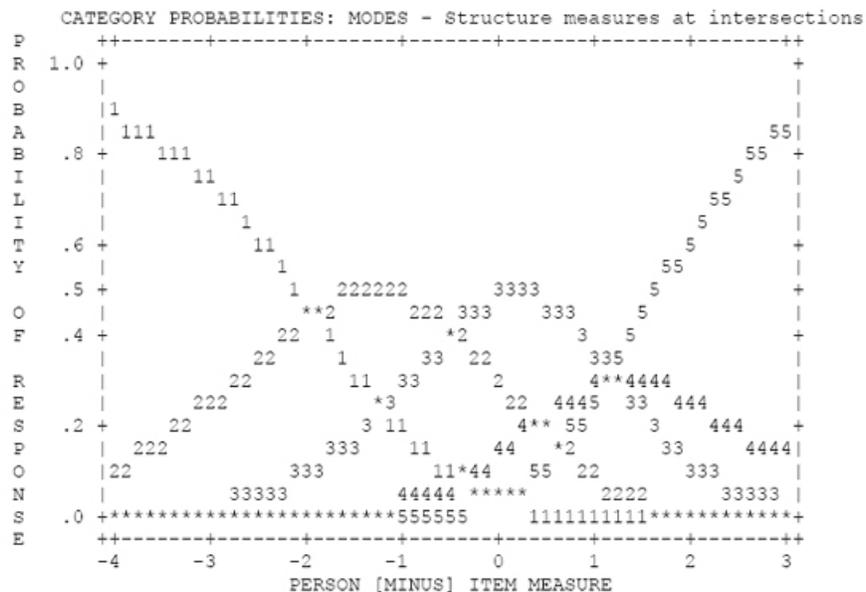


Figure 2. Rating scale structure

Once the viability of the rating scale was confirmed as robust, the calibrations were converted to percentages and numbers of items. Item calibrations are shown in Figure 3. This conversion was accomplished by solving the simultaneous equations that appear below.

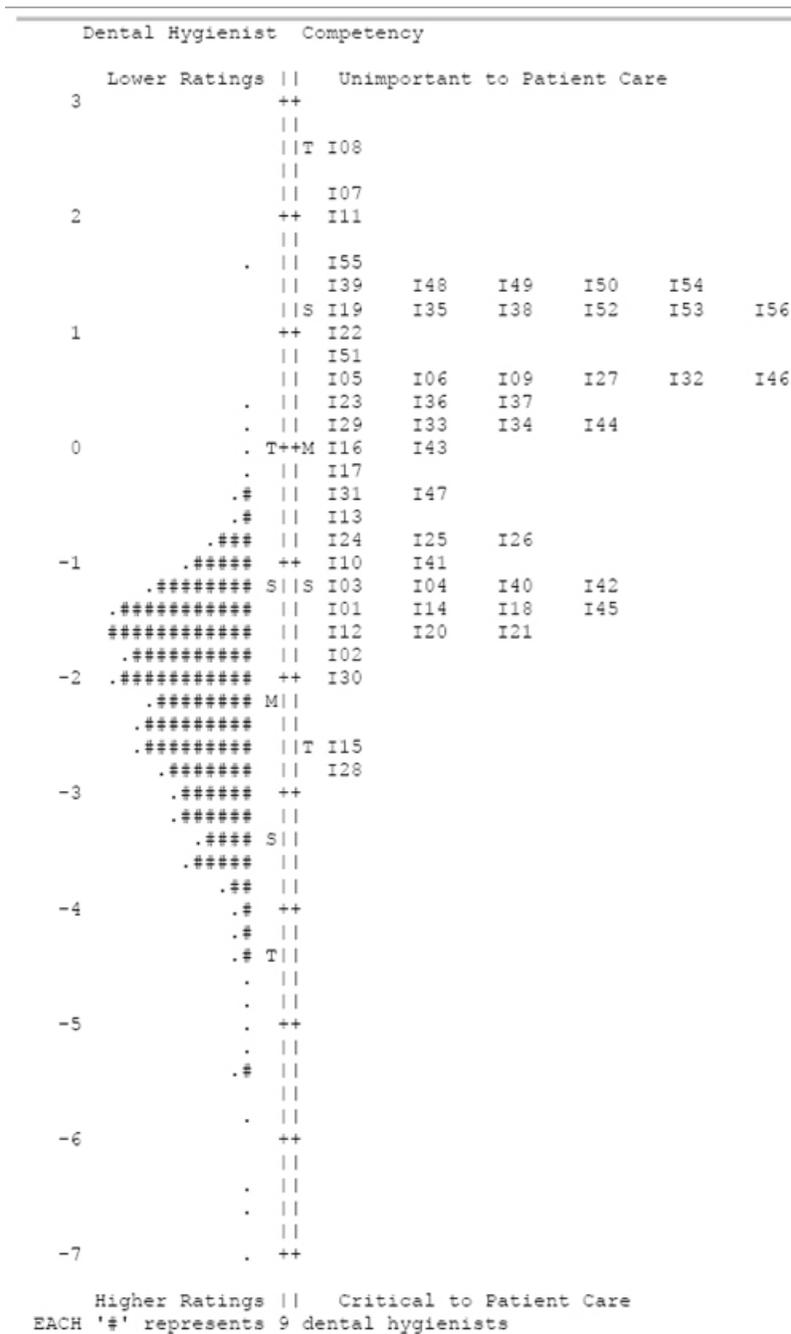


Figure 3. Map of importance of the competencies for patient care

$$0.05 = a + 2.80b$$

$$0.00 = a + (-2.68)b$$

The values of 0.05 and 0.00, which appear on the left sides of the equations, represent the percentages of items devoted to the most and least important competencies, respectively. The 2.80 value is the Rasch calibration associated with the competency rated most important by the survey participants, and the -2.68 is associated with the least important. Solving

these equations yields the translation formula: $y = 0.024 + 0.009x$, where x is the Rasch calibration and y is the percentage of items.

As anticipated, applying this translation formula directly to the calibrations resulted in an over estimation of the percentages and associated numbers of items devoted to the competencies. Using the translation equation, a total of 134% or 470 items would result rather than 100% and 350 items. To make the appropriate adjustments, the correction factor was applied as follows.

$$R = 1 / \Sigma y$$

$$R = 1 / 1.344$$

$$R = 0.744$$

The application of the correction factor resulted in transforming these estimates to the appropriate percentages and numbers of items. The percentage and number of items devoted to each competency appear in Table 4a, 4b.

Table 4. Corrected percentages and number of items devoted to each competency

Competency	Percent†	Number‡
Professionalism		
1	2.7	9
2	3.0	11
3	2.5	9
4	2.6	9
5	1.3	5
6	1.4	5
7	0.3	1
8	0.0	0
9	1.4	5
10	2.5	9
11	0.4	2
Patient/Client Care		
12	2.8	10
13	2.1	7
14	2.8	10
15	3.6	12
16	1.8	6
17	1.9	7
18	2.8	10
19	1.0	3
20	2.9	10
21	2.9	10
22	1.1	4
23	1.5	5
24	2.3	8
25	2.3	8
26	2.4	8
27	1.4	5
28	3.7	13
29	1.7	6
30	3.1	11
31	2.0	7
32	1.4	5
33	1.7	6
34	1.7	6
35	1.0	4
36	1.5	5

37	1.5	5
38	0.9	3
39	0.9	3
40	2.5	9
41	2.4	9
42	2.6	9
43	1.8	6
44	1.6	6
45	2.7	10

Community Health Involvement

46	1.4	5
47	2.0	7
48	0.8	3
49	0.8	3
50	0.8	3
51	1.2	4
52	0.9	3
53	0.9	3
54	0.8	3
55	0.7	2
56	1.0	3

† Rounded to the nearest 10th. ‡ Rounded to the nearest whole number.

During the third phase, the expert panel convened to forge the link between the competencies and the individual content elements. The panel was provided with a 2-dimensional matrix reflecting the model. One dimension consisted of a list of the competencies and the numbers of items devoted to each competency and the other dimension consisted of the traditional content elements, ie, those in place prior to 2005. The panel distributed the items allocated to each competency to the content elements in the specifications that relate to the theoretical and applied knowledge necessary to support that competency. The panel members made an initial set of assignments of items to content elements. Then, it refined its assignments by making a number of minor adjustments. Following the adjustments, the panel achieved full consensus. In some instances, traditional content elements were eliminated, eg, Clinical Testing subsumed under Assessing Patient Characteristics. In other instances, content elements were introduced for the first time, eg, Dental Hygiene Treatment Strategies was included under Planning and Managing Dental Hygiene Care, which is an element subsumed under Provision of Clinical Dental Hygiene Services. Also, the various responsibilities of the dental hygienist that were dispersed throughout the specifications in effect prior to 2005 were grouped together and expanded under the category of Professional Responsibility. This category was introduced under Provision of Clinical Dental Hygiene Services and under Case Dependent Items. The distribution of items under the traditional content specifications and under the practice analysis for the major categories appears in Table 5.

Table 5. Distribution of items under the traditional content specifications and under the practice analysis

		Distribution	
		TC†	PA‡
<i>Case-Independent Items</i>			
Scientific Basis for Dental Hygiene Practice		60	60
1.0.	Anatomic Sciences	17	15
2.0.	Physiology	5	4
3.0.	Biochemistry and Nutrition	6	7
4.0.	Microbiology and Immunology	10	11
5.0.	Pathology	12	13
6.0.	Pharmacology	10	10
Provision of Clinical Dental Hygiene Services		120	116
1.0.	Assessing Patient Characteristics	23	16
2.0.	Obtaining and Interpreting Radiographs	19	14
3.0.	Planning and Managing Dental Hygiene Care*	30	34
4.0.	Performing Periodontal Procedures	27	19
5.0.	Using Preventive Agents	12	9
6.0.	Providing Supportive Treatment Services	9	7
7.0.	Professional Responsibility	0	17
Community Health/Research Principles		20	24
1.0.	Promoting Health and Preventing Disease Within Groups	4	5
2.0.	Participating in Community Programs	8	11
3.0.	Analyzing Scientific Literature understanding Concepts and Applying Research Results	8	8
<i>Case Dependent Items**</i>		150	150
1.0.	Assessing patient characteristics	37	35
2.0.	Obtaining and interpreting radiographs	15	16
3.0.	Planning and managing dental hygiene care	38	43
4.0.	Performing periodontal procedures	30	21
5.0.	Using preventive agents	15	13
6.0.	Providing supportive treatment service	15	11
7.0.	Professional Responsibility	0	11

† Traditional content specification. ‡ Content specifications under the practice analysis.

* Four new items on Treatment Strategies included under this general area. ** Approximations.

During Phase 4, the overall validity study, the practice analysis methodologies, and the content specifications resulting from the work of the panel were approved by the Joint Commission through its standing Committee on Research and Development and its Committee on Dental Hygiene. The new specification became effective in January of 2005.¹⁰

Discussion

One of the central responsibilities of a testing agency involved in credentialing is to gather evidence from a variety of sources to demonstrate that the scores resulting from the administration of its examination are aligned with a particular purpose, ie, the scores are valid for use in evaluating the qualifications of candidates for certification or licensure. One source of information regarding the validity of scores is the findings of studies, which are designed to address the particular purposes of the examination.

The first step in conducting validity research is to confirm that the domain of practice has been carefully and fully defined. In this study, the domain of entry-level dental hygiene practice was defined in terms of competencies rather than other possible components such as specific job tasks. Further, to guarantee that the domain was fully defined, a committee of experts in the various aspects of dental hygiene, ie, the Joint Commission's Committee on Dental Hygiene, met and synthesized the set of competencies from 2 separate sources. This was accomplished during Phase 1 and supports the basic assertion that the domain was adequately defined, ie, the competencies were considered expressive of the essential knowledge, skills, and abilities of the newly licensed dental hygienist. To the extent that the competencies are comprehensive, the findings of the practice analysis are durable. The Joint Commission determined that the 56 competencies adequately represent the domain of dental hygiene practice and approved their use as the basic ingredient of the practice analysis survey. The findings of research support the assumption that the competencies were sufficiently comprehensive to adequately represent the domain of knowledge, abilities, and problem solving skills necessary to successful entry-level practice of dental hygiene.¹¹

Phase 2 of this validity study involved estimating the importance of each of the 56 competencies. Estimating their relative importance is essential because it is the basis for determining the various content elements to be included in the specifications and the emphasis to place on the elements in sampling candidate knowledge. To ensure the adequacy of the survey process, a stratified random sample of recently examined dental hygienists was drawn. The sample was limited to relatively recent graduates to avoid potential bias in responses by dental hygienists whose perspective on practice may be influenced by cumulative practice experience and additional formal and/or informal education. The sample was drawn across a 5-year period of time, with higher percentages of participants sampled from the earlier years to compensate for the potential lower response rate attributable to dated addresses for candidates and other ineffable factors. The sample was drawn from the files of the Joint Commission in such a way that each state was sampled in accordance with the percentage of candidates testing from that state. The overall sample of 16% of all candidates was deemed sufficient by Survey Center staff to arrive at stable estimates of importance. This judgment was supported by the response rate that was found to be 75.6%, after adjusting for unclaimed and undeliverable surveys.

By virtue of being included in the list of 56 competencies synthesized by experts who deemed them to be important to practitioners, the survey findings indicated that some competencies are relatively more important to patient care than others. The mean ratings for the competencies varied across the range of scale values from 2.80 to 4.94, which suggests that all competencies were at least moderately important to patient care. In the general area of Professionalism, the competency "Participate in community service activities" was considered unimportant and received a mean rating of 2.80, while the competency "Adhere to state and federal laws" was considered important and received a mean rating of 4.85. In the area of Patient/Client Care, the competency "Use and compare indices" received a mean rating of 3.75, and "Adhere to established infection control protocol" received a rating of 4.94. This high rating can no doubt be attributable to the ever-increasing emphasis placed on infection control procedures. In the area of Community Health Involvement, the least important competency was found to be "Evaluate the outcomes of community-based programs and plan for future activities" at a mean rating of 3.56, and the competency "Communicate effectively both verbally and in writing" was found to be relatively important at 4.51. Of the 3 major areas, the mean rating for all competencies included in the area of Patient/Client Care was the highest at 4.46, and the mean for competencies included in Community Health Involvement was 3.85. The mean rating for Professionalism was 4.13. These mean ratings suggest that practicing dental hygienists place the most importance on those competencies directly associated with individual patient care. This finding might reflect an artifact of the survey instrument itself, however, because the rating scale defined importance in terms of patient care. Therefore, competencies directly addressing essential abilities related to patient care would be rated as more important. Different results might have been found if the rating scale referred to the practice of dental hygiene more broadly. Patient care was used in the survey to determine importance because it relates directly to the purpose of the Dental Hygiene Examination: to determine whether candidates are minimally competent to deliver safe patient care. Relatively lower importance ratings given to certain competencies unrelated to patient care or to the Dental Hygiene Examination should not be construed as lessening their value as goals in the education of dental hygienists since the purpose and goals of dental hygiene education are broader than the specific purpose of the Dental Hygiene Examination.

One question that surfaces when using Likert-type rating scales relates to the number of levels of the scale. In the case of this practice analysis survey, the question arises as to whether the 5-point Likert scale was appropriate. If the preliminary analysis suggests that one or more levels of the scale are not functioning, then it is important to collapse the scale and

recode the data accordingly before proceeding to further analyses. Such an approach does not require the survey to be re-administered with fewer scale points. Figure 2 indicates that all 5 levels of the rating scale are functioning, even though level 4 is weak in the sense that participants seem to have some difficulty differentiating between level 3 and 4 and between 4 and 5. Despite this apparent lack of clarity among some levels of the scale, level 4 is functional, and its elimination before further analysis is not necessary or even desirable.

One of the features of the Rasch modeling of rating scale data is that the agreeability of the raters in endorsing competencies as important is shown on the same scale of measurement as the endorsability of competencies as important. Figure 3 shows that rater agreeability, ie, level of concern for patient care issues as articulated by this sample of dental hygienists through their assigned importance ratings, is not uniformly dispersed across the endorsability of this set of competencies. As shown, the mean rating for the participants is higher than the mean rating for the competencies, and the tail of the dental Hygienists' configuration of ratings extends beyond the competencies considered more critical. This implies that the participating dental hygienists considered these competencies to have included the important patient care issues of the day. This finding supports the proposition that the set of competencies originally developed by the Committee on Dental Hygiene describes a comprehensive range of competencies important to the novice dental hygienist and further supports the use of the 56 competencies in this practice analysis.

Following the application of the correction factor to the Rasch rating scale calibrations, the expert panel met to determine the theoretical and applied knowledge necessary to support the fulfillment of the competencies. Essentially, the panel members assigned the items devoted to each competency to the existing supporting content elements. This process required the judgment of members of the expert panel since many competencies could be interpreted as multidisciplinary or interdisciplinary, covering more than a single content area. Overall, there were changes in approximately 20% of the content. This relatively significant percentage change in content can be largely attributable to the reorganization of content under a new area. As such, the change is descriptive of changes in organization in the specifications but is artificially high as a characterization of the addition of new content or the elimination of existing content elements.

While few, if any, of the competencies directly addressed the basic sciences, the panel observed that much of the content in the basic sciences is important for the successful acquisition of some of the competencies. In light of this, the number of items devoted to the "Scientific Basis of Dental Hygiene Practice" remained the same at 60 items. There were relatively insignificant changes in the number of items devoted to most of the subject matter areas, however.

The examination is focused on assessing theoretical and applied knowledge in the basic and dental hygiene clinical sciences. This knowledge tends to support the competencies in the Provision of Clinical Dental Hygiene Services, which is, in turn, supported by the results of the survey. Shifts in the number of items in the traditional content specifications as a function of the practice analysis represent trends that reflect the scope of the competencies and the judgments of the expert panelists. With 2 very noticeable exceptions, the Provision of Dental Hygiene Services remains largely unchanged. The most obvious exception is the introduction of the area of Professional Responsibilities. This new area was assigned 17 items distributed across the general area (1), Ethical principles, including informed consent (8), Regulatory compliance (3), and Patient and professional communication (5). This new category was also introduced into the case-dependent portion of the examination with 11 items. While this content is now localized under one category, professional responsibilities were included in the traditional content specification. The introduction of the category, the integration of items from other areas under this new category, and the overall expansion in the number of items reflect the increased emphasis assigned to this area as a function of 2 factors that include: 1) the number of competencies primarily in the area of Professionalism and 2) the importance ratings assigned by dental hygienists to the competencies related to professionalism and communication.

Another noteworthy change in the content specifications is also subsumed under the Provision of Clinical Dental Hygiene Services. This new category of "Dental Hygiene Treatment Strategies" is included under Planning/Managing Dental Hygiene Care. It consists of "Dental Hygiene Diagnosis" (1), "Treatment Plan" (2), and "Case Presentation" (1). This content directly supports several competencies.

With regard to "Community Health/Research Principles," there was a minor change in the number of items from 20 to 24, for the traditional content and the content under the practice analysis, respectively. The case-dependent portion of the examination remained at 150 items by design. Aside from the addition of 17 items grouped under Professional Responsibility, there were no significant changes to the content.

While the findings of the validity study are the basis for the content specifications, the Joint Commission continues to gather information from test constructors with regard to minor shifts in focus and changes in terminology. The Joint Commission through its Committee on Dental Hygiene evaluates this information and approves of viable changes on an annual basis.

Conclusion

The purpose of this validity study was to gather evidence in support of the use of scores achieved on the National Board Dental Hygiene Examination in the initial phase of the licensure process. The most robust and durable form of evidence is the demonstrated link between examination content and the competencies involved in the entry-level practice of dental hygiene. In general, the study findings indicate that the content specifications in effect prior to 2005 were valid. However, in using this alternative and independent methodology, the study findings demonstrate that an adjustment in approximately 20% of the content specifications resulted in the Dental Hygiene Examination more closely assessing the theoretical and applied knowledge that supports the competencies in accordance with their importance to patient care. Conversely, an agreement of 80% of the specifications from one method to the other is an indication that the traditional content was valid. This is especially true since a substantial part of the 20% is actually an estimate of the reorganization of content.

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Notes

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Service-Learning and Dental Hygiene: A Literature Review

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Dental hygienists should be aware of the concept of service-learning and how it can enhance dental hygiene education. A look at national documents and other relevant historical literature will be reviewed, in addition to more recent books and articles to define service-learning. Although perceived as a new teaching strategy, service-learning has its roots in experiential education. Several definitions of service-learning have emerged, which take into consideration the reciprocal needs of the student and community, bridging academic theory with community service, and instilling civic responsibility through a reflective component. Considering the advantages and disadvantages, service-learning seems to be a good methodology for dental hygiene education. Recommendations include the expansion of the ADA Accreditation Standards to include service-learning, and incorporation of an operational definition of community-based oral health programs, as well as the term service-learning in its Definition of Terms.

Keywords: service-learning, dental hygiene education, educational methodology, experiential education

Introduction

Service to the public on the national level is outlined in the *Competencies for Entry into the Dental Hygiene Profession* developed by the American Dental Education Association (ADEA). One of the domains of these competencies states, "dental hygienists must appreciate their role as health professionals at the local, state, and national levels. This role requires the graduate dental hygienist to assess, plan, and implement programs and activities that benefit the general population. In this role, the dental hygienist must be prepared to influence others to facilitate access to care and services."¹ According to the competency regarding Community Involvement (CM), item CM.3 states: "provide community oral health services in a variety of settings."¹

The *Report of the ADEA President's Commission: Recommendations for Improving the Oral Health Status of All Americans: Roles and Responsibilities of Academic Dental Institutions* highlighted 2 important concepts that are related to serving the public. Recommendation 3: To prepare students to provide oral health services to diverse populations, item 3.3 states: "provide in the curriculum and in other forums opportunities to teach students about their professional obligation to serve the public good and encourage students to explore how they and the profession can ensure oral health care for all Americans."²

In addition, Recommendation 5: To improve the effectiveness of allied health professionals in reaching the underserved, item 5.1 states: "develop the knowledge and skills necessary to serve a diverse population, provide experiences of oral

health care delivery in community-based and nontraditional settings, and encourage externships in underserved areas."² Providing care in settings outside of the traditional academic clinic should foster an environment where students can exercise critical thinking and decision-making skills.

Standards set by the Commission on Dental Accreditation (CODA) of the American Dental Association (ADA) mandates, in Standard 2-18 of the Patient Care Competencies, that dental hygiene graduates must be competent in providing dental hygiene care to various population groups including children.³ Not only should dental hygienists be competent in providing dental hygiene care, they should ensure that there is access to oral health care. The Code of Ethics of the American Dental Hygienists' Association (ADHA) mandates justice and fairness in access to dental hygiene services through basic beliefs, core values, and professional responsibility to the community.⁴ This supports strategies outlined in the *Oral Health in America: A Report of the Surgeon General*. In the description of "the nature of community health programs," the primary focus is on a group in need, in this case to decrease disparities in health care particularly among low-income and minority families.

Typically, government agencies, charities, schools, or religious groups "spearhead" programs that incorporate the values of the specific organization, tapping into the expertise, enthusiasm, and knowledge of the community. Members of the community organizations often can be used as staff, volunteers, or consultants.⁵⁻⁶ The government documents discussed above provide support for communities to partner with academia through service-learning activities.

While the authors recognize the integration of service-learning within other disciplines (ie, nursing, dietetics), the focus will be on the dental profession, specifically dental hygiene. The purpose of this article is to acquaint grassroots dental hygienists with service-learning and to facilitate the role of dental hygiene education in these activities. Although a suggestion is offered later in this article to establish a more universally clear definition of service-learning for the dental hygiene profession, the definition that suits health care professions is displayed in Table 1.

Table 1. Definition of Service-Learning

- Service-learning strives to achieve a balance between service and learning objectives - in service-learning; partners must negotiate the differences in their needs and expectations.
- Service-learning places an emphasis on addressing community concerns and broad determinants of health
- In service-learning, there is the integral involvement of community partners - service-learning involves a principle-centered partnership between communities and health professions schools.
- Service-learning emphasizes reciprocal learning - In service-learning, traditional definitions of "faculty," "teacher" and "learner" are intentionally blurred. We all learn from each other.
- Service-learning emphasizes reflective practice - In service-learning, reflection facilitates the connection between practice and theory and fosters critical thinking.
- Service-learning places an emphasis on developing citizenship skills and achieving social change - many factors influence health and quality of life. The provision of health services is not often the most important factor. In service-learning, students place their roles as health professionals and citizens in a larger societal context

Citation: Seifer SD. (1998). Service-learning: Community-campus partnerships for health professions education. *Academic Medicine*, 73(3):273-277. Source: <http://www.ccpn.info/>

Review of the Literature

It is often said, "experience is the best teacher." As in the other health and helping professions, on-the-job training has been a big component of the education experience. As one assesses community needs, it is also necessary to investigate how students can help solve problems.⁷ Many youth programs such as 4-H Clubs and Boys/Girls Scouts model the tenets of community service and responsible citizenship. School-based programs have been integrated into the school system through clubs or co-curricular activities, volunteer clearinghouses, community service credit, labs for existing courses,

community service classes, and finally to school-wide focus or themes.⁸ Thus the concept of *service-learning* is being applied in the educational system where service is combined with *learning*.

According to Seifer, as cited on the website for Community-Campus Partnerships for Health (CCPH), service-learning is now integrated into higher education as students combine service with required coursework. Seifer contends that there are differences from traditional clinical education within the health care professions, as displayed in Table 1.⁹ Sigmon defined service-learning as experiential, reciprocal education that occurs only when both the providers and the recipients of the service benefit from the activities.¹⁰

Service-learning is often confused with other activities such as volunteerism, internships, field education, clinical rotation, and community service (See Table 2), Although these activities may offer both service and learning, the primary focus of these activities is either service or learning. That is, the elements of service and learning are not balanced and either service or learning may be a by-product of the original intent of the activity.

Table 2. Comparison of Service-Learning with other Activities

Activity	Primary focus is meeting student learning needs	Primary focus is meeting agency/community needs
Volunteerism		X
Community Service		X
Field Education	X	
Practicum	X	
Clinical Rotation	X	
Internships	X	
Service-Learning	X	X

Adapted from: Sigmon, Furco; Seifer; Eylar & Giles; Hemphill in Geruink.¹⁰⁻¹³

For example, with volunteerism and community service, the objective is to serve, any learning is unintentional, and the student may or may not make the academic link (if there is a link). The main purpose of internships, practicum, clinical rotations, and field education is to increase technical skills, knowledge, or understanding of the field of study or vocational development. These activities can be considered "on-the-job training" to benefit the academic learning of the student and not to provide service to the agency. Furthermore, these activities do not: 1) meet the encompassing definition of service-learning as an activity that balances service and learning objectives; 2) link the needs of the student and the community; 3) develop citizenship skills; and 4) contain a reflective component.^{10,11,12,13}

Service-learning "is a teaching strategy that combines service to the community with classroom curriculum in K-12 schools."¹⁴ Mission statements of educational institutions that address social problems, commitment of students to community, or contribution to society support service-learning methodology. Many institutions have joined organizations such as Campus Compact, AmeriCorps, and the National Society for Experiential Education. According to the website for the National Service-Learning Clearinghouse (NSLC), there were 712 000 students who participated in some form of service among the 349 campuses that responded to a survey of institutions offering courses in which service-learning was a component of instruction.¹⁵

Additionally, there are publications that create a body of literature on service-learning activities. The *Michigan Journal of Community Service Learning* is a peer-reviewed publication devoted to service-learning. *Synergist*, a journal started around 1971, has articles that link service to learning. Other educational literature such as *Action in Teacher Education* prints articles that links service to learning.

Although it may seem like a new approach in education, the philosophy of service-learning is rooted in the ideas of Dewey and Kolb. Dewey believed that the student needed to be an active participant in learning and to address social issues. Dewey's continuum of learning demonstrated the relationship of education, work, and experience. Regarding the nature of experience, Dewey wrote: "when we experience something we act upon it, we do something with it; then we suffer or undergo the consequences."¹⁶ It is perhaps from the consequences that the learner is then forced to reflect upon his/her experiences and learn from them, thereby producing a change. According to Taylor "[f]or Dewey, experience and education were inextricably linked to social and political development, making community service an integral aspect of citizen

participation in a democratic society."¹⁷ Later, Kolb theorized a learning cycle comprised of different ways people learn in school, in the community, in a career, and in other facets of life. Kolb's work on learning styles or preferences demonstrated how service-learning activities can have an impact on careers and lives.¹⁸

Various initiatives of the US government have demonstrated a commitment to service in the form of creating jobs, while meeting needs or providing service. One of the earliest government developments in service-learning was the creation of the Civilian Conservation Corps (CCC) in the 1930s. Further opportunities were developed in the 1960s from the Peace Corps on an international level to the "War on Poverty" for improving local neighborhoods with organizations such as Volunteers in Service to America (VISTA) and the Job Corps. In addition, the Higher Education Act of 1965 defined a community service program as educational, assisting to solve a community problem, and part of an academic degree or college level course that utilizes an institution's resources and faculty.¹⁹ More recently, the National and Community Service Act of 1990 provided support for service in the areas of service-learning programs including higher education service programs. The National Community Service Act of 1993 created AmeriCorps and the Corporation for National Service.²⁰

For true service-learning to occur there must be: 1) academic course content within a discipline or field of study; 2) an activity that meets a social need and civic responsibilities; and 3) a reflective component such as personal journals, portfolios, in-class or online discussions, case studies, or essays.²¹ Eyler and Giles integrates the critical thinking and reflective components in their definition of service-learning, and makes the distinction between *service learning* with or without the hyphen. The authors stated: "In our own practice, we have embraced the position that service-learning should include a balance between service to the community and academic learning and that the hyphen in the phrase symbolizes the central role of reflection in the process of learning through community experience."¹²

Activities are designed in which the student encounters moral dilemmas not found in the classroom, meets individuals with different personal values, and is challenged with moral decision making. Thus, service-learning is not just experiential learning, but a bridge for theory with practice that demands reflective thinking. Assessment of the students' learning may be accomplished through the following: written work by the student (ie, essays, journals, diaries, etc.), group discussions, individual conferences with students, evaluation by supervisor, and self-assessment by the students themselves.⁸ According to Howard, the concept of service-learning contains 3 components: 1) relevant and meaningful service with the community; 2) enhanced academic learning; and 3) purposeful civic learning. This is depicted in the diagram from the journal²² (See Figure 1).

(Adapted from Howard, J., Editor, Summer 2001 Michigan Journal of Community Service Learning)

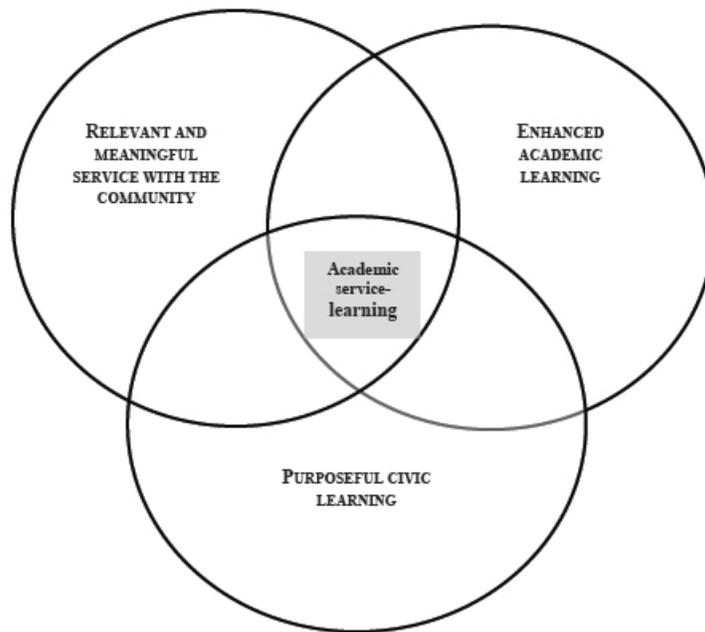


Figure 1. Venn Diagram of the Components of Service-Learning.

More specific to dentistry, service-learning activities have been reported "not only to enhance the students' knowledge and clinical skills, but also to facilitate their personal and professional development, ethical and critical reasoning, and values and attitudes."²³ Hemphill used the principles developed by the Center for Healthy Communities (CHC) as the impetus for her discussion on service-learning in dental hygiene education while Yoder developed her own framework for service-learning in dental education.^{13,24} Both models take into consideration collaboration during the planning stage, the academic needs of the student, the oral health of the community, and the reflective element in the evaluation of the activity (See Table 3).

Table 3. Components of Service-Learning

A. Center for Healthy Communities (as cited by Hemphill)	B. Yoder's Framework for Service-Learning in Dental Education
<ul style="list-style-type: none"> ❖ Community Partner Collaboration ❖ Mutual Objective Formation ❖ Orientation ❖ Preparation ❖ Service-Learning Experience ❖ Reflection ❖ Evaluation 	<ul style="list-style-type: none"> ❖ Academic Link ❖ Sustained Community Partnership ❖ Service-Learning Objectives ❖ Broad Preparation ❖ Sustained Service ❖ Reciprocal Learning ❖ Guided Reflection ❖ Community Engagement ❖ Ongoing Evaluation and Improvement ❖ Opportunities for Community-Engaged Scholarship

Sources: (A) Hemphill S. Service-learning in Geurink, KV. *Community Oral Health Practice for the Dental Hygienist, 2nd ed. 2005*, Elsevier Saunders, St. Louis, MO. (B) Yoder K. A framework for service-learning in dental education. *J Dent Ed* 2006; 70(2): 115-123.

In a report published by *Campus Compact*, responding institutions indicated that 65% of their service-learning programs and projects addressed health issues.²⁵ These institutions also ranked *health* fourth out of the top 10 disciplines that utilized

service-learning in their curriculum. Elementary students (89%) and low-income (83%) populations were the highest groups among those served through service-learning activities.²⁵

Dental Hygiene Service-Learning in Action

A school-based dental sealant program provides a good example for incorporating service-learning into the dental hygiene curriculum.²⁶⁻²⁹ At a midwestern university within a rural community, senior baccalaureate dental hygiene students are scheduled in several rotations as part of a multicultural course. A sealant program is a good opportunity for students to work with a population they (typically) will not frequently see in the dental hygiene clinic. An activity such as this blends academia with the community in order to meet some of the preventive oral health needs of underserved children. This program was made possible through funds from the state health department. Yoder stated that service-learning projects are often linked to external funding sources.²⁴

In addition to the school-based sealant program, senior dental hygiene students gain competencies in a variety of dental settings via a nursing home/skilled care facility, a Veteran's Administration hospital, a rural dental health clinic, a campus-based community dental center, and a rural dental health clinic, which includes migrant farmworkers as a portion of the population served. At the end of each rotation, students write a reflective essay on their experiences. In turn, not only does this allow the supervising faculty to improve upon the course content, but gives students an awareness of how they can become better equipped to face particular needs of individuals within their own communities.

Furthermore, Lam wrote about dental hygiene students' participation in a community dental sealant program with its base in the dental hygiene clinic, as well as other services provided by students within a community dental health course at a community college located in a large urban area. In addition to the dental sealant program, other service-learning activities are integrated into the dental hygiene curriculum.³⁰

Advantages and Impact of Service-Learning

Oral Health in America: A Report of the Surgeon General has provided further rationale for the dental hygienist's role in reducing the disparities in oral health and oral health care among population groups.⁵ *A National Call to Action to Promote Oral Health* has as one of its goals for improving access to oral health care, "to ensure an adequate number and distribution of culturally competent providers to meet the needs of individuals and groups, particularly in health care shortage areas."³¹

Service-learning can create a mechanism by which dental hygiene students can acquire skills that enable them to become culturally competent by providing opportunities to work with ethnically diverse populations and individuals with special needs. Thus, students are able to meet objectives outlined in accreditation standards, as well as addressing the core competencies for entry in to the dental hygiene profession.^{1,3,32-33}

There are positive outcomes from the incorporation of service-learning into higher education curricula. Zlotkowski spoke of several successful service-learning programs, including one in which he served as its first director. The Bentley Service-Learning Project began as the Bentley Homelessness Project, and through its success based upon student involvement, became the impetus for a college-wide, faculty-led service-learning program.³⁴

At Brevard Community College, a conscientious effort was made to support faculty in numerous service-learning endeavors to include: research, mini-grants for course development in underrepresented disciplines (eg, math, art, technology and English), K-14 collaboration to establish service-learning in the public school system, international service-learning pilot projects, faculty travel and professional development, and support for faculty who served as recruiters or consultants for other campuses.³⁴

The 2 examples above, along with the service-learning efforts mentioned previously, that are associated with dental hygiene programs, are just a few of the many programs and institutions that have had successful service-learning projects. Thus,

service-learning appears to be a viable teaching methodology in the education of dental hygienists. This would entail meeting all 3 criteria of service-learning: relevant and meaningful service with the community, enhanced academic learning, and purposeful civic learning with academic service-learning as the core.

Disadvantages of Service-Learning

Coordination of service-learning activities may not be incorporated into the faculty teaching assignments. Consequently, faculty members volunteer to facilitate certain activities. By placing them into a course, this would raise the level of importance of any service-learning activity as an integral part of the dental hygiene curriculum. It would also give recognition for faculty willing to be committed to the philosophy of service-learning and the role it plays in the educational process.

The authors have taken note that this lack of recognition in the faculty reward structure has been suggested in the literature as a deterrent for those who do not use this as a teaching strategy.³⁵ According to Chapdelaine, Ruiz, Warchal, and Wells, "service-learning is a labor-intensive activity that should not be a risky undertaking for faculty. [...] Campus barriers to service-learning include resource limitations, poor community relations, and lack of student involvement in the educational process."³⁶ With respect to faculty support, Zlotkowski stated:

"One only need consider how little experience most faculty members have had working outside the classroom, let alone working with community partners. In other words, most faculty need to develop a new skills set—skills of designing, coaching, and helping students process fieldwork—to complement their traditional skills of lecturing, and guiding text-based discussion. They also need an opportunity to develop new, more appropriate assessment techniques."³⁴

As cited in *Campus Compact*, the major obstacles to institutionalization or advancement of service-learning were time and pressure on faculty teaching loads.²⁵ Although service-learning programs can be easily incorporated into the tenure, promotion, and merit review process, this is not the case.³⁴ While community outreach or service is expected of faculty, research and teaching obligations often outweigh the focus on developing students' sense of civic engagement.³⁷

Service-learning can easily be recognized as a viable pedagogical experience. For example, the term "service-learning" could be included in the ADA *Accreditation Standards for Dental Hygiene Education Programs* as part of educational methodology in the enriching clinical and community dentistry experiences.³

Conclusions and Recommendations

If dental hygiene educators are to take the lead with integrating service-learning into the curriculum, the communities of interest (ie, the leaders in the profession, the faculty and administrators of dental hygiene education programs, and the academic institutions) will have to embrace the philosophy of service-learning. Opportunities for networking currently exist at various professional association meetings. Time constraints, however, may prohibit the interaction among practicing dental hygienists and junior and senior faculty members to have an active discussion on the issues concerning the integration of service-learning into the curriculum, and community collaboration.

In order to facilitate the probability of incorporating service-learning into the existing dental hygiene curriculum, faculty and the profession need to understand:

How to plan and develop service-learning activities.

The needs of the community that is to be served.

How to evaluate the activity and the students' participation in the activity.

The importance of collaborating with grassroots dental hygienists to bridge the gap between academia and the community at large. In other words, **ask** them to take part in the assessing, planning, implementing, and evaluating the activity.

Initiatives need to be expanded that increase the role of dental hygienists in providing access to oral health care. Opportunities need to be developed for dental hygienists to work outside of private practice and to reach those individuals who do not seek regular preventive dental care due to barriers such as cost, transportation problems, and limited providers. Positive experiences need to be given to dental hygiene students so that they may not only apply for employment in alternative practice settings, but also help develop these opportunities in non-formal clinical settings.

With respect to the *ADA Accreditation Standards for Dental Hygiene Education Programs*, which are currently undergoing revisions, and utilizing elements from Yoder's *Framework for Service-Learning in Dental Education*,²⁴ the authors further recommend that either a new standard be developed or the (current) standard 2-22 (proposed revision would make this standard 2-20, if adopted; see Table 4) be expanded to incorporate examples of evidence to demonstrate compliance from service-learning activities.

Table 4. Proposed Revision to ADA Accreditation Standards for Dental Hygiene Education

2-20	Graduates must be competent in assessing, planning, implementing and evaluating community-based oral health programs including, health promotion and disease prevention activities.
2-22	
	Intent: <i>Dental hygienists should experience a series of broad-based activities dealing with diverse populations to ensure competence in oral health education and preventive counseling for individuals and groups. Population based activities will allow students to apply community dental health principles to prevent disease and promote health.</i>
	Examples of evidence to demonstrate compliance include:
	<ul style="list-style-type: none">• student projects demonstrating assessing, planning, implementing and evaluating community-based oral health programs• examples of community-based oral health programs implemented by students during the previous academic year• evaluation mechanisms designed to monitor knowledge and performance

Source: http://www.ada.org/prof/ed/accred/announcements/appen_03.pdf Accessed December 22, 2006.

For example:

- a. Reflective mechanisms designed to monitor changes in students' attitudes and behavior, (ie, journals, essays, discussions).
- b. Documentation of hours devoted to the service-learning activity(ies).
- c. Surveys from dental hygiene graduates indicating participation in volunteerism, advocacy, political initiatives, etc.

Furthermore, the terms "community-based" and "service-learning" should be added to the section within the standards document entitled: *Definition of Terms Used in Dental Hygiene Accreditation Standards*. Additionally, the ADHA policy number 11-97 regarding curriculum under Education/Continuing Education as printed in the September 2006 *Policy Manual* should be revisited to incorporate service-learning and perhaps include a definition of community-based and service-learning in its Glossary, also contained within the *Policy Manual*. The current policy reads: "The ADHA supports externships and internships within accredited dental hygiene programs in order for students to gain practical experience in public health and alternative practice settings."³⁸

The authors feel that clarification of these terms would facilitate the interpretation and implementation of the standard pertaining to competency in the area of community-based oral health programs; and that an official, universally recognized definition of service-learning be adopted for use among dental hygiene educators. Also, this could foster a better understanding of the roles of the dental hygiene student, the grassroots dental hygienists, and academe in meeting the oral health needs of their respective communities.

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Notes

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Oral Assessment of Children with an Autism Spectrum Disorder

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Purpose. *The study assessed the oral health status of children with an autism spectrum disorder (ASD) to help establish the oral health needs of this population.*

Methods. *Oral assessments were conducted on 39 children with an ASD and 16 children with other developmental disabilities (DD), solicited from 3 different schools. Conditions assessed were bacterial plaque, gingivitis, dental caries, restorations, bruxism, delayed eruption/missing teeth, oral infection, developmental anomalies, injuries, occlusion, salivary flow, and oral defensiveness.*

Results. *Chi-square and Fisher's exact test of significance were used to compare groups. Young children with an ASD who resided with parents showed significantly more signs of bruxism than the comparison groups. Likewise, older children who lived at the residential school manifested significantly more gingivitis. No other significant differences existed when age and residence were considered for children with an ASD. When comparing children with ASD to those with another DD, the latter group showed significantly more oral injuries, abnormal salivary flow, and developmental anomalies. Children with an ASD displayed the following percentages for clinically visible conditions: plaque (85%), gingivitis (62%), and caries (21%). Approximately half of the children with ASD were orally defensive.*

Conclusions. *Children with an ASD appear to have oral conditions that might increase the risk of developing dental disease. The extent of risk is unclear and needs further investigation.*

Keywords: autism, oral health, access to care, developmental disabilities, oral assessment

Introduction

In 2000, the United States Surgeon General's first report on the oral health status of Americans was released. One major message of this report is that oral health is essential to the general health and well being of all Americans. Although they can achieve it, not all Americans are achieving the same degree of oral health. The Surgeon General's Report emphasized that "a silent epidemic" of oral diseases is affecting our most vulnerable citizens, including those with special needs. At the time the Surgeon General's Report was published, no national studies had been conducted to determine the prevalence of oral and craniofacial diseases among the various subpopulations with disabilities.¹ Very little has been reported in the literature about the oral health needs of individuals with an autism spectrum disorder (ASD); however the oral health status of individuals with mental retardation (MR) and other developmental disabilities (DD) are more readily available. Some local and regional reports show that persons with DD have significantly higher rates of poor oral hygiene and need for

periodontal treatment than the general population. Although there is variability in reports on caries rates, overall, individuals with disabilities appear to have a higher prevalence than individuals without disabilities. Published reports describing the oral health needs and prevalence of oral disease for individuals with an ASD are sparse to nonexistent.

The aim of this study was to investigate the oral health status of children with an ASD. The 4 goals of this research were to (a) investigate the oral health status of all participants in the areas of plaque accumulation, gingival health, caries, restorations, bruxism, malocclusion, delayed eruption and missing teeth, oral infections, developmental anomalies, salivary flow, oral injuries, and oral defensiveness; (b) determine whether there is a significant difference between the oral conditions observed in children with an ASD who reside with their parents/guardians and those children with an ASD who live in the residential school; (c) determine whether there is a significant difference between the oral conditions observed in young children with an ASD and older children with an ASD; and (d) determine whether there is a significant difference between the oral conditions observed in children with an ASD and those children with other DD.

Review of Literature

The term Pervasive Developmental Disorder (PDD) refers to the overarching group of conditions to which autism spectrum disorder (ASD) belongs.² PDD is often used synonymously with the term ASD and consists of 5 subtypes. The 5 subtypes are: (1) autism disorder (AD); (2) Asperger's Disorder, also known as Asperger Syndrome (AS); (3) Rett's disorder; (4) childhood disintegrative disorder (CDD); and (5) pervasive developmental disorder-not otherwise specified (PDD-NOS).³ The most common and best studied form of ASD is AD. Individuals with ASD vary widely in abilities, intelligence, and behaviors. Symptoms may include problems using and understanding language; difficulty relating to people, objects, and events; unusual play with toys and other objects; difficulty with changes in routine or familiar surroundings; and repetitive body movements or behavior patterns.²

Limited studies are available that report oral health needs of children with an ASD. The studies that are available show that oral health in children with an ASD was not inferior to that of their healthy comparison group.^{4,5,6,7} Unclear is whether the oral health needs of children with an ASD parallel those of children with other DD. There is limited evidence-based research that provides a comparison between the oral health needs of children with an ASD and those with another DD.

Reports concerning dental disease in children with disabilities are contentious, and there are many differences of opinion regarding what extent children with disabilities differ in oral health and disease from children without disabilities.⁸ Surveys generally report more missing and fewer filled teeth among individuals with mental disabilities than among the general population, as well as poor oral hygiene, more inflammation or gingivitis, and more periodontal involvement.⁹ Other reports of the oral health needs of children with mental retardation (MR) include early childhood caries, prescription medicine-induced dental decay, altered salivary flow, tooth decay, malocclusion, fractured and nonvital teeth, soft tissue complications, bruxism, medicine-induced gingival overgrowth, delayed eruption, oral infections, and developmental defects.^{10,11,12} Although there appears to be no known autism-specific oral manifestations, oral problems might arise because of autism-related behaviors such as communication limitations, personal neglect, self-injurious behaviors, dietary habits, effects of medications, resistance to receiving dental care, hyposensitivity to pain, and possible avoidance of social contact.¹³ Research is necessary to determine whether behaviors and characteristics inherent in autism predispose those with an ASD to compromised oral health.

Parents consistently report dental care as one of the top needed services for their children with disabilities, regardless of age.^{1,14} Often parents and caregivers are unsuccessful in locating dentists who are capable and willing to provide oral care services for their child with special care needs.

Over 13% of US children and adolescents ages 17 and under have a special health care need and are almost twice as likely to have unmet oral health care needs as their typically developing peers across all income levels. Additionally, more than 20% of children and adolescents with a special care need have conditions that create financial problems for their families.¹⁵

Medicaid serves as a primary source of funding for dental services for a significant proportion of children with DD, yet only 1 in 5 Medicaid-eligible children receive any preventive dental services by age 20.¹⁶

The reason for inadequate access to oral care for individuals with disabilities is multifactorial. One salient reason is the lack of oral care providers who are willing to serve this population. Waldman and Perlman (2003) discussed reasons why providing dental care to people with MR and other DD is such a low priority.¹⁷ Many of these factors are associated with costs. The dentist's production decreases when extra time is needed for a procedure. Commonly, dentists refuse to accept Medicaid patients into their practice because of low reimbursement rates. Third-party support for the delivery of complex services is often limited.¹ Without third-party support, many parents cannot afford the high costs of dental services. In addition to being time consuming, providing oral care to individuals with DD, mental impairments, and behavioral challenges can be very difficult.¹¹ Many oral care providers enter their profession ill-prepared to address the oral needs of individuals with disabilities.

Most education programs for dentists and dental hygienists provide either extremely limited or no preparation for the care of individuals with disabilities. Essentially, half of dental hygiene school programs provide minimal didactic training and no clinical experience in the care of patients with special needs.¹² Currently, 50% of dental students report no clinical training in special need patient care and three-fourths report little to no preparation in provision of care for special needs patients. A 2001 study reported only 25% of national general dentists reported having hands-on experience with children with special needs in dental school.¹⁸ Dental hygiene programs fared no better. A 1994 study found that 48% of dental hygiene programs had 10 hours or less of didactic training and 57% reported no clinical experience.¹⁹ More recently, a 2000 study reported 53% of 175 practicing dental hygienists in Idaho had never received training directed toward patients with special needs.²⁰ In 2004, the Commission on Dental Accreditation adopted a new standard that dental and dental hygiene programs were required to implement beginning January 1, 2006. The new standard states that "Graduates must be competent in assessing the treatment needs of patients with special needs."²¹

Methods

Participants. Participants were solicited by mailing consent forms and cover letters to parents/guardians or direct caregivers of students from 3 different schools: a residential school for children with severe developmental disabilities (DD), including autism spectrum disorder (ASD), a university laboratory preschool for children with an ASD, and a public special education school. Parents/guardians or direct caregivers of all residential students were asked to participate, regardless of age and diagnosis of the children. Diagnosis with an ASD was the selection criterion for soliciting participants from the preschool and the public special education school. Children with other DD were solicited from the residential school to form a comparison group.

Of the 117 consent forms and cover letters mailed, 55 were returned, for a 47% return rate; 41 participants were from the residential school, 11 from the preschool, and 3 from the public school. Children's ages ranged from 2.6 to 21.0 years old. Children were placed into either a younger group (ages 2.6 to 5.0) or an older group (ages 9.0 to 21.0). No children younger than 2.6 years or between the ages of 5.1 and 8.11 years participated in this study. All of the children in the younger age group had a diagnosis of ASD. There were 40 boys and 15 girls. A total of 39 participants (27 boys and 12 girls) had an ASD diagnosis, and the remaining 16 participants (13 boys and 3 girls) had diagnoses of other DD that included mental retardation, Klinefelter's syndrome, seizure disorder, cerebral palsy, Down's syndrome, developmental delay, tuberous sclerosis, and/pr Angelman's syndrome. The diagnoses were reported initially on the survey by parents/guardians or caregivers, and then confirmed or corrected by the diagnosis reported in the child's school file.

The project was evaluated and approved by the Southern Illinois University's Human Subjects Committee as an expedited project, and by the Internal Review Board of the residential school.

Instruments. There were 12 categories (ie, bacterial plaque, gingivitis, caries, restorations, bruxism, malocclusion, delayed eruption/missing teeth, infections, developmental anomalies, salivary flow, injuries, and oral defensiveness) assessed

clinically using the evaluation criteria shown in Appendix A Appendix A part 2. The oral assessments were conducted by 2 registered dental hygiene faculty researchers, each with over 25 years of dental hygiene experience. A clinical observation form was developed to record the findings of the oral assessment. Each finding was expressed as a numerical value and entered into an Excel spreadsheet observation form.

Nine of the 12 oral conditions were scored dichotomously; the dental hygienists measured the presence or absence of an oral condition and assigned a 1 or 0 score, respectively. In addition, when an oral condition was present, the dental hygienists would determine whether it was in urgent need of care (UNC). A condition was considered to be in UNC if dental treatment was needed to avoid or eliminate pain or acute infection. In addition, oral defensiveness was scored using an 8-point ordinal scale that identified the level of cooperation exhibited during the oral assessment. Oral defensiveness was operationalized as the degree to which the participant cooperated with the oral assessment. Cooperativeness was scored according to participants' willingness to open their mouth, allow the researchers to lift the lip, insert the mirror, retract the cheeks, and view the oral conditions. A score of 0 indicated complete cooperation, whereas a score of 7 indicated aggressive refusal. Prior to analyzing group data using chi-square or Fisher's exact test of significance, oral defensiveness data were artificially dichotomized to categorize those children who willingly cooperated with the oral assessment by opening their mouth, allowing for the insertion of the mouth mirror, and lifting of their lips, and those who would not allow these procedures.

The remaining 2 oral conditions, salivary flow and malocclusion, were scored on a 4- and 5-category rating scale, respectively. As shown in Appendix A, the score assigned represented the quality of the oral condition.

The 2 dental hygienist raters scored the first 14 oral assessments independently to establish interrater reliability. The dental hygienists independently scored each of the categories for the 14 children. An agreement occurred when both dental hygienists scored the same category identically (eg, both scored either present or absent). A disagreement occurred when the raters differed on the scoring. Scoring reliability was established for each of the 12 oral categories by dividing the number of scoring agreements by the number of agreements plus disagreements multiplied by 100%. Across the 12 oral conditions, the mean interrater reliability coefficient was 91.1%. The range of interrater agreement across the 12 categories was 79% to 100%. The researchers conducted the remaining oral assessments together and collaborated on the scoring of each category. A total of 55 oral assessments were completed across 3 sites.

Procedure. A cover letter and consent form for the oral assessment were mailed either to the parents/guardians or primary caregivers to solicit participants. Follow-up letters or phone contacts were made by school staff to encourage participation; staff members were provided a phone script for consistency of solicitation. Consent forms were requested to be returned to the schools. Oral assessment data were coded to protect the participants' confidentiality.

Oral assessments were conducted by 2 registered dental hygienists who were dressed in muted colored street clothes. Immediately prior to each oral assessment, direct care staff members were asked to give suggestions for the appropriate stimulus to prompt participants to open their mouth and to identify the behavioral approach most likely to be effective for each participant.

Participants were instructed to sit either in a portable dental chair, a straight-back chair, or on the floor. After a brief greeting, the researchers donned gloves and offered participants a new toothbrush. One of the researchers then stated that she needed to look in the participants' mouths. If participants opened their mouths, the researchers moved within viewing distance and the oral conditions were scored based on those that were visible. Next, the hygienist would show the participants a disposable mouth mirror and state, "I need to see better." The mouth mirror would be inserted for the inspection of the occlusal and lingual surfaces of teeth. Finally, the hygienist would state that she was going to touch participants' face and the lips. If participants were cooperative, the cheeks were retracted for inspection of the facial surfaces of the teeth. If participants were compliant, the entire oral assessment was completed in approximately 3 minutes.

Participants were considered to be uncooperative if they refused to willingly open their mouths and allow the insertion of the mouth mirror. If participants were uncooperative, additional behavioral approaches were used to encourage cooperation. Those approaches included using verbal instruction; modeling mouth movements; prompting mouth opening with a toothbrush; using a puppet; distracting the child with a favorite toy; providing positive reinforcement for opening mouth; providing negative reinforcement by escape after the oral assessment was completed; singing songs; including the parent, caregiver, or school staff in the examination process; using a picture activity schedule; and using a social story. For participants with a history of aggressive or extremely uncooperative behavior, parents, caregivers, or school staff would

decide whether to conduct the oral assessment. If necessary, parents or caregivers would assist by giving instructions or providing gentle restraint.

A letter was sent to the parents or caregivers summarizing the children's oral conditions, and a report was placed in the children's medical records at the residential school. Children from the residential facility who were in need of care were referred for dental treatment.

Results

Data were analyzed for all 55 participants with an autism spectrum disorder (ASD) and those with other developmental disabilities (DD). Descriptive statistics are used to present frequency data for each condition assessed. Additionally, Fisher's exact test of significance was used in cases where the smallest expected frequency was less than 5. Otherwise, chi-square tests were used to determine the significant difference between each group and oral condition.

Table I shows frequency and percent of the sample on 12 oral conditions for participants with an ASD. The upper portion of the table shows 10 oral conditions evaluated (columns) and the 4 scoring options (rows). In round figures, the table shows that 85% of the 39 participants with an ASD had visible plaque, with 1 participant in Urgent Need of Care (UNC); 62% had visible gingivitis (2 participants in UNC); 21% had visible caries (2 participants in UNC); 15% had restorative treatment (fillings) that indicate previous dental treatment; 44% had clinical signs of bruxism; 5% had delayed eruption or missing teeth (with 1 participant in UNC); 0% appeared to have an oral infection considered to be in UNC; 0% had a developmental anomaly involving the oral cavity; 26% had an oral injury with 23% involving teeth and 2% involving the cheeks, lips, tongue, or gingiva; and 49% were considered to be orally defensive.

Table I Oral Assessment Results for Participants with an ASD (n=39)
 Number of participants (and frequencies) manifesting the criteria for each oral condition evaluated.

Scoring Options	Visible Plaque	Visible Gingivitis	Visible Caries	Visible Restorations	Clinical Signs of Bruxism	Delayed Eruption	Oral Infection	Develop anomalies	Oral Injuries	Oral Defensiveness
No	6 15.4%	15 38.5%	31 79.5%	33 84.6%	22 56.4%	37 94.9%	39 100%	39 100%	29 74.4%	20 51.3%
Yes	33 84.6%	24 61.5%	8 20.5%	6 15.4%	17 43.6%	2 5.1%	0 0%	0 0%	10 25.6%	19 48.7%
UNC	1 * 2.6%	2 * 5.1%	1 * 2.6%							

* The columns with numbers and percentages in the UNC row add to more than 39 and 100% because scores shown in the UNC row are also displayed in the Yes row.
 Only three participants were in urgent need of care, one of which manifested two conditions that were in UNC, accounting for 4 scores shown.

	Class I Normal	Class II	Class III	Crowding	Crossbite
Occlusion (1 not scored)	18 46.2%	14 35.9%	7 17.9%	5 12.8%	1 2.6%

	Normal	Excess	Dry	Mucous
Salivary Flow	34 87.2%	5 12.8%	0 0%	0 0%

Participants may receive more than one score for occlusion, for example Class II and crowding, therefore the numbers are greater than 39 and the percentage greater than 100%.

The bottom portion of Table I shows data for occlusion and salivary flow for participants with an ASD. The table shows that 54% of the children had abnormal occlusion with 36% manifesting Class II occlusion and 18% manifesting Class III occlusion; 13% had crowding and 2% had a crossbite. The lowest panel of Table I presents salivary flow results. The table shows that 13% had excess salivary flow, 0% had xerostomia, and 0% had saliva with a mucous consistency.

The frequencies and percentages in Table I include the participants whose conditions met not only the criteria for "yes" but also for UNC. The conditions that were considered to be in UNC appeared to be well established and needed therapeutic intervention before more serious emergency situations such as abscesses or acute infections developed. Three of the participants had 4 conditions that were considered to be in UNC. One participant had excess plaque accumulation and severe gingivitis, one participant had severe gingivitis, and one participant had severe decay.

Oral assessment results were compared between (a) children with an ASD who live with their parents/guardians and those who live at a residential school; (b) children with an ASD and children with another DD, not including ASD; and (c) children with an ASD ages 2.6 to 5.0 and those ages 9.0 to 21.0. Chi-square analyses and Fisher's exact test of significance are shown in Tables II, III and IV.

Table II Comparison of the Presence of Oral Conditions in Children with an ASD who Reside with Parents/Guardians vs. Children with an ASD who Live at a Residential School

Oral Condition Present	Lives with parents/guardians (n=14)		Lives at residential school (n=25)		Chi-square	Probability
	Frequency	Percent	Frequency	Percent		
1. bruxism	10	71%	7	28%	6.88	p<.01
2. malocclusion	8	57%	13	52%	.09	
3. oral defensiveness	7	50%	12	48%	.91	
Fisher's p-value						
1. plaque	11	79%	22	88%	.65	p<.01
2. gingivitis	3	21%	21	84%	.00	
3. visible caries	5	36%	3	12%	.11	
4. restorations	1	7%	5	20%	.39	
5. delayed eruption	0	0%	2	8%	.53	
6. oral infections	0	0%	0	0%		
7. developmental anomalies	0	0%	0	0%		
8. oral injuries	2	14%	8	32%	.28	
9. abnormal salivary flow	1	7%	4	16%	.64	

Table III Comparison of the Presence of Oral Conditions in Children with an ASD with Children with Another DD

Oral Condition Present	Children with an ASD (N=39)		Children with another DD (N=16)		Chi-square	Probability
	Frequency	Percent	Frequency	Percent		
1. restorations	6	15%	5	31%	1.78	p <.01
2. bruxism	17	44%	5	31%	0.72	
3. oral injuries	10	26%	10	63%	6.66	
4. malocclusion	21	54%	11	69%	0.31	
5. oral defensiveness	19	49%	8	50%	1.03	
Fisher's p-value						
1. plaque	33	85%	15	94%	0.66	p <.05 p <.01
2. gingivitis	24	62%	14	88%	0.11	
3. visible caries	8	21%	4	25%	0.48	
4. delayed eruption	2	5%	2	13%	0.57	
5. oral infections	0	0%	1	6%	0.29	
6. developmental anomalies	0	0%	3	19%	0.02	
7. abnormal salivary flow	5	13%	8	50%	0.00	

Table IV Comparison of the Presence of Oral Conditions in Children with an ASD ages 2.5-5.0 with Children with an ASD ages 9.0-21.0
 (There were no participants between the ages of 5.1 and 8.11)

Oral Condition	Ages 2.5 to 5.0 (n=10)		Ages 9.0-21.0 (n=29)		Chi-square	Probability
	Frequency	Percent	Frequency	Percent		
1. oral defensiveness	7	70%	12	41%	2.44	
2. malocclusion	5	50%	16	55%	.08	
						Fisher's p-value
1. plaque	8	80%	25	86%	.64	
2. gingivitis	1	10%	23	79%	.00	p <.01
3. visible caries	3	30%	5	17%	.16	
4. restorations	1	10%	5	17%	.55	
5. bruxism	10	100%	7	24%	.00	p <.01
6. delayed eruption	0	0%	2	7%	1.00	
7. oral infections	0	0%	0	0%		
8. developmental anomalies	0	0%	0	0%		
9. oral injuries	1	10%	9	31%	.18	
10. abnormal salivary flow	1	10%	4	14%	1.00	

When comparing the children based on type of residency, a statistically significant difference was detected with the presence of gingivitis and bruxism. Chi-square and p-values from Fisher's exact test of significance for each oral condition are presented in Table II. Fisher's exact test of significance indicated that children of the residential school had significantly more gingivitis than children who resided with their parents. In contrast, children who lived with their parents or guardians manifested more clinical signs of bruxism, $X^2 (1, N=39) = 6.88, p < .01$. There were no statistically significant differences between children who reside with their parents and those who live at the residential school for the other oral conditions assessed.

Table III shows results for the oral conditions for children with ASD and DD. When children with an ASD were compared to children with another DD, the latter had significantly more oral injuries, $X^2 (1, N=55) = 6.66 p < .01$, developmental anomalies (Fisher's p-value=.02), and abnormal salivary flow (Fisher's p-value=.00) than children with an ASD. None of the other oral conditions were found to be statistically significant between children with an ASD and those with another DD.

Children with an ASD were compared according to 2 age groups (See Table IV). Older children (ages 9.0 to 21.0) demonstrated significantly more gingivitis than the younger group (ages 2.6 to 5.0). In contrast, the younger age group showed more clinical signs of bruxism than the older children. None of the other oral condition differences were found to be statistically significant between the 2 age groups.

In addition to analyses found in the tables, frequencies associated with the levels of oral defensiveness are presented below. Of the participants with as ASD, 49% were orally defensive compared to 50% of children with other DD. Three participants with an ASD displayed aggressive behaviors toward the dental hygienists either by hitting, biting, pinching, or grabbing for the dental hygienist's eyeglasses.

Limitations and Conclusion

The use of a nonprobability sample limits the generalizability of the results of this study. Because of confidentiality and child protection laws, it is difficult to obtain a representative sample of individuals with an autism spectrum disorder (ASD); therefore, a convenience sample was used. Other limitations are the relatively small number of participants involved in the study and unequal size of the subgroups. Also, the categories of age and residence were not independent of each other. Caution is required in the interpretation of the individual chi-square analyses because as the number of nonindependent tests of significance increases, so does the probability of obtaining one or more Type I errors.²² Evaluator bias must be

considered, even though steps were taken to establish interrater reliability. Lack of an intense overhead dental light and improper participant positioning made it difficult to see surfaces of some teeth. Ideally, oral assessments should be conducted with the patient reclined in a dental chair while using adequate lighting.

This study showed that with the exception of bruxism and gingivitis, there was not a significant difference in the oral health status of children with an ASD when comparing younger children to older children or when comparing children with an ASD who resided with their parents to those who lived at the residential school. Younger children who resided with their parents showed signs of bruxism significantly more and older children of the residential school had significantly more gingivitis than their comparison groups. Since few older children with an ASD showed signs of bruxism, young age rather than ASD may be the factor associated with bruxism. Many parents of children with an ASD express concern about their child's bruxism, yet bruxism is common in 13 to 26% of all children.²³ Additional studies are needed to investigate whether bruxism is a unique problem for children with an ASD. It is not surprising to find a significantly higher incidence of gingivitis in older children who lived at the residential school. Heavy plaque accumulation and hormonal influences are likely explanations for the high occurrence of gingivitis in this group. Moreover, children of the residential school may have inadequate oral care skills or may rely on caregivers who are unskilled in providing oral care to others, resulting in excessive plaque accumulation and subsequent gingivitis. Of concern, are the consequences of developing dental diseases as a result of constant plaque accumulation over time.

Considering the high incidence of oral defensiveness, one would expect the large amount of plaque accumulation found in children with an ASD. The presence of plaque was consistently high for all groups assessed. The risk of developing oral disease is increased when children resist daily oral hygiene as well as professional oral care procedures. Interestingly, the presence of caries in the participants was slightly lower than what is reported for children without disabilities in the Surgeon General's Report. According to *Oral Health in America*, over 50% of all 5.0-to-9.0-year-old children in the US have at least one cavity or filling.¹ Since it is unknown whether this sample is representative of the population of children with an ASD, further investigation into the caries rate of children with an ASD is warranted. Oral infections, other than gingivitis, and developmental anomalies were not reported for any children with an ASD.

Oral conditions were similar when children with an ASD were compared to those with another developmental disability (DD), except when oral injuries, developmental anomalies, and salivary flow were considered. Children diagnosed with a DD, other than ASD, had significantly more oral injuries, developmental anomalies, and abnormal salivary flow than the children diagnosed with an ASD.

Oral defensiveness appeared to occur slightly less often in older children with an ASD, with approximately 60% meeting the criteria for compliance compared to only 30% of the children in the younger group with an ASD. No single behavior management approach was effective with all of the children. Most children appeared to understand that they were expected to open their mouth when the tooth brush was presented as a stimulus. Very few children were willing or able to hold their mouth open long enough for any procedure other than a simple visual inspection. The behavior and cooperation needed to complete the oral assessment cannot be compared to that required for intraoral procedures involving sharp dental instruments. Although the researchers were able to score most of the children on all oral conditions, it cannot be assumed that any intraoral procedure using dental instruments would be feasible without behavioral intervention, sedation, or restraint.

At the time of this study, no national studies had been conducted to determine the prevalence of oral and craniofacial diseases among the various populations with disabilities and studies of the oral health needs of subgroups within the disabled population were lacking.¹ Existing publications report data for various populations with disabilities, but it is difficult to generalize findings to the various subgroups because of the heterogeneous nature of the population. Moreover, little is written about the oral status of children with an ASD. Additional studies are needed to expand the data base and determine whether children with an ASD are living with compromised oral health. The oral health status of children with an ASD needs further investigation to determine how they compare to other populations including typically developing age mates.

Evidence-based behavioral management approaches for children with ASD need to be developed to improve compliance with oral care procedures so parents, caregivers, and oral health care providers will have more efficient ways to promote oral health in children with an ASD. Institutes of dental and dental hygiene education can play an integral role in increasing

access to care for this population. In addition to conducting research and providing services to individuals with an ASD, it is the responsibility of dental and dental hygiene schools to adequately prepare their graduates to meet the needs of children with ASD. Mandating educational preparation in dental and dental hygiene programs through accreditation standards may help alleviate the perceived lack of preparation future dentists and dental hygienists have in the treatment of special needs individuals.

Appendix A

Appendix A Evaluation Criteria for Scoring Oral Conditions

Condition	Scoring	Criteria
Plaque	0= no visible plaque 1= visible plaque (Silness & Loe PI 2) 10= UNC abundance of soft matter (Silness & Loe PI 3) Teeth assessed: anterior teeth only	Assessment of extent and thickness of plaque. Use of Silness & Loe Plaque Index: Yes= (PI 2) moderate accumulation of soft deposits within the gingival pocket that can be seen with the naked eye on the tooth or gingival margin. UNC= (PI 3) abundance of soft matter within the gingival pocket and/or on the tooth and gingival margin.
Gingival	0= no visible gingivitis 1= visible gingivitis 2= hyperplasia involving one or more teeth where tissue covers cervical 1/3 10= UNC spontaneous bleeding	Assessment of presence of gingivitis based on color, consistency, size/contour, and bleeding.
Caries	0= no visible cavitated lesions 1= suspicious cavitated lesion 10= UNC lesion .5mm or larger	Assessment of the integrity of enamel.
Restorations	0= no visible restorations 1= visible restorations	Assessment of past restorative care.
Bruxism	0= no visible attrition 1= visible attrition 10= UNC pulp visible	Assessment of enamel status as related to grinding.
Malocclusion	1= normal 2= Class II Division 1 Class II Division 2 3= Class III 4= Crowding 5= Crossbite 10= UNC malocclusion causing tooth fracture or potential for impaired chewing	Assessment of occlusion based on Angle's Classification of Occlusion. Patients may be scored in more than one category.
Delayed eruption/Missing teeth	0= WNL 1= anterior involvement 2= posterior involvement 10= UNC retained deciduous teeth, contributing to malocclusion	Assessment of the eruption patterns and presence of teeth.

Appendix A part 2

Infections	0= none 1= yes 10= UNC abscesses, yeast	Assessment of the mouth for infections involving teeth and soft tissues.
Developmental anomalies	0= none 1= yes 10= i.e. enamel dysplasia, anodontia, supernumerary teeth, microdontia, hypodontia, fusion, gemination, amelogenesis imperfecta, others.	Assessment of the development of oral structures.
Salivary flow	0= normal 1= excess 2= dry 3= mucous	Assessment of the quality and quantity of saliva.
Oral Injuries	0= none 1= soft tissues 2= teeth 10= UNC apparent recent or acute injuries	Assessment of the mouth for injuries to the teeth and soft tissues. Oral injuries are operationally defined as any soft tissue lesion resulting from injury (accidental or SIB) OR tooth fractures as confirmed by the caregiver or parent.
Oral defensiveness	0= opens willingly, allows clinician to lift lip, allows mirror insertion all with verbal instruction 1= opens willingly, allows clinician to lift lip, allows mirror insertion with prompt 2= opens and allows clinician to lift lip, but does not allow mirror insertion 3= opens only 4= allows clinician to lift lip only 5= shows anterior teeth only 6= refuses passively 7= refuses aggressively	Assessment of the patient's acceptance of the oral assessment. Participants were not considered to be orally defensive if they willingly opened their mouth and allowed for the insertion of the mouth mirror (scores 0 & 1). Participants were considered to be orally defensive if they did not willingly open and allow for the insertion of the mouth mirror (scores 2-7).

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Notes

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Articaine: A New Alternative in Dental Hygiene Pain Control

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***Purpose.** Local anesthesia administration is integral to pain control in dental hygiene. As of 2006, 40 licensing jurisdictions in the United States include local anesthesia administration in the scope of dental hygiene practice. While the risks associated with use of intraoral local anesthesia are not great, careful attention to recommended practices helps foster patient safety. As new products are introduced, it is important to study their advantages and limitations to see where they fit into dental hygiene practice. An amide local anesthetic agent, articaine, that has been available in Europe for over 20 years, was approved for US distribution in 2000.*

***Methods.** The purpose of this article is to review the current peer reviewed literature on the characteristics of articaine so it can be incorporated into dental hygiene practice when indicated.*

***Results.** Rather than simply using one agent for all procedures, patient care is enhanced when local anesthetics are selected based on the unique needs of the procedure, the patient and with safety and effectiveness in mind.*

Keywords: Local anesthetics, analgesia and anesthesia, dental hygiene car, pain control

Introduction

The first edition of what came to be a classic textbook in dental hygiene, *Clinical Practice of the Dental Hygienist*,¹ was published in 1959. Esther Wilkins, RDH, DMD, and Patricia McCullough, RDH, devoted one page to the topic of pain control during scaling procedures. The authors noted that, under the dentist's direct supervision, topical anesthetic could be used for patients with a low pain threshold, patients who were nervous, or to gain cooperation of apprehensive patients. For isolated patients who experienced "supersensitive" gingiva, injection of a local anesthetic by the dentist prior to scaling was the only answer.

The most recent edition of *Clinical Practice of the Dental Hygienist*, the ninth, was published in 2005.² A whole chapter is dedicated to the topic of pain and anxiety control, with the understanding that pain management is an integral part of dental hygiene practice. In the past 5 years, 13 licensing jurisdictions (Connecticut, District of Columbia, Kentucky, Massachusetts, Michigan, North Dakota, New Hampshire, New York, Ohio, Rhode Island, Tennessee, Virginia, and West Virginia) have added the administration of local anesthesia to the practice of dental hygiene.³ Currently, 38 licensing jurisdictions (37 states and DC) include the administration of block and infiltration anesthesia for the dental hygienist. Only New York and South Carolina limit dental hygiene local anesthesia administration to infiltration injections. Continued resistance by the remaining 11 states could be due to perceptions that procedures completed by dental hygienists do not warrant pain control, or that the risk of local anesthesia administration is high. However, it is clear that the trend is to include local anesthesia into the scope of dental hygiene practice.

Local anesthetics are the drugs most widely used in provision of oral health care. Malamed estimates that over 300 million local anesthetic injections are administered on an annual basis in the United States.⁴ With nearly 6 million injections each week in the United States, there are few reports of adverse events as a result of intraoral local anesthesia use by dentists or dental hygienists. Scofield and colleagues surveyed 26 state dental boards to determine the extent of disciplinary actions against dental hygienists and dentists related to the use of local anesthetics.⁵ States were included if they had included local anesthesia administration by the dental hygienists for at least one year. Of the 18 state boards that responded, none reported a disciplinary action against a dental hygienist related to the administration of local anesthesia. This confirms a previous finding by Sisty-LePeau that no adverse patient reactions of formal complaints were recorded against dental hygienists using local anesthesia.⁶

While local anesthesia administration by dental hygienists has grown to be an integral component of dental hygiene practice, and has shown few, if any, adverse reactions, the administration of local anesthetic is not totally free from risk. Careful attention to the patient's health status and adherence to recommended techniques help keep the risks as low as possible. Researchers and manufacturers are continually working to enhance existing products and techniques for intraoral pain control. Over the past years, new anesthetic agents and techniques have been introduced to improve patient safety and success rates in local anesthesia. This article will review safety and effectiveness of articaine, an anesthetic agent recently introduced in the United States for consideration as part of their pain control armamentarium.

Articaine: a new local anesthetic agent

Since the introduction of procaine (Novocain) in 1904, the search for an ideal local anesthetic agent has been ongoing. The ideal agent would take effect immediately, produce profound anesthesia, pose no risk of local or systemic toxicity, and be non-allergenic. Early anesthetic agents belonged to the ester group, and while they were acceptable, they were not ideal. Amide agents were introduced in 1948. They had quicker onset, longer duration, but allergenicity was the factor that gave amides an advantage over ester agents. Amide agents were far less allergenic than ester agents. Lidocaine, the first amide agent to be marketed, quickly replaced procaine as the dental local anesthetic agent of choice.⁷ As of 1996, the last remaining ester local anesthetic product in a dental cartridge, a combination of procaine and propoxycaïne, was removed from the US market.⁴ There are currently 5 injectable amide agents available to US dental hygienists when pain control needs require local anesthetic administration: lidocaine, prilocaine, mepivacaine, bupivacaine, and the relative newcomer, articaine.

Articaine has been available in Europe for over 20 years, but was approved for use in the United States only in 2000.⁸ Articaine is marketed as Septocaine (Septodont, Inc, New Castle, DE; www.septodontusa.com) and Zorcaine (Cooke-Waite-Eastman Kokak, Rochester, NY) in the United States.⁸ Although articaine is grouped as an amide agent, it has unique properties that distinguish it from the other amides. In addition to its amide linkage, articaine also has a thiophene or sulfur-containing ring and an ester side chain.⁹ The thiophene ring gives articaine a higher lipid solubility, which can impart better diffusion through tissues and enhanced ability to cross lipid membranes.¹⁰ The ester side chain contributes to the rapid breakdown of articaine once it is injected.¹¹ Amide local anesthetic agents are generally metabolized by microsomal enzymes in the liver; articaine, with its ester side chain, is hydrolyzed primarily by plasma esterases. Plasma hydrolysis is much quicker, resulting in a shorter half life for articaine. The clinical advantage of a short half life is that there is less articaine accumulated and circulating in the blood. A shorter half life can reduce systemic toxicity if additional doses are administered over time as might occur in a full mouth disinfection situation. In articaine, the theoretical advantage of shorter half life with less toxicity compared to other amide agents may be offset by the fact that articaine is marketed as a 4% solution.¹¹ The maximum recommended dose of articaine for a healthy adult patient is 7 cartridges compared to 8 cartridges for lidocaine.^{4,8}

For all dental local anesthetics, toxicity is reduced by slow injection (giving the body time to metabolize the agent), aspiration prior to injection (reducing the risk of intravascular injection and higher systemic levels of the drug), careful review of history (identifying patients who may require lower doses or different agents), and dosage control. Malamed

notes that administration of too large a dose of local anesthetic in relation to patient age and weight is **the most important cause** of serious local anesthetic reactions in dentistry.⁴ As dental hygiene clinicians consider treatment plans that include full mouth disinfection, the risk of overdose reactions can be lowered by administering anesthesia to one quadrant and treating that area before administering anesthesia to the next quadrant regardless of the agent selected.

One final unique aspect of articaine is that, in spite of its ester linkage, it is not linked to higher rates of allergy like the ester anesthetic agents. Unlike ester anesthetic agents, articaine is not metabolized to PABA, the agent responsible for ester anesthetic agent allergic reactions. Yagiela notes that early information related to articaine suggested that it should not be used with patients who have an allergy to "sulfa," possibly due to the sulfur atom in the chemical structure.¹¹ This is **not** the case; there is no relationship between allergy to sulfonamide-related drugs and allergy to articaine.¹¹ Therefore, articaine has an allergy profile that is similar to those of other amides. Allergic reactions to amide agents are extremely rare.⁴ Malamed notes that follow-up evaluations of reported cases of amide allergy usually find the case describing overdose, idiosyncrasy, or psychogenic reactions. Further, allergy to one amide local anesthetic does not preclude use of other amide agents.⁴ So, allergy to lidocaine will not preclude use of articaine, or any of the other amide agents. This makes it essential that clinicians have more than one injectable local anesthetic agent available in practice. Table I details the characteristics of the currently available injectable dental local anesthetics.⁴

Table I Summary Characteristics of Injectable Dental Anesthetics

Anesthetic Agent*	Onset Minutes	Duration (nerve block)	MRD** # cartridges	Patient Considerations
Articaine 4%	~1 to 3	Intermediate 60-75 min.	500 mg 7 cartridges	
Bupivacaine 0.5%	~ varies, but often 6-10	Long 90-180 min.	90 mg 10 cartridges	For lengthy procedures or to manage significant postoperative pain
Lidocaine 2%	~2 to 3	Intermediate 60 min.	300 mg 8 cartridges	Pregnancy Class B; elective treatment should be deferred; if anesthetic is indicated during pregnancy, use smallest dose possible; ideally in 2 nd or 3 rd trimester. ⁷
Mepivacaine 3% (no vasoconstrictor)	~1 to 2	Short 20-40 min.	300 mg 5.5 cartridges	Least vasodilating; provides longer duration when a vasoconstrictor is contraindicated.
Prilocaine 4% (no vasoconstrictor)	~2 to 4	Intermediate- 40-60 min.	400 mg 5.5 cartridges	Duration of plain solution varies by injection type; Relatively contraindicated in patients with decreased oxygen carrying capacity. ^{***}
Prilocaine 4%	~2 to 4	Intermediate 60-90 min.	400 mg 5.5 Cartridges	Relatively contraindicated in patients with decreased oxygen carrying capacity. ^{***}

Source: Malamed SF. *Handbook of Local Anesthesia*. 5th ed. St. Louis, MO: Elsevier Mosby; 2004.

* Unless otherwise noted, details are for cartridges containing local anesthetic agent AND vasoconstrictor; use of vasoconstrictor is recommended unless contraindicated since it reduces systemic levels of anesthetic agent.

** Maximum recommended dose (MRD) for healthy adult patient; pediatric dose should be calculated using mg/kg or mg/lb.

*** Congenital or idiopathic methemoglobinemia, hemoglobinopathies, anemia, cardiac or respiratory failure evidenced by hypoxia

Research on articaine

Given its unique characteristics, potential advantages of articaine include profundity of anesthesia, longer duration, faster onset, and less toxicity. Ninety-four dentists participated in a practice-based study of articaine after its introduction into the US.¹² The study reported perceptions of practicing clinicians using articaine in 13 000 procedures classified as simple or complex. Eighty-four percent reported that articaine produced anesthesia more profound than other routinely used anesthetics. (Lidocaine was the agent the majority of practitioners reported as their "usual" anesthetic agent.) Seventy-four percent reported faster onset with articaine; 54% reported greater success with patients who were difficult to anesthetize; and 45% reported that infiltration provided excellent anesthesia on both the mandible and the maxilla, including excellent for root planing. A smaller percentage (23%) reported a reduced number of missed blocks using articaine. Higher cost

was the one disadvantage reported by practitioners. Adverse reactions reported by the practitioners included 2 cases of paresthesia and one case of tissue sloughing. Ninety seven percent of the evaluators rated articaine as excellent or good, and 71% said it would replace the products they currently use. Clinical Research Associates (CRA) concluded that articaine had fast onset, very profound anesthesia, and infiltration properties that often allowed restorative procedures without the need for a block.

It is important to obtain perspectives of practitioners in evaluating new products, but it is also essential that new products are tested in controlled trials, which have the benefit of reducing bias. A search of PubMed with limits to randomized trials in the past 10 years yielded 10 published reports comparing articaine to one of the available amide agents. Four papers reported superior results with some aspect of articaine-longer duration, longer analgesic effect, or more episodes of no response to pulp tester in studies ranging in size from 20 to 62 patients.^{13,14,15,16} Six randomized, double-blind studies that ranged from small (20 patients) to large (1324 patients) found articaine comparable to other commercially available intraoral local anesthetics.^{10, 17-21} The largest studies were those by Malamed et al.^{10, 20, 21} He reported on 3, identical single-dose, randomized, double-blind, parallel-group, active-controlled multicenter studies involving 1324 patients conducted to test the safety and efficacy of articaine. The authors concluded that articaine was well tolerated, produced clinically effective pain control during most procedures, and had onset and duration comparable to lidocaine. In short, controlled clinical trials have failed to demonstrate a superiority of articaine, but have shown that it is comparable to available dental local anesthetics.

While reported clinical trials have concluded that articaine is a safe effective addition to the dental armamentarium, there have been reports suggesting that articaine use is associated with higher rates of paresthesia (persistent anesthesia). The practitioner based study reported by CRA noted 2 cases of paresthesia after use on 13 000 patients.¹² One patient had placement of an endosseous implant and the other had an intraosseous injection making it difficult to determine if paresthesia was the result of the procedure or the local anesthetic agent. Haas conducted a 21-year retrospective study of paresthesia of the lingual and inferior alveolar nerves after mandibular block injections and restorative procedures (no surgery). While the overall risk was small, the use of articaine and prilocaine was associated with an elevated risk of paresthesia.²²

Any trauma to nerve tissues may lead to paresthesia.⁴ Most paresthesias associated with dental procedures have been related to surgical procedures in the mandibular posterior region. In a small percentage of cases of dental related paresthesia, trauma from the needle, a contaminated solution, or the agent itself, may be the cause of paresthesia and may occur even with strict adherence to proper protocol. Since both prilocaine and articaine are used in a higher concentration (4% solutions), the possibility exists that local anesthetics of higher concentration are more neurotoxic.⁴ At this point, no controlled clinical trials or prospective trials have confirmed the elevated risks of paresthesia associated with articaine and mandibular injections. Hawkins²³ reported that "high" block techniques (such as the Akinosi or the Gow Gates technique as opposed to the traditional inferior alveolar block) have not been associated with increased risk of paresthesia. He further suggests that these high approaches may hold promise for reducing the risk of paresthesia even further. Certainly, it is prudent to use informed consent any time local anesthesia is administered so the patient is aware of risks of adverse reactions, no matter how small.

Conclusions

New local anesthetic agents are periodically introduced and may have superiority over existing agents. Articaine has been used with good results in Europe for over 20 years. While it has not yet demonstrated superiority over existing local anesthetic agents in controlled clinical trials, it is comparable and some clinicians have indicated a preference for articaine. Articaine provides an option for pain control in dental hygiene practice. For the dental hygienist, articaine can be used when an intermediate duration anesthetic, such as lidocaine with vasoconstrictor, would be indicated. Articaine also provides the opportunity for research specific to dental hygiene practice. Dental hygiene researchers can build on the dental hygiene body of knowledge by examining articaine and other pain control agents and their effectiveness in dental hygiene practice. Dental hygienists should test this agent out when indicated and watch for future research to clarify its benefits and limitations.

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Notes

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An Examination of the Bleeding Complications Associated with Herbal Supplements, Antiplatelet and Anticoagulant Medications

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Dental professionals routinely treat patients taking prescription, nonprescription, and herbal medications that are known or have the potential to alter bleeding. Prescription anticoagulant and antiplatelet medications, as well as over-the-counter drugs such as aspirin, are typically taken to reduce the risk of thromboembolic events, including stroke. Herbal supplements are widely used for a variety of indications, and both patients and health care practitioners are often unaware of the anticoagulant and antiplatelet effects that occur as either predictable pharmacologic effects or adverse side effects of herbal medicines. In addition, patient use of these herbal supplements is usually undisclosed to health care providers. The purpose of this literature review is to examine the mechanisms of action of drugs and herbs that alter bleeding, and to educate dental professionals as to the proper care and management of patients using these medications. Decision-making strategies, including interpretation of laboratory tests, and when to discontinue the use of these medications are discussed. Patients undergoing routine dental and dental hygiene procedures do not need to discontinue the use of anticoagulant and antiplatelet medications. However, alterations in drug use may be required for those patients undergoing invasive surgical procedures. It is recommended that herbal supplements must be discontinued 2 weeks prior to receiving invasive surgical procedures. Dental practitioners must learn to weigh the risks of discontinuing drug therapy against the potential risks to patients, and implement risk reduction strategies to minimize adverse bleeding complications associated with dental treatment.

Keywords: Anticoagulants, Antiplatelet medications, Aspirin, Bleeding, Clotting, Dental treatment, Garlic, Ginger, Ginkgo biloba, Ginseng, Herbal supplements, NSAIDS, Platelets, St. John's wort, Warfarin

Introduction

Cardiovascular disease, including ischemic coronary heart disease, stroke, and peripheral vascular disease, is the leading cause of death in the United States.¹ Stroke is the third leading cause of death, and is the primary cause of adult disability.² Yearly, over 1 million Americans experience new or recurrent myocardial infarction (MI) or fatal coronary heart disease. Most of these events occur in the elderly or in those with known risk factors for cardiovascular disease.³ The age-adjusted mortality rate due to coronary heart disease, cerebrovascular disease and atherosclerotic disease is 194 per 100 000 cases, which translates to more than 500 000 deaths per year.¹ These leading causes of death correspond directly to chronic

conditions experienced by many patients, especially the elderly, who may live for decades with illnesses that are typically controlled with medication use.^{2,4}

Given these disease trends, dental professionals are seeing more patients taking anticoagulant and/or antiplatelet medications to prevent arterial or venous thrombosis and stroke.⁵ Controversy and confusion persist as to whether these medications actually pose a risk for significant postoperative bleeding following invasive dental procedures. However, excessive or life-threatening bleeding caused by medication use in the dental office is an extremely rare event, even among patients at risk.^{6,7}

Determining the proper management strategy to safely treat patients taking anticoagulant and antiplatelet medications must take into account the risk of thrombus formation in the patient. The clinician must weigh the risks of potential bleeding complications against the potential risks associated with altering the medications used to reduce significant cardiovascular risk.⁶ According to Little and associates (2002), risk of "thrombosis is of greater overall clinical importance in terms of morbidity and mortality than all of the hemorrhagic disorders combined."⁵

The decision to alter the patient's medication regimen, by either lowering the dosage of or discontinuing the medication prior to dental treatment, is not supported by clinical studies in the literature.^{6,8,9} Yet, many dental clinicians continue to recommend medication alteration as a management strategy, with the belief that they are promoting patient safety. Proposed regimens are based on case reports, opinions published in the literature, and habit, and are not supported by clinical data.^{6,9}

The justification for reducing or withdrawing anticoagulant medication prior to dental treatment can be dated back to a time when less than a dozen case reports in the literature reported excessive bleeding following dental treatment in patients taking warfarin. However, it is important to note that during the timeframe when those case studies were published, the prothrombin time test (PTT) was used to evaluate the effectiveness of warfarin; but, testing was not yet standardized, and variations in clinical efficacy were bound to occur.^{6,10,11} Today, standardized measures, such as the International Normalized Ratio (INR), are used to assess coagulation time in patients taking warfarin, and guidelines for therapeutic ranges of anticoagulation have been established.¹² These guidelines make it easier for the clinician to predict the risks for bleeding in medicated dental patients.

A variety of other medications can contribute to bleeding complications in dental patients, including nonsteroidal anti-inflammatory analgesics, hormones, herbs, and dietary supplements. It is critical that dental professionals conduct a pharmacologic history review as a component of a comprehensive review of systems for all patients who present for oral health care. Assessing the patient's prescription and over-the-counter (OTC) medication use provides important information about the patient's current medical status, disease severity, compliance with drug and treatment recommendations, and orientation to health and wellness.¹³

Understanding medication use helps dental professionals anticipate and prevent oral and systemic complications associated with adverse drug events.¹⁴ Drug-induced adverse bleeding events can happen outside of the dental office, as well as during treatment. Assessing potential bleeding complications associated with medication and supplement use is a vital service that dental professionals provide to their patients.¹⁴ Most dental patients taking prescription medications are aware of the bleeding risks associated with their drugs, and in fact, are monitored routinely to detect alterations in coagulation before complications arise. However, these same patients may not fully understand how their lifestyle, including diet, alcohol use, and the use of OTC medications, can alter the bleeding effects of their prescription medications.

In addition, dental professionals must remember to ask their patients about the use of herbs, vitamins, and dietary supplements when assessing medication use. Surveys estimate dietary supplement usage by 12% to 24% of the general population.¹⁵ In addition, usage doubled for individuals aged 65 years and older from 1999 to 2002.¹⁶ Recent estimates suggest that over 15 million Americans take herbs, vitamins, or both, along with their prescription medications.¹⁷ Since these supplements are available OTC, many patients do not include these products when listing medications on health history forms. For example, over 51% of patients scheduled to undergo surgical procedures in a Colorado hospital were taking herbal

medications, some of which may alter blood coagulation.¹⁸ Further, in a preanesthesia interview at a university medical center, nearly 70% of patients taking herbal medications did not report their usage.¹⁹

Several herbs contain substances that have coumarin, salicylate, or antiplatelet properties, such as garlic, ginkgo, and ginseng.²⁰ Although no definitive studies have been performed to show a direct cause and effect of herbal use and bleeding complications, the literature suggests that this is a phenomenon of increasing concern due to the extreme popularity and increasing use of these products.

During January 2005, the National Institutes of Health (NIH) conducted a joint conference with the National Heart, Lung and Blood Institute (NHLBI), the Office of Dietary Supplements (ODS), the NIH Clinical Center (CC), the National Center of Complementary and Alternative Medicine (NCCAM), the National Institute of Neurological Disorders (NINDS), the NIH Foundation, and the Office of Rare Diseases (ORD) at the NIH that specifically addressed this issue as a public health concern. The conference goal was to "increase our understanding of the potential for dietary supplements to interfere with hemostasis and antithrombotic therapies."¹⁵

According to the Natural Medicines Comprehensive Database, approximately 180 dietary supplements have the potential to interact with warfarin, and more than 120 may interact with aspirin, clopidogrel (Plavix®), or dipyridamole (Aggrenox®). The 2005 NIH conference specifically identified the following supplements as having this interaction potential:

Anise

Dong Quai

Omega-3 fatty acids in fish oil

Ajoene in Garlic

Ginger

Ginkgo

Vitamin E

Fucus

Danshen

St. John's Wort

American Ginseng

In addition, the following herbs may affect blood clotting, which is dependent on vitamin K:

High dose vitamin E (specific dosage not indicated), a vitamin K antagonist

Alfalfa -high vitamin K content

Coenzyme Q10 - dependent on vitamin K

Several of these listed herbs are consistently among the top sellers. Data from the Centers for Disease Control and Prevention (CDC) in 2002 included ginseng, ginkgo biloba, and garlic as the dietary supplements with the 2nd, 3rd, and 4th highest sales, respectively. St John's wort was 6th and ginger was 9th.²¹ The popularity of herbs with anti-coagulation potential was further validated by *HerbalGram's* report of dietary supplement sales in mainstream retail stores in 2004. Garlic was the top seller with ginkgo at 4th, ginseng at 7th, St John's wort at 9th, and ginger at 20th.²² Clearly, the popularity of these herbs has not waned.

Of the 11 herbs highlighted during the NIH conference, this article will only focus on garlic, ginkgo, ginseng, ginger, and St John's wort for several reasons. First, as indicated above, these herbs consistently rank high in sales, indicating

predominant usage. Second, the amount and quality of scientific evidence is more prevalent on these botanicals as compared to other herbs.

Health care professionals have an increasing responsibility to understand the rationale for use of these herbal medications and their reported effects on the body, given the large percentage of patients who take them. Unfortunately, it is challenging to locate accurate, consistent, and comprehensive information pertaining to herbal medications and their supposed mechanisms of action. While the knowledge base pertaining to herbs and other dietary supplements continues to grow, there are few studies that have determined conclusively how these products alter bleeding or interact with other herbals and prescription anti-thrombotic medications.²³ Speculation and case reports from the literature have provided clues as to the purported mechanisms of action; however, relatively few clinical trials have been conducted to formally examine these issues. Further, case reports in the literature sometimes fail to take into account other herbals or drugs that the patient may have been taking. Therefore, it is difficult to credit the results of a case study to one definitive herbal action.

Clinicians encounter this same phenomenon with their own patients. When asked, a patient may know a product's brand name, but cannot identify the multiple herbs that are contained within that same product. Further, it is not unusual for a patient to take upwards of 7 individual dietary supplements at the same time, but often on an inconsistent basis. When the CDC last reported on dietary supplement usage (1988-94), 14.4% of respondents reported usage of 3 or more supplements.²⁴ The highest segment of users (22%) was among those aged 40 years and older. More recently, the Hartman Group, a research firm, surveyed 43 000 U.S. households, and found that 31% reported using 7 or more supplements.²⁵ These statistics may not reflect, and in fact may underestimate, the growing use of combination products, or supplements that contain multiple herbs as well as vitamins. Given these trends, it is highly likely that an individual is unknowingly taking several herbs that have either anticoagulant or antiplatelet activity. Therefore, use of dietary supplements has the potential to a) cause a bleeding condition, b) exacerbate an existing bleeding condition, or c) alter the effectiveness of other OTC and prescription medications being taken concurrently. Obviously, the resulting complications may be potentially serious.

The purpose of this article is to assist dental professionals with understanding the mechanisms of action of popular prescription and herbal medications that alter bleeding. Drug and herbal interactions will also be discussed. Finally, practice management considerations for medicated patients and strategies for risk reduction will be presented to increase the dental professional's confidence in making treatment decisions for patients taking these medications.

Blood Clotting

There are over 50 substances in the blood that affect blood coagulation by acting as either procoagulants or anticoagulants. Normally, the anticoagulant substances predominate, keeping blood clots from forming. However, when a blood vessel is ruptured, procoagulant substances in the area of the damaged vessel become activated and override the effects of the anticoagulant substances, allowing a blood clot to form.²⁶

When clotting poses risk to a patient, anticoagulant or antiplatelet drug therapy is used to reduce the risk for thromboembolism. A thrombus is an abnormal clot that forms in a blood vessel. When the velocity of the blood flowing past the clot breaks the clot free from its attachment to the vessel wall, the free floating clot is referred to as an embolus. Clots that originate on the left side of the heart on the arterial side of the circulation clog arteries and arterioles that feed organs, resulting in ischemia and permanent damage to the organ tissue. Clots that originate on the venous side of the circulation or on the right side of the heart flow through the pulmonary arteries to the lungs, resulting in pulmonary embolism (PE). Risk for PE is high for patients who are immobile or bedridden, as intravenous clotting forms in the legs due to blood pooling in the lower extremities. This condition is known as deep vein thrombosis (DVT), a problem that can also occur in those traveling for long periods of time sitting in a motor vehicle or airplane.

Dental hygienists should be aware that circulating bacteria and bacterial endotoxins can also activate clotting mechanisms, producing small but numerous clots that plug blood vessels in the periphery, depriving many tissues of oxygen and other essential nutrients.²⁶ This is why patients who develop bacterial endocarditis are treated with anticoagulants as well as antibiotics: the antibiotics kill the causative bacteria, while the anticoagulants help to prevent clotting and ischemia initiated by bacterial endotoxins.

Parenteral Anticoagulants

Heparin

Heparin is an endogenous substance produced by many cells in the body, but is primarily made by mast cells found in the connective tissue surrounding capillaries in the body. These mast cells continuously produce small quantities of heparin that diffuses into the circulation. Basophils in the blood also release heparin into the plasma. The concentration of heparin in the blood is normally very low, and only produces significant anticoagulant effects under specific circumstances. It is used medically in much higher concentrations to prevent intravascular clotting.²⁶

Heparin itself is not an anticoagulant; however, by binding to antithrombin III, it serves as a catalyst to enhance the inactivation of multiple coagulation factors, including thrombin. Heparin also prevents the conversion of fibrinogen to fibrin, thus inhibiting clot formation.^{5,26} Unfractionated heparin (Hep-Lock®, heparin sodium, heparin calcium) has been used in medicine since the 1920s, and is used primarily in hospitalized patients to treat thromboembolism and PE.²⁷ High-dose therapy is used for DVT and PE, while low-dose therapy is used preventively.⁵

Both warfarin (Coumadin®) and heparin therapy are started on the first day of treatment, and the overlap allows for the 4 days to 5 days needed for warfarin to take effect. Heparin inactivates existing coagulation factors relatively quickly, while warfarin therapy blocks the synthesis of new clotting factors by the liver. In older adults undergoing general surgery, prophylaxis with low-dose unfractionated heparin (LDUH) or an intermittent pneumatic compression device, such as compression elastic stockings, is recommended to prevent DVT and venous thromboembolism (VTE).²⁸ Heparin is also used to prevent clot formation in catheters, shunts, pumps, and infusion machines (eg. dialysis machines).⁶

Standard heparin is comprised of an unfractionated heterogeneous mixture of polysaccharide chains with mean molecular weights ranging from 12 000 to 16 000 daltons. Heparin is administered parenterally, usually by intravenous injection, which results in an immediate anticoagulant effect.^{5,27,29} When administered by intravenous infusion or as a deep subcutaneous injection, onset of action occurs anywhere from 20 minutes to 30 minutes.^{27,29} Response to heparin is varied and unpredictable; therefore, patients receiving heparin are monitored with an aPTT (activated partial thromboplastin time) test.^{5,27}

Most patients receiving heparin will be treated in the hospital setting, and invasive dental procedures should be avoided during active treatment. Dental emergencies in these hospitalized patients must be treated carefully and conservatively.⁵ The most common dental patients taking heparin seen outside of the hospital setting are those who are undergoing hemodialysis, who receive heparin on an outpatient basis. As heparin has a half-life of 1 hour to 2 hours, its effects last for only a few hours after dialysis has been completed. It is safe for these patients to receive invasive dental procedures on the day following dialysis.⁵

Heparin may induce thrombocytopenia in up to 30% of users; however, for most affected patients, this adverse event is not clinically significant. However, heparin may induce an immunologically-mediated thrombocytopenia in 1% to 2% of users that causes a marked decrease in platelet count, leading to thromboembolic complications, such as PE, skin necrosis, and gangrene.²⁹ Daily platelet counts for the first week following the initiation of drug therapy can help to detect this condition.

Hemorrhage, including gingival hemorrhage, is another risk associated with heparin. This risk is increased by the use of other anticoagulant medications, thrombolytic agents and drugs that alter platelet function (see below). It is important to note that heparin is often used in conjunction with thrombolytics and during the initiation of warfarin therapy to assure adequate anticoagulation. Certain cephalosporins and parenterally administered penicillins may also increase risk for hemorrhage in heparinized patients.²⁹

Low Molecular Weight Heparins

Low molecular weight heparins (LMWHs) are the preferred method for prophylaxis for elective hip replacement surgery, started preoperatively or immediately after surgery, as these drugs have been found to be very effective in preventing asymptomatic VTE.³⁰ For elective knee replacement or hip fracture surgery, LMWH or adjusted-dose warfarin may be used.²⁸ Routine prophylaxis for VTE with LDUH or LMWH is recommended for patients with ischemic stroke and impaired mobility. These agents are also recommended for patients with other risk factors for VTE including immobility, cancer, heart failure, and severe lung disease.²⁸

LMWHs act in a similar manner to standard heparin, by inhibiting activated factor X and thrombin; however, they produce a lesser effect on the inhibition of thrombin.^{31,32,33} LMWHs are formed by depolymerization of unfractionated heparin side chains, producing "smaller" heparin fragments, with mean molecular weights ranging from 1000 daltons to 10 000 daltons.²⁷

LMWHs are administered subcutaneously, and exhibit a better bioavailability than standard heparin, as they are less bound to plasma proteins, endothelial cells and macrophages. They also have a longer half-life (2 hours to 4 hours) than heparin, and dosage is based upon body weight. Because LMWHs produce a more predictable anticoagulant response, laboratory monitoring during treatment is generally not necessary.^{5,27} Dental professionals do not need to order laboratory testing for patients taking these drugs for routine dental care.

For patients undergoing orthopedic surgery to the lower extremities, the optimal duration of prophylaxis is unknown.²⁸ Risk for DVT following surgery is related to the length of time that the patient remains immobile and other risk factors; risk persists for up to 2 months following total hip replacement surgery.^{28,34,35,36,37} Six randomized double-blind controlled clinical trials demonstrated reduced risk of total and proximal DVT by at least 50% for patients with total hip replacement who received prophylaxis with either LDUH or LMWH for 5 weeks beyond the hospital stay.³⁰

LMWHs can be provided on an outpatient basis, and patients taking these drugs have lower risks for hemorrhage and heparin-induced thrombocytopenia, as compared to patients taking heparin. Risks for bleeding increase when the LMWHs are used with thrombolytic agents, oral anticoagulants, and drugs that alter platelet function, although they are frequently used during initial therapy with oral anticoagulants to ensure proper anticoagulation. There are 3 FDA approved LMWHs in the United States: dalteparin (Fragmin®), enoxaparin (Lovenox®), and tinzaparin (Innohep®).^{27,29} Enoxaparin is the most widely used LMWH, and has been shown to prevent ischemic complications associated with unstable angina and non-Q wave myocardial infarction (MI).^{5,29,38}

Patients on LMWHs who present to the dental office can usually receive invasive dental treatment without any modifications necessary to their medication regimen. Should excessive bleeding be anticipated, as with oral or periodontal surgery, a physician consultation is warranted to determine whether the medication should be temporarily discontinued prior to performing the dental procedure. Given the short half-life of these drugs, high dose LMWH can be stopped for one day on the day before the surgery; then, therapy is resumed following hemostasis on the day of surgery. However, the best option is to wait until LMWH therapy has been completed before attempting any elective dental surgery.⁵

Antithrombotic Agents

There are 3 FDA approved antithrombotics that are used for the prevention of postoperative deep vein thrombosis (DVT), and for the treatment of heparin-induced thrombocytopenia and related thromboembolic complications. These drugs are argatroban (no brand name), danaparoid (Orgaran®), and lepirudin (Refludan®).

Argatroban is indicated for the prevention and treatment of thromboembolic complications in patients with heparin-induced thrombocytopenia. This drug is a highly selective thrombin inhibitor and binds reversibly to the active thrombin site of free and clot-associated thrombin. Drug administration is by IV, which produces an immediate onset of action. The drug inhibits fibrin formation, the activation of numerous clotting factors, and platelet aggregation.^{27,29}

Danaparoid (Orgaran®) is indicated for the postoperative prevention of DVT following elective hip replacement surgery. This drug prevents fibrin formation by inhibiting activated factor X by antithrombin. It is administered subcutaneously, with maximum effect occurring within 2 hours to 5 hours.^{27,29}

Lepirudin (Refludan®) is indicated for anticoagulation in patients with heparin-induced thrombocytopenia and related thromboembolic complications, and has investigational use for the prevention of ischemic complications associated with unstable angina. This drug is a highly specific inhibitor of thrombin, and is administered by IV. All antithrombotic agents have a risk for hemorrhage, which is increased with concurrent use of oral anticoagulants and drugs that alter platelet function.^{27,29}

Factor Xa Inhibitor

There is 1 antithrombotic agent in this new class of medications called fondaparinux (Arixtra®). This drug is indicated for prevention of deep vein thrombosis (DVT) in patients undergoing hip or knee replacement or hip fracture surgery. It may also be used for the treatment of acute pulmonary embolism (PE) or for treatment of acute DVT without PE. Fondaparinux is a synthetic pentasaccharide that inhibits activated factor X, which inhibits thrombin formation. It is administered subcutaneously, once daily. Risk for hemorrhage is increased when this drug is taken concurrently with oral anticoagulants, antiplatelet drugs, non-steroidal anti-inflammatory drugs (NSAIDS), salicylates, and thrombolytics.^{27,29}

Oral Anticoagulants

Warfarin

Warfarin (Coumadin®, Jantoven™) is an oral anticoagulant used for prevention and treatment of VTE, PE, atrial fibrillation with risk of embolism, and to prevent systemic embolism after MI.²⁹ Warfarin is also used for anticoagulation therapy in patients with prosthetic heart valves. Coumarin derivatives work differently than the other parenteral anticoagulants described above, by inhibiting the synthesis of vitamin K- dependent clotting factors.

Several clotting factors are dependent upon vitamin K for their synthesis in the liver. Warfarin binds to the liver microsomal enzyme vitamin K 2,3-epoxide reductase, and inhibits the production of the reduced form of vitamin K. Reduced vitamin K is a necessary cofactor in the gamma carboxylation of the 4 vitamin K-dependent clotting factors: factors II, VII, IX, X. Precursors to these 4 clotting factors undergo vitamin K-dependent modification to produce their active forms. By inhibiting the formation of reduced vitamin K, coumarins prevent the activation of these clotting factors. Thus, the clotting factors remain as inactive molecules that cannot participate in the clotting process, thereby stopping the formation of thrombin and fibrin.

Warfarin also depresses proteins C and S, which are endogenous anticoagulants. Levels of these 2 proteins may be depressed by warfarin prior to depression of the other clotting factors, resulting in a dangerous period of hypercoagulation for a short period of time. The anticoagulant effects of warfarin are not initially evident until 8 hours to 12 hours after oral administration, and given its 36 hour half-life, it may take up to 4-7 days of dosing to reach the desired target International Normalized Ratio (INR) value.²⁹ For this reason, heparin therapy (LDUH or LMWH) usually overlaps warfarin therapy for at least the first 2 days of oral anticoagulant therapy to allow for the warfarin to take effect and to achieve an optimal therapeutic range of anticoagulation.^{28,39} Heparin is discontinued after the INR has been in the therapeutic range for at least 2 measurements taken more than 24 hours apart.

Despite its widespread use, physicians often find it difficult to prescribe warfarin, given its narrow therapeutic index. It may take weeks of clinical testing (via the INR) to find the exact dose that results in the desired level of anticoagulation. Even small variations in dose can result in large clinical effects, including excess bleeding (over-anticoagulation) or inadequate anticoagulation, which places the patient at risk for developing clots.

Individuals taking warfarin vary in their response to given doses of the drug. It is known that a variation in the gene that encodes the CYP2C9 liver enzyme that metabolizes warfarin accounts for about 10% of the difference in response to the drug observed in warfarin users. Recently, investigators have identified another genetic variation in the VKORC1 gene (vitamin K epoxide reductase), which makes a protein that helps control clotting and is the target site of action of warfarin. By matching the genetic variations to the actual dose taken by study subjects, the researchers found that individuals with particular variations in the VKORC1 gene generally took similar doses of warfarin. Study results suggested that variation in this one gene accounted for 25% of the overall variance in warfarin dose. In the future, genetic testing could help to predict a person's response to warfarin, and could be used to determine the proper initial dose.⁴⁰

The major complication of anticoagulation therapy is bleeding. There is a positive relationship between the risk for hemorrhage and the intensity of anticoagulation.⁴¹ Patients on high-intensity warfarin therapy (INR>3.0) are at higher risk for hemorrhage as compared to warfarin therapy with an INR that falls between 2.0-3.0. The risk for intracranial hemorrhaging rises dramatically with an INR>4.0.^{41,42} The major determinants of warfarin-induced bleeding are the intensity of anticoagulation, unique patient characteristics, concurrent use of drugs that interfere with hemostasis (eg, aspirin), poorly controlled hypertension, and the duration of drug therapy.⁴¹ Multiple large, randomized controlled clinical trials support the use of combination therapy with aspirin plus warfarin (INR 2.0-2.5) in high-risk patients with atherosclerotic heart disease. Combination therapy increases the risk of both minor and major bleeding, but not intracranial bleeding in atherosclerotic patients. The most common bleeding complications include epistaxis (nosebleed), purpura (skin hemorrhages), gastrointestinal (GI) bleeding, hemoptysis (expectorating blood), and hematuria (blood in urine).^{42,43,44}

Unexpected elevations in the INR increase concerns for adverse bleeding events. Frequent monitoring of therapy, including the INR, is especially important in older adults, and adjustments to the treatment regimen are often necessary.⁴⁵ When the INR is elevated, but no bleeding is present, warfarin therapy can be reduced or stopped, which lowers the INR within 24 hours to 48 hours without returning it to baseline levels. In patients with non-life-threatening bleeding, a small dose of vitamin K₁ (1-2.5 mg) is administered orally or subcutaneously (SC). If urgent correction of the INR is needed, a larger dose of vitamin K₁ (2-4 mg) is given initially, with additional 1-2 mg doses given as needed. When the INR >9.0 and/or bleeding is life-threatening, warfarin therapy is stopped and large doses of vitamin K₁ (3-5 mg orally; 5-10 mg SC) are given. Fresh frozen plasma may also be given to replace the vitamin K-dependent clotting factors. Vitamin K₁ may also be given by IV in life-threatening situations, but it must be administered slowly and carefully monitored, given the risk for anaphylaxis.^{46,47,48,49,50,51,52}

Multiple factors can contribute to alterations in the INR. Poor compliance with warfarin therapy is the most common reason for fluctuations in anticoagulation therapy.⁵³ Switching between different brand names of warfarin product formulations has been shown to contribute to major medical complications, and patients are advised not to switch brands once the desired therapeutic effect has been achieved.^{29,54} Alterations in vitamin K intake, interference with intestinal bacterial synthesis of vitamin K, and impaired vitamin K absorption all cause significant fluctuations in response to warfarin.⁵⁵ Many common foods, especially dark green leafy vegetables and 4 plant oils (soybean, canola, cottonseed, and olive) serve as primary dietary sources for vitamin K.⁵⁶ Patients should maintain consistency in their diet and meet the recommended dietary allowance for vitamin K of 65 to 80 micrograms of phylloquinone per day.⁵⁶ Patients who increase their intake of "heart-healthy" green vegetables without informing their physicians may be inadvertently increasing their warfarin requirements; sudden decreases in vitamin K intake then increases the risk for hemorrhagic events.

Other factors that contribute to alterations in anticoagulation effects include illness, fever, thyroid disease, biliary disease, liver disease, malabsorption syndromes, congestive heart failure, malignancy, and diarrhea.^{6,55} Warfarin is also highly affected by medication use. In fact, more food and drug interactions have been reported for warfarin than with any other prescription medication.⁵⁷ Alcohol consumption has also been reported to increase bleeding in warfarin users.^{55,58}

Dental professionals should be aware that many commonly prescribed drugs used during dental treatment have the potential to alter the effects of warfarin. The dental drugs that have been reported to enhance the anticoagulant effect of warfarin include antibiotics (cephalosporins, macrolides, metronidazole, quinolones, penicillins, tetracyclines), analgesics

(acetaminophen, NSAIDS), prednisone, and the systemic azole antifungals (fluconazole, ketoconazole, itraconazole).^{29,55,59} Single-dose antibiotic prophylaxis for the prevention of endocarditis and prosthetic joint infection is not likely to alter the effect of warfarin, although 3 case reports have been reported in the literature describing elevations in INR following prophylactic antibiotic use.^{60,61} Salicylates and NSAIDS should be avoided in warfarin users, given their antiplatelet activity.⁶⁰ All dental professionals are encouraged to consult a drug reference guide prior to prescribing any medication to a patient taking warfarin to ensure drug compatibility and safety. Foods and herbs that alter warfarin activity are summarized in Table I.

Table I. Foods and herbs that alter warfarin activity.

Alcohol	Acute binge drinking increases PT/INR Chronic daily drinking decreases PT/INR
Foods rich in vitamin K	Decreases effect of warfarin
Vitamin C	Increases effect of warfarin
Cranberry juice	Increases effect of warfarin
St. John's wort	Decreases serum levels of warfarin
Alfalfa	Decreases effect of warfarin due to large amount of vitamin K
Coenzyme Q10	Decreases response to warfarin
Bromelain	Avoid concurrent use: antiplatelet action
Cat's claw	Avoid concurrent use: antiplatelet action
Dong quai	Avoid concurrent use: antiplatelet action
Evening primrose	Avoid concurrent use: antiplatelet action
Feverfew	Avoid concurrent use: antiplatelet action
Garlic	Avoid concurrent use: antiplatelet action
Green tea	Avoid concurrent use: antiplatelet action
Ginseng	Avoid concurrent use: antiplatelet action
Ginkgo	Avoid concurrent use: antiplatelet action
Horse chestnut	Avoid concurrent use: antiplatelet action
Red clover	Avoid concurrent use: antiplatelet action

Source: Wynn RL, Meiller TF, Crossley HL. Drug Information Handbook for Dentistry. 10th ed., Hudson:Lexi-Comp, Inc. 2005. ²⁹

Oral Antiplatelet Agents

Aspirin

Aspirin was first used as an analgesic and antipyretic drug in 1899, and has quickly become the most widely used drug in the history of medicine.⁶² During the 1960s, the antiplatelet properties of aspirin were discovered.⁶² Since then, aspirin has become the most comprehensively studied and least expensive of all antiplatelet medications.⁵ Aspirin blocks the synthesis of thromboxane A2 from arachidonic acid in platelets by inhibiting the enzyme cyclooxygenase 1 (Figure 1). Thromboxane A2 is necessary for platelet aggregation and promotes blood clotting. The inhibitory effect of aspirin on the formation of this substance is irreversible and lasts for the life of the platelet, which is 7 days to 10 days. In fact, a single dose of aspirin impairs platelet aggregation for up to 4 days, until new platelets enter the circulation in sufficient numbers to exert a thrombotic effect.⁶³

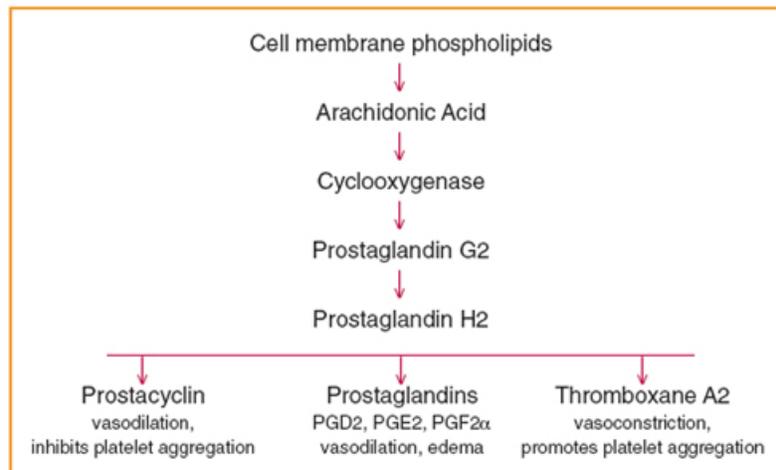


Figure 1. The arachidonic acid cascade.

Aspirin reduces mild to moderate pain, inflammation, and fever.²⁹ Aspirin is also used for the primary prevention of MI in patients at increased risk, and for the secondary prevention of ischemic cardiovascular events, such as stroke.⁶² Further, aspirin is used as an adjunctive therapy during revascularization procedures (eg, coronary bypass).²⁹ Aspirin should be available in the dental office as a pre-hospitalization drug for use in patients experiencing MI. It is thought that the fibrinolytic properties of aspirin, given at an 81-325 mg dose, may help to reperfuse the ischemic myocardium.⁶⁴

Despite the cardioprotective benefits of this drug, aspirin is still underused by many at-risk populations.⁶⁵ It is important to note that although aspirin is not approved for primary prevention of ischemic events, it may be possible for people who are at an even higher risk than those who have already experienced an adverse cardiovascular event to benefit from the effects of aspirin. The potential number of people in this highest risk category exceeds the number of people who are already taking the drug.⁶² Safety concerns, including risks for hemorrhage and gastrointestinal (GI) ulceration and bleeding, are thought to limit the recommendations of this drug by physicians to their patients.⁶² However, many patients choose to self-medicate with aspirin, and may be unaware of its potential adverse effects.

In addition to data that supports the benefits of aspirin in patients with cardiovascular disease, data from 55 000 individuals supports aspirin use for the prevention of first MI in healthy individuals, with an overall risk reduction of 32%.⁶⁶ Both the American Heart Association (AHA) and the U.S. Preventive Services Task Force (USPSTF) have published guidelines for the use of aspirin for the primary prevention of MI.^{3,67,68}

A meta-analysis of all available randomized, placebo-controlled clinical trials evaluating the effects of low-dose aspirin therapy for secondary prevention revealed that aspirin reduces the risk of death by approximately 20%. Further, aspirin also reduces the relative risk for cardiovascular events (eg, MI) and cerebrovascular events (stroke) by 20% to 30%.⁶⁹

The most common adverse event associated with aspirin use is GI ulceration and hemorrhage. These GI complications are attributed to aspirin's inhibitory effect on prostaglandin synthesis, which stops the production of protective prostaglandins that coat the walls of the stomach that normally form a barrier between the hydrochloric acid and the gastric mucosa. Further, aspirin inhibits the synthesis of prostaglandins that protect the kidney. Notably, chronic aspirin use can lead to kidney damage and renal failure. Hemorrhagic stroke is also a risk associated with long-term aspirin use. A meta-analysis of 16 clinical trials demonstrated an increased absolute risk of 12 hemorrhagic stroke events per 10 000 aspirin users.⁷⁰ Although aspirin increases risk for adverse bleeding events, the cardioprotective benefits of the drug outweigh these risks when used appropriately in at-risk patient populations.⁶²

Many adverse events caused by aspirin are dose-related and are extremely rare with low-dose therapy (81 mg per day). Bleeding risk increases with concurrent use of other medications that alter hemostasis, including NSAIDs, warfarin, and

alcohol. Drinking more than 3 alcoholic beverages per day significantly increases risk for GI hemorrhage. Aspirin use should be discontinued if patients develop tinnitus or hearing loss. Caution should be used when using aspirin in patients with bleeding or platelet disorders, peptic ulcer disease, and liver or kidney dysfunction.

Other serious reactions include hypersensitivity reactions and idiosyncratic reactions. Patients who are sensitive to tartrazine dyes, or who have nasal polyps or asthma are more likely to be sensitive to aspirin. In patients with bronchial asthma, aspirin and other NSAIDs may precipitate a condition known as aspirin-induced asthma (AIA), a syndrome characterized by aggressive and continuous inflammatory disease of the airways. AIA progresses from the upper to lower respiratory tract and affects women more than men, with an average age of onset at 30 years. Rhinorrhea and nasal congestion are the first symptoms, with asthma and aspirin hypersensitivity developing 2 years to 15 years later. Once developed, aspirin intolerance remains throughout life.⁷¹ Further, patients who are allergic to NSAIDs may not take aspirin or aspirin-containing products.²⁹

There is increasing concern about the number of individuals who exhibit aspirin resistance, also known as hypo-responsiveness, to the effects of aspirin. These individuals experience first MI or suffer a second adverse event while taking aspirin. For some reason, aspirin therapy is not enough to stop thrombotic activity. Three possible explanations have been offered to explain aspirin resistance: platelets become activated by pathways not blocked by aspirin; patients require a higher dose of aspirin to produce an effect; or patients generate thromboxane A2 despite aspirin therapy.⁷² Early data suggests that aspirin resistance may be dose related; resistance is found more often during low-dose therapy (< 100 mg daily) than at higher doses (> 300 mg daily). Platelet aggregation studies of these individuals reveal no biochemical activity of aspirin. Urinary concentrations of a thromboxane metabolite (11-dehydrothromboxane B2), a marker for aspirin resistance, may be used to identify potential aspirin-resistant individuals. Patients who are aspirin resistant should continue to take aspirin for its anti-inflammatory effects, but may require additional antiplatelet therapies for risk reduction.^{72,73}

Aspirin has many drug interactions, and dental professionals should consult a drug reference text prior to prescribing any medications to patients taking this drug. For example, concurrent use of aspirin with NSAIDs may decrease the serum concentration of some NSAIDs.²⁹ Dental professionals must remember that the effects of this drug are irreversible; therefore, additional bleeding will be evident during any invasive procedure. There is no evidence to support the discontinuation of low-dose aspirin therapy prior to dental procedures or dental surgery, as the risk for an adverse cardiovascular event outweighs the risk for intraoperative and postoperative bleeding in dental patients.^{8,29} Such bleeding can be managed locally with the use of hemostatic agents. However, a physician consultation is warranted to discuss whether patients who require major surgery require an alteration in aspirin therapy. The decision to discontinue therapy must take into account the risks to the patient. If the decision is to discontinue aspirin, the patient should stop taking aspirin 10 days to 14 days prior to surgery to allow for the synthesis of new platelets.

Dipyridamole

Dipyridamole (Persantine®) stimulates the release of prostacyclin or prostaglandin D2 (PGD2), inhibiting platelet aggregation and producing coronary vasodilation. The drug is primarily used to prevent angina pectoris, and to maintain the opening of the coronary arteries following bypass surgery. This drug is often used in combination with aspirin to prevent coronary artery thrombosis, or with warfarin, to decrease the risk of thrombosis in patients with mechanical heart valves. It may also be used prophylactically to prevent myocardial reinfarction.^{27,29} The drug is administered orally and intravenously.

Aspirin with dipyridamole

Combination aspirin with extended-release dipyridamole is an antiplatelet drug known as Aggrenox®. Aggrenox® is used to reduce the risk of stroke in patients who have had either transient brain ischemia or an ischemic stroke due to thrombosis. The drug contains 25 mg of aspirin and 200 mg of dipyridamole. The aspirin inhibits platelet aggregation by inhibiting platelet cyclooxygenase and the generation of thromboxane A2. Dipyridamole stimulates the release of prostacyclin, the antagonist of thromboxane A2. The antithrombotic effects of this drug are irreversible, given the aspirin component of the drug.^{27,29}

Clopidogrel

Clopidogrel (Plavix®) inhibits platelet aggregation by a different mechanism than aspirin. This drug inhibits the binding of ADP to its platelet receptors, which prevents the binding of fibrogen between platelets, reducing platelet adhesion and aggregation. Clopidogrel also blocks the amplification of platelet activation caused by released ADP. Plavix® is used as an antithrombotic for the prevention of myocardial infarction, stroke and vascular death in patients with atherosclerosis. It is also prescribed for the prevention of thromboembolic events following the placement of coronary stents.^{27,29}

Plavix® was developed for use for patients who are unable to tolerate the adverse gastrointestinal effects of aspirin, and has recently replaced ticlopidine (Ticlid®) as the drug of choice for patients who are allergic or intolerant to aspirin.²⁷ Evidence supports that both clopidogrel and ticlopidine are more effective than aspirin in preventing stroke and other serious vascular events in high risk patients.⁷⁴ Like aspirin, this drug produces irreversible effects that last for the life of the platelet. Patients can receive routine dental procedures, including oral prophylaxis, without altering the dose of the drug.^{5,8} However, patients that are scheduled to undergo invasive surgical procedures, including dental surgery, are advised to discontinue the drug for 7 days prior to surgery.⁵ Consultation with the patient's physician prior to discontinuing the drug is warranted to ensure patient safety.

Risk for hemorrhage is associated with this drug and bleeding may occur at any site, including the oral cavity. Risk for hemorrhage increases with concurrent use of other drugs that alter hemostasis, including anticoagulants and antiplatelet drugs. Avoid the use of herbs that demonstrate antiplatelet activity (Table I). Concurrent use of clopidogrel with naproxen has resulted in GI blood loss. Cases of thrombotic thrombocytopenia purpura have been reported with use of this drug, usually occurring within the first 2 weeks of therapy.²⁹

At high doses, clopidogrel may alter the metabolism of some NSAIDS, which can result in toxicity reactions. Finally, CYP3A4 inhibitors, including the macrolide antibiotics, may decrease the effects of clopidogrel. Dental patients who are prescribed these antibiotics should be closely monitored.²⁹

Cilostazole

Cilostazole (Pletal®) is an oral antiplatelet drug used to manage the symptoms of peripheral vascular disease. This drug and its metabolites inhibit phosphodiesterase III, which increases cyclic adenosine monophosphate (AMP), causing inhibition of platelet aggregation and vasodilation. Inhibiting phosphodiesterase III increases cardiac contractility, atrioventricular (AV) nodal conduction, ventricular automaticity, heart rate, and coronary blood flow.²⁹

The blood levels of cilostazole may be increased by erythromycin. Increased blood concentrations of this drug are observed with concurrent use of CYP3A4 inhibitors, including the macrolide antibiotics and the systemic azole antifungals. Inhibition of platelet aggregation caused by aspirin is potentiated with concurrent use of cilostazole.²⁹

Ticlopidine

Ticlopidine (Ticlid®) is an irreversible platelet aggregation inhibitor used to reduce the risk for thrombotic stroke. The other primary indication for use is to reduce the incidence of thrombotic complications in patients with coronary stents. Use of this drug is typically reserved for patients who are intolerant to aspirin, and for those whose aspirin therapy has failed. Ticlopidine has a mechanism of action that is unique from other platelet aggregation inhibitors. While the drug inhibits adenosine diphosphate (ADP) platelet receptor fibrinogen binding (like Plavix®), this drug also significantly increases bleeding time. The increase in bleeding time can be further prolonged by the addition of aspirin.²⁹

Ticlopidine has been associated with life-threatening hematologic disorders, including neutropenia and thrombotic thrombocytopenic purpura.⁷⁵ Thus, use of clopidogrel has surpassed this drug due to a better safety profile. Ticlopidine use may increase the effect and risk for toxicity of aspirin, anticoagulants, and NSAIDS.²⁹

NSAIDS

Nonselective NSAIDS, such as ibuprofen, inhibit both cyclooxygenase 1 and 2, and thus alter thromboxane A₂ synthesis and platelet aggregation (Figure 1). However, unlike aspirin, the effects of these drugs are reversible and last for a shorter period of time, based upon the half-life of the individual drug.²⁷ When the drug is removed from the body, platelet function is restored. A recent study demonstrated that platelet function returned to normal within 24 hours of discontinuation of ibuprofen use in healthy individuals.⁷⁶ Many professionals continue to recommend discontinuing the use of NSAIDS at least 7 days prior to surgery, when in fact, a much shorter timeframe may suffice. Practitioners should look up the half-life of the NSAID to determine how long it will take for the drug to clear from the body.

The degree of platelet inhibition seems to vary among different nonselective NSAIDS, but for most drugs, this effect does not appear to last throughout the length of the dosing period. For example, taking naproxen 500 mg twice daily inhibits platelet aggregation throughout the dosing period, versus ibuprofen, which achieves adequate platelet inhibition at peak levels, but is not sustained, given the short half-life of the drug. Further, data suggests that the antiplatelet effects of naproxen are significant and comparable to those produced by aspirin, but are less with ibuprofen and diclofenac.⁷⁷ This suggests that naproxen may have greater cardioprotective properties than other NSAIDS. The variance in effect on platelet inhibition is among the many reasons why NSAIDS are not used for cardioprotective therapy.

A large epidemiologic study found no evidence of cardioprotective effects of traditional NSAIDS.⁷⁸ Several studies concluded that current use of NSAIDS does not substantially reduce the risk of acute myocardial infarction (MI).^{79,80,81,82} Given the effects of naproxen, several investigations examined whether naproxen therapy could reduce the risk for MI; study results were inconclusive.^{80,81,83,84,85,86,87,88} There is also increasing evidence that concurrent use of NSAIDS with aspirin may decrease the cardioprotective effects of aspirin.^{89,90,91}

A recent retrospective case-control analysis of 8688 case patients with first-time acute MI revealed that current use of NSAIDS does not alter the risk of acute MI. Further, the risk for acute MI was higher among subjects who stopped taking NSAIDS within 2 months before the MI occurred. The authors hypothesize that current NSAID use does offer some protective effect, such as reducing MI risk related to chronic inflammation, but that this effect only occurs while the drug is being taken.⁹²

Selective NSAIDS, known as the COX-2 inhibitors (eg, Celebrex®, Vioxx®, Bextra®), inhibit cyclooxygenase 2 without affecting cyclooxygenase 1. Thus, their effects predominantly alter prostacyclin versus thromboxane A₂ (Figure 1). Studies in healthy volunteers show that treatment with COX-2 inhibitors decreases systemic production of prostacyclin with no effects on platelet-derived thromboxane A₂ synthesis.^{79,93}

Expression of cyclooxygenase 2 is increased during ischemia, which is thought to be a protective mechanism against vascular injury, causing increased prostacyclin synthesis, resulting in vasodilation and decreased platelet aggregation to facilitate blood flow. Inhibition of the COX-2 enzyme blocks these protective effects, and because platelet thromboxane A₂ is unaffected, the balance of the equilibrium maintained between these 2 prostanoids becomes disrupted. This allows the influence of thromboxane to predominate, increasing vasoconstriction and clotting. This is the mechanism thought to underlie the adverse hypertension and stroke events found with long-term use of COX-2 inhibitors (eg, Vioxx®)

Herbal Supplements

Physicians closely monitor patients taking prescription medications that alter bleeding, because the effects of these medications are known. Unfortunately, patient use of OTC medications that alter bleeding, including the use of dietary supplements, is not supervised as closely, especially since many patients do not report taking these medications. In fact, use of any form of alternative medicine is not disclosed to health care providers over 60% of the time.¹⁷

A study in England documented that a significant number of patients may be co-ingesting herbal medicines with warfarin. One thousand three hundred and sixty patients from 35 different medical practices were surveyed about the use of garlic,

ginseng, ginkgo biloba, feverfew, ginger, and St. John's wort. One hundred and nineteen patients (8.8% of the respondents) reported taking one or more of these herbs. When asked if they had discussed their herbal use with any health care professional, 92.2% reported that they had not. The authors concluded that all general practitioners prescribing warfarin should always ask about the use of herbal medications. They also added that there are risks involved with any herbal preparations, and charged that physicians, as well as their patients, share a joint responsibility to discuss potential herb-drug interactions.⁹⁴ Dental professionals are also well positioned to help patients understand the vital nature of this type of disclosure along with responsible product use.

Both the desired and adverse effects caused by prescription medicines are predictable, as they are manufactured and tested according to exacting standards. The effects of herbal phytotherapies, including adverse reactions, are hard to foresee. The FDA does not regulate herbal product manufacturing, nor is safety testing required, so it is challenging to find documented safety and efficacy information. However, the popularity of these products has dictated the need for further study to gain a better understanding of how herbs affect the body, and significant improvements in both herbal manufacturing and research have occurred in recent years.

Unlike prescription drugs, individual herbal preparations are often a mixture of more than one active ingredient. Thus, it is difficult to determine which or how many constituents of the herbal product are pharmacologically important. In addition, comparable herbal products vary in formulation, and their undefined composition makes analysis of the active constituents extremely complex.⁹⁵ This further confounds the understanding and utility of findings gleaned from research studies about the effects of herbal drugs.

Ciocon and colleagues have stated "that certain herbals have been associated with increased risk of bleeding by inhibiting platelet function, platelet aggregation and thromboxane synthesis, thrombin and thromboplastin mechanisms, and by those which contain coumarin-like effects, and salicylate-like effects."⁹⁶ They propose a mnemonic of a "Few G's" to help health professionals remember a list of herbs that are known to alter bleeding. The Few G's include fever**f**ew, plus g**ink**go biloba, g**ing**er, g**ar**lic and g**in**seng. They add that when the "g" is followed by a vowel (eg, g**ink**go), the herb is associated with this adverse effect. When an herb that starts with the letter "g" is followed by a consonant (eg, green tea), there is not a concern for bleeding.⁹⁶ This mnemonic can also be used to remember the herbs that are most likely to interact with anticoagulant and antiplatelet agents.

It is important to note that other herbal products have been implicated in causing adverse bleeding effects as well (Table II).²⁹ However, this article will focus on 5 herbs that are widely used and have some scientific evidence to support the effects described here.

Table II. Herbs with anticoagulant/antiplatelet properties.

Alfalfa
Anise
Bilberry
Bladderwrack
Bromelain
Cat's claw
Celery
Coleus
Cordyceps
Dong quai
Evening primrose
Fenugreek
Feverfew
Garlic*
Ginger*
Ginkgo biloba*
Ginseng*
Grape Seed
Green tea
Guarana
Guggul
Horse chestnut seed
Horseradish
Horsetail rush
Licorice
Prickly ash
Red Clover
Reishi
St. John's wort*
Sweet clover
Turmeric
White willow

*Herbs discussed within this article

Source: Wynn RL, Meiller TF, Crossley HL. Drug Information Handbook for Dentistry. 10th ed., Hudson:Lexi-Comp, Inc. 2005.*

Garlic Allium sativum

Recommended Dosage for general use: Extract, aged: 4 ml daily; Fresh: 4 g daily; Oil: 10 mg daily

Garlic is a perennial bulb with reported uses as an antilipidemic, antimicrobial, anti-asthmatic and anti-inflammatory. The bulb contains aliin and degradation products such as allicin, polysulfides, ajoenes, mercaptanes, thioglycosides, thiosulfinates, adenosine, and selenium.⁹⁷ The primary chemical components that have been implicated in bleeding include volatile oil and ajoene. The antiplatelet effect of garlic has been demonstrated by studying some of its pure isolated components on human platelet aggregation. Ajoene apparently functions as the chemical component responsible for these effects.⁹⁸ Ajoene is an unsaturated sulfoxide disulfide and is a component of allicin, a sulfinyl compound that gives garlic its strong odor and flavor. Like aspirin, the effect of ajoene appears to be irreversible, which lasts for the life of the platelet, and may potentiate the effect of other platelet inhibitors.²⁰ Several sulfur-containing compounds isolated from garlic have also demonstrated significant inhibition of human platelet aggregation.⁹⁹

Garlic oil exerts its effects on the arachidonic acid pathway (Figure 1). Garlic interrupts the synthesis of thromboxane, and stimulates the synthesis of prostacyclin. By reducing thromboxane and increasing prostacyclin, garlic decreases platelet aggregation and increases bleeding. Further, garlic inhibits platelet aggregation in a dose-dependent fashion. Case reports support that both dietary garlic and garlic supplements demonstrate these effects.¹⁰⁰ Further, the constituents of garlic, particularly alliin/allicin, also inhibit the production and/or release of chemical mediators such as platelet-aggregating

factor and adenosine, which decreases platelet function.¹⁰¹ Interestingly, many herbalists feel that the best quality, most consistent, and strongest source of *allium sativum* is the natural garlic clove itself.

Harenberg and colleagues (1988) studied the effects of dried garlic intake on blood coagulation, fibrinolysis, platelet aggregation, serum cholesterol levels and blood pressure in 20 patients with hyperlipoproteinemia. During a 4-week study period, subjects received 600 mg (200 mg bid) of dried garlic in a sugar-coated pill. After 4 weeks of garlic use, both fibrinogen and fibrinopeptide A levels significantly decreased by 10%. Streptokinase-activated plasminogen and fibrinopeptide B beta 15-42 significantly increased by 10%. Serum cholesterol levels significantly decreased by 10%, and both systolic and diastolic blood pressure decreased.¹⁰²

In another *in vivo* study, 6 subjects were given 5.0 g of crushed garlic bulbs daily for a 3-week study period. Fasting blood samples were taken at baseline and at weekly intervals to assess the level of serum triglycerides. Results showed that the addition of garlic in the diet resulted in significantly lower levels of serum triglycerides and an increase in blood fibrinolytic activity by the end of the second and third weeks.¹⁰³

Case reports in the literature also suggest that ingesting garlic while taking warfarin (Coumadin®) may result in over-anticoagulation. One case report documented that the INR of a previously stabilized patient on warfarin had more than doubled and that hematuria occurred 8 weeks after commencement of ingesting 3 garlic tablets a day.⁹⁷ Izzo and Ernst (2001) cite 2 case reports suggesting that the concomitant use of warfarin and garlic resulted in an increased INR.⁹⁵ It is evident that this popular herb has the potential to cause adverse bleeding effects.

Ginkgo Ginkgo biloba

Recommended Dosage for general use: Standardized extract: 40 mg tid

Ginkgo is a tree native to Asia and is now also found in the United States. The primary use of ginkgo is to prevent decreased cerebral functioning and peripheral vascular insufficiency associated with Alzheimer's disease or age-related dementia. Other reported uses are summarized in Table III.

Table III. Additional indications for the use of ginkgo.

antioxidant
peripheral artery disease
circulatory problems
depressive mood disorders
sexual dysfunction ("herbal Viagra")
asthma
glaucoma
menopausal symptoms
multiple sclerosis
headaches
tinnitus
dizziness
arthritis
altitude sickness
intermittent claudication

Components of ginkgo include flavonoids (ginkgo-flavones) and terpenoids (ginkgolides and bilobalide). The ginkgo leaf is processed and often standardized to 24% ginkgo flavonglycosides and 6% trilactones (terpene lactones). The primary chemical component that has been implicated in bleeding is the terpene ginkgolides. Ginkgolides, a terpene lactone, are potent and specific platelet activating factor (PAF) antagonists. Their effects are long lived and are rapidly established after oral dosing.¹⁰⁴ Ginkgolide B, one component of ginkgo, inhibits platelet activating factor by displacing it from its receptor binding site, resulting in reduced platelet aggregation.¹⁰⁵ In laboratory tests, ginkgo increases prothrombin time (PT), and blood salicylate levels, and may decrease platelet activity.¹⁰⁶

Ginkgo holds particular interest to the baby boomer and geriatric populations as its cerebral and vascular benefits continue to be researched. Whereas earlier and better known research focused on older and cognitively impaired individuals, a recent review in *Herbalgram* provided a comprehensive report of its successes with "healthy and cognitively intact adults." Both short- and long-term studies resulted in positive benefits of ginkgo in the improvement of processes such as memory, attention, and speed of processing.¹⁰⁷

Case reports document dangerous bleeding episodes following the regular use of ginkgo: intracranial bleeding (4 cases), spontaneous hyphema (hemorrhage within the anterior chamber of the eye) (1 case), and postoperative bleeding after cholecystectomy (1 case).⁹⁶ One of these reports occurred when a 70-year-old man presented with bleeding from the iris into the anterior chamber of the eye just 1 week after beginning a self-prescribed regimen of a concentrated ginkgo extract twice daily. He was also taking 325 mg of aspirin daily and had done so for 3 years. It is interesting to note that when he discontinued taking the ginkgo, but not the aspirin, the bleeding resolved. There was no recurrence of bleeding 3 months later.¹⁰⁸

Another case is a 61-year-old man who developed subarachnoid hemorrhage after consuming 40 mg of ginkgo 3 or 4 times per day for more than 6 months. No other medication was used. The patient's bleeding time increased to 6 minutes but normalized to 3 minutes within 4 months after discontinuing the ginkgo.¹⁰⁹

A systematic review by Izzo and Ernst discusses 2 case reports documenting that patients taking warfarin and aspirin had experienced severe spontaneous bleeding after self-prescribing ginkgo at recommended doses.⁹⁵ A fatal intracerebral mass bleeding was reported in a 71-year-old man who had taken ginkgo in conjunction with ibuprofen. He was previously in excellent health. He had been taking ginkgo for 2 ½ years for self-reported dizziness and had added ibuprofen 600 mg daily for osteoarthritis of the hip just 4 weeks prior to his death.¹¹⁰ This is a good example of an otherwise healthy older patient self-medicating with fatal consequences.

A 40-year-old woman was admitted to the hospital with an acute subdural hematoma with no history of head trauma, falls, alcohol abuse, or bleeding disorders. Her hematoma was evacuated via burr holes, yet her blood results, especially the INR, were difficult to stabilize. After treatment and questioning, it was revealed that she had been taking 40 mg of ginkgo twice daily for the past 2 months to "assist her while studying." Disturbingly, her family continued to give her the herb while in the hospital, stating that they were "just herbs." Once the herb was discontinued, the blood results returned to normal.⁹⁷

Clearly, ginkgo has tremendous potential for causing bleeding complications, and with its broad range of claimed benefits, the use of this herb is attractive to many. With a growing geriatric population and baby boomers wishing to preserve cognitive function, it is safe to expect use of this herb to increase.

Ginseng Panax quinquefolius Panax ginseng

Recommended dosage for general use: Capsules: 200-500 mg extract daily; Powdered root: 1-4 g daily; standardized extract: 200-500 mg daily; Tincture: 1-2 ml extract daily (1:1 dilution)

Ginseng is one of the most popular, well-known, and valued herbs worldwide. *Panax Ginseng* has been used medicinally in Asia for more than 5000 years and, in China, it is more highly valued than gold.¹¹¹ The Chinese believe that ginseng can fight cancer, slow aging, protect one against heart attack and other sudden illnesses, strengthen digestion, and reduce high blood pressure, among numerous other benefits.¹¹² The Asian population is significant in the United States. According to the US Census 2000, almost 12 million Asians are living in the United States, and the Asian population increased faster than the total population between 1990 and 2000.¹¹³ With the increasing interest in both alternative medicine and traditional Chinese medicine, the use of ginseng will continue to be strong by a large segment of the population.

The word *Panax* is derived from the Greek word for panacea, as the herb is considered a cure-all, ie, good for all parts of the body. In fact, the plant itself resembles a human figure. According to Chinese sages, ginseng replenishes vital energy,

increases production of vital body fluids, and promotes health and longevity. This is the concept of a tonic or adaptogen, which our culture has little understanding of.

Standardized ginseng extracts contain 5% ginsenosides, an aglycone chemical component believed to act as a stimulant. Ginsenosides act on the hypothalamus-pituitary-adrenal cortex axis, stimulating the secretion of adrenocorticotropic hormone (ACTH), which increases production of the adrenal hormones (eg, cortisol, sex hormones, aldosterone). Thus, ginseng produces central nervous system (CNS) stimulating effects, estrogen-like effects, and elevates blood pressure.²⁹ Ginseng is also thought to restore and strengthen the body's immune response, and promotes growth of normal cells.¹⁰⁴

The ginsenosides are also believed to have the potential to inhibit platelet-activating factor.¹⁰⁶ Ginseng has been reported to inhibit platelet-activating factor (PAF), platelet aggregation, thrombin and thromboplastin, and can cause further bleeding when combined with aspirin, heparin, warfarin, and non-steroidal anti-inflammatory drugs.¹¹⁵

There are only a few kinds of "true" ginsengs in the botanical genus *Panax*. There are other plants that are in the ginseng family, but they are more distantly related to ginseng botanically, such as *eleuthero* or *Siberian Ginseng*. These other ginsengs affect the body in similar ways. They are not as powerful as "true" ginsengs, but they are less costly. True ginsengs in the *Panax* category include: Oriental, Chinese, Korean and American ginseng.¹¹²

The effects of ginseng are supported by hundreds of laboratory experiments, but there are very few controlled human studies.¹¹² Two laboratory studies assessed the potential for ginseng to cause bleeding. Chung and colleagues (1987) examined the effect of a ginkgolide mixture (BN 52063) in antagonizing skin and platelet responses to PAF in human subjects. The ginkgolide significantly inhibited PAF-induced platelet aggregation in platelet-rich plasma ($p < 0.001$). The researchers concluded that the BN 52063 "seems to be an antagonist of PAF in man."¹⁰⁵

There is some research to suggest that Oriental ginseng (*Ginsana*) may antagonize the anticoagulant effects of warfarin. In 1 case report, the INR of a 47-year-old man who had been receiving warfarin for 9 months (7.5 mg every Tuesday and 5 mg on all other days) to prevent thrombotic complications associated with a mechanical heart valve was stabilized at 3.9 - 4.0. The patient began taking Oriental ginseng, and within 2 weeks, his INR fell to 1.5. The patient denied any other changes in his medication regimen, including the use of other nonprescription or herbal products, diet, alcohol consumption, or other lifestyle factors that may have affected his response to warfarin. The patient's INR returned to therapeutic level (3.3) 2 weeks after he stopped using ginseng.¹¹⁶

Ginseng possesses a paradoxical effect. Despite ginseng's anticoagulant potential, it has been noted to decrease the effectiveness of warfarin. Yuan and colleagues (2004) conducted a study with 20 healthy volunteers to assess this potential drug-herb interaction. Subjects had no medical conditions requiring warfarin, nor had they taken warfarin or ginseng. During the 4-week study period, all of the volunteers were given warfarin. During the second week, the researchers randomly assigned each volunteer either a placebo or ginseng, taken in addition to the warfarin. Subjects had their blood clotting times tested using the INR. Results of the study revealed that the subjects taking ginseng had lower blood levels of warfarin, thus compromising anticoagulation.¹¹⁷

As previously stated, ginseng increases the production of adrenal hormones, including the sex hormones, leading to estrogen-like effects. There is a case report of postmenopausal bleeding that was attributed to the use of topical ginseng. A 44-year-old woman used a ginseng face cream from China in the hopes of relieving some post-menopausal symptoms. After using the cream, she experienced 2 episodes of spotting and her follicle-stimulating hormone (FSH) dropped significantly. After one month of discontinuing the product, the bleeding stopped and her FSH returned to previous levels. The authors concluded that ginseng appeared to have an estrogen-like effect on genital tissues.¹¹⁸ With its broad range of claimed benefits from increased physical endurance to improved ability to cope with stress, it seems reasonable to expect that all ginsengs will continue to be a popular choice in an increasingly fast-paced society.

Ginger Zingiber officinale

Recommended dosage for general use: Dried ginger capsules: 1 g/day; Dried root equivalent: 500mg bid-qid; Fluid extract: 0.7-2ml/day (1:2 dilution); Tablets/caps: 500 mg bid-qid; Tincture: 1.7-5 ml/day (1:5 dilution)

Ginger is primarily used to relieve motion and morning sickness, and preliminary research documents its efficacy in decreasing pain and inflammation associated with arthritis and other joint disorders.¹⁰⁶ Traditionally, in herbal folklore, ginger is best known for settling upset stomachs. The major constituents of ginger are pungent principles (gingerol, shogaol, zingerone), volatile oils (bisabolene, zingiberene, zingiberol), and proteolytic enzymes. Many people consider ginger to be a root, but it is actually a rhizome. *Zingiber* comes from the Sanskrit word for ginger, *singabera*, meaning "shaped like a horn."¹¹⁹

The research on ginger is mixed and limited to a few case reports, small scale in vivo studies and some *in vitro* studies. In one laboratory test, aqueous ginger extract reduced platelet thromboxane and also inhibited platelet aggregation.¹²⁰ In a small study of 8 healthy male volunteers, subjects ingested either 2 grams of dried ginger in capsule form or a placebo. Bleeding time, platelet count, thromboelastography, and whole blood platelet aggregometry were performed before, 3 hours, and 24 hours after ingestion. It was concluded that the effect of ginger on thromboxane synthetase activity was dose dependent and only occurs with fresh ginger, and that up to 2 grams of dried ginger is unlikely to cause platelet dysfunction when used therapeutically. Data obtained from case reports and studies with very small sample sizes (eg, N=7) suggest that ginger's antiplatelet effect exists with raw ginger only. For example, in one case report, an unspecified amount of marmalade with 15% raw ginger was consumed leading to inhibition of platelet aggregation. One week after discontinuing ginger, platelet function was described as spontaneously returning to normal.¹²¹ It is important to note that these are very small sample populations, and additional study is needed to further define the effects of ginger on platelet function.

Despite the lack of substantial evidence, ginger continues to be included in published literature reviews that detail the ability of herbal therapies to increase clotting time either alone or together with another herb or prescription drug.^{96,114,122} Further, as one of the "few G's," health care professionals need to be aware of the potential for adverse bleeding events.

St John's wort Hypericum perforatum L

Recommended Dosage for general use: 300 mg hypericum extract, standardized to 0.3% hypericin, tid

St John's wort is a popular herb used to manage mild to moderate depression. Depression is a silent health threat and statistics from the NIH indicate the highest risk is among middle-aged adults, aged 45 years to 64 years.¹²³ Depression is considered to be of epidemic proportion among adolescents in the United States, and is more common in women. This herb is one of few herbs with a significant body of research to support its efficacy. Given its popularity and numerous adverse effects, there are significant risks associated with undisclosed usage among patients.

St John's wort has had a colorful history. Ancient Europeans believed it had magical protective powers against disease and evil. Ancient herbalists from Hippocrates to Dioscorides valued St John's wort not only for the treatment of "melancholia" and other emotional disorders, but also for burns, wounds (especially those involving nerve injuries), neuralgia or nerve pain, inflammation, ulcers, and more. Today, it is used as an antidepressant. The major constituents of the herb include: hypericin, hyperforin, pseudohypericin, flavonoids, xanthenes, and essential oils.

A meta-analysis of 23 randomized European clinical investigations involving a total of 1757 patients concluded that standardized St. John's wort extract was significantly more effective than placebo and just as effective as standard antidepressant medications in the treatment of mild or moderate depression.¹¹⁹ Since 1998, 7 case reports were received by the Medical Products Agency (MPA) in Sweden that demonstrated a reduced anticoagulant effect of warfarin (decreased INR) associated with the concomitant use of St John's wort. This is the opposite of the other herbal interactions previously discussed, and is actually more dangerous, as the effect would be to potentially increase clotting. The reduced anticoagulation effect of warfarin is likely caused by induction of the liver enzyme cytochrome P450 2C9, which increases the metabolism of warfarin, thus decreasing its effect.¹²⁴ None of the patients in these studies developed thromboembolic complications,

but the decrease in INR was thought to be clinically significant. The INR returned to target values either after the warfarin dose was increased or the St John's wort was withdrawn.

The induction reaction of hepatic cytochrome P450 has been attributed to the hypericum extracts from St. John's wort, which may double the metabolic activity of the liver, and thus reduce the effects of many drugs.¹²⁵ For example, use of St John's wort (900 mg per day of hypericum extract LI160) resulted in a significant decrease of digoxin when compared to placebo in subject taking 0.25 mg of digoxin per day.¹²⁶ Digoxin is a drug that is used for the treatment of congestive heart failure and various types of arrhythmias.²⁹ It is easy to see that the adverse metabolic effects of this herb can cause many significant complications in patients with heart disease.

The National Center for Complementary and Alternative Medicine is studying the effects of St John's wort for a wide spectrum of mood disorders. Positive research findings will likely lead to renewed interest in this herbal remedy.

Practice Considerations for Dental Professionals

The most important risk reduction strategy implemented by dental professionals is the completion of a comprehensive health history for every patient on a regular basis. The review of systems allows for the discovery of systemic conditions that alter bleeding, or that require the use of drugs that alter bleeding. Systemic causes of bleeding include liver disease, kidney disease, chronic alcoholism, bone marrow suppression, blood dyscrasias, Vitamin K deficiency, and inherited coagulopathies.^{127,128} As most clotting factors are formed by the liver, liver disease can greatly affect bleeding tendencies. Dental patients may present with liver disease caused by a variety of conditions, most commonly alcoholism, cirrhosis, and/or infections, such as hepatitis.

Intestinal bacteria continually produce Vitamin K, thus, a deficiency is rarely seen in a normal person due to an absence of Vitamin K from the diet. Exceptions are those with gastrointestinal diseases that result in poor fat absorption, as Vitamin K is fat-soluble and is absorbed into the blood along with dietary fats. One of the most common causes of Vitamin K deficiency is failure of the liver to secrete bile into the gastrointestinal tract, as lack of bile prevents fat digestion and absorption, thus reducing Vitamin K absorption as well.²⁶

Dental professionals should remember to question patients about recent illnesses, changes in health behaviors, or modifications to their diets. Intestinal viruses that cause vomiting or diarrhea, changes in the intake of green leafy vegetables, or the use of medications can dramatically alter the patient's response to warfarin. Fluctuations in the patient's INR may be seen for several days, even weeks, following illness, dietary, or medication changes. It is essential to ask all patients taking warfarin about the results of their most recent INR. A follow-up with the patient's physician may be warranted.

At every appointment, patients should provide a list of all of the medications and herbs that they take, including dosing schedules. This medication list should be documented in the treatment record at every appointment. Follow-up questioning of the patient is conducted as a component of the comprehensive health history to ensure that this list is accurate and complete. It is important to note that many patients think of some herbs as merely popular cooking ingredients (eg, garlic and ginger) and/or that these plant-derived substances are all natural, and must therefore be "safe" health products for ingestion. For this reason, patients must often be prompted to disclose the use of herbal medications. Remember that many herbal preparations contain multiple herbs within one supplement and that patients may not always know what herbs they are consuming in these products. While clearly herbs provide substantive and beneficial health properties, consuming herbs on a regular basis from either supplement use or cooking can potentially alter bleeding.

It is imperative that dental professionals have access to a good drug reference guide, either as a chairside reference text or in the form of an electronic database, to assist with completing an accurate medication list. Many popular dental drug resources also contain information on herbal medications, although dental professionals may find it helpful to also have a resource that is strictly devoted to herbal supplements. Resources provide valuable information about drug dosing, common side effects, drug interactions, and precautions for treating patients using these medications. Dental professionals should look up all medications that a patient is taking prior to prescribing other medications to ensure safety and compatibility. Text versions of reference guides should be replaced on an annual basis, as the field continuously evolves

and changes. The advantages to electronic databases include speed of access to and the immediate availability of a vast quantity of information, and access to the most current drug data. Suggested resources for dental professionals are listed at the end of this paper. **(Please see Resources for Dental Professionals.)**

Dental professionals should also observe their patients for physical manifestations of bleeding complications. Signs of altered bleeding may include excessive or diffuse bruising, petechial hemorrhaging, prolonged bleeding following dental procedures, and spontaneous gingival bleeding. Patients may report bruising easily or noticing an increase in bleeding with toothbrushing and flossing. Bruising is frequently observed in elderly patients taking antiplatelet and anticoagulant medications, who also demonstrate epithelial thinning as a normal part of aging. Clinical signs from observation and symptoms described by the patient should be documented in the treatment record.

Whenever there is doubt as to the patient's safety and/or the stability of his current medical status, the patient's physician should be contacted. The dental professional must be prepared to discuss the nature of the concern and proposed dental treatment with associated or potential risks, then request any information needed to safely proceed with treatment. Results from recent, relevant laboratory tests should be obtained for the treatment record. Copies of any test results ordered by the dentist that are required prior to initiating dental treatment should be forwarded to the patient's physician as needed. Conversations with the patient's physician must be documented in the treatment record.

As previously discussed, few anticoagulant and antiplatelet medications require discontinuation prior to routine dental treatment. Exceptions have been previously noted elsewhere in this paper. However, discontinuation may be required prior to invasive dental surgery. Herbal supplements should always be discontinued prior to any type of surgery, including dental surgery. Different herbs possess specific safety windows that range from 24 hours (ephedra) to 7 days to 14 days (garlic and ginseng) prior to undergoing surgery.²⁰ Patients taking herbal supplements that possess anticoagulant and/or antiplatelet properties should be advised to discontinue use at least 2 weeks prior to having a surgical procedure until more is definitively known about the potential for bleeding complications.^{6,29} This 2 week to 3 week safety window is suggested by the American Society of Anesthesiologists (ASA).²⁰ It is important to note that the safety window also takes into account other herbal side effects that may increase surgical risk, such as the ability to recover from general anesthesia. A discussion of these and other effects is beyond the scope of this paper. The reader is referred to Ang-Lee et al (2001) for a detailed discussion of these considerations.

Despite careful planning and precautions, the potential for an unexpected bleeding event always exists for patients taking these medications. Therefore, it is essential that dental professionals have access to local hemostatic agents for use in the operatory. There are a variety of pharmacologic agents that are available for this purpose; however, a complete discussion about these products is beyond the scope of this paper. The reader is referred to Burrell and Glick (2003) for a review of hemostatic agents used in dentistry.¹²⁹ Invasive procedures should be performed with as minimal trauma to the tissues as possible. Careful post-surgical monitoring is advised.⁶

To determine whether increased gingival bleeding is caused by a medication side effect, or is a manifestation of gingival disease, a thorough oral examination should be performed at each visit. Patients should be taught proper oral hygiene techniques to decrease etiologic bacteria that cause gingival inflammation. Manual plaque removal may be improved through the use of power-assisted toothbrushes, floss aids, and oral irrigators. Chemotherapeutic agents that exhibit antimicrobial properties are useful adjuncts to kill residual organisms that brushing and flossing may leave behind. Broad-spectrum antimicrobial agents, such as chlorhexidine, essential oil mouthrinse, and triclosan toothpaste, have demonstrated efficacy in reducing supragingival plaque and gingivitis, and resultant gingival bleeding. Improving oral hygiene reduces gingival inflammation, thus eliminating the primary etiologic factor for gingival bleeding. It is important to teach patients that gingival bleeding is not "normal," as so many patients mistakenly believe, so that gingival bleeding as a complication of medication therapy can be quickly and accurately identified.

Dental hygienists possess an important role in educating patients about bleeding effects that may affect the oral cavity and the provision of oral health care services. Patients should be taught about the importance of accurately reporting their medication and herbal use, compliance with their medication regimens, and routine monitoring with blood tests as prescribed by their physicians. Patient education may also include dispelling myths about the need to discontinue medication use prior to undergoing routine oral care. Many patients discontinue their medications on their own, without consulting their

physicians or dental professionals, because they are worried about a bleeding complication. It is important to educate patients about how bleeding is adequately managed in the oral health care setting, provide reassurance, and how, if needed, their medications should be discontinued.

Resources for Dental Professionals:

National Center for Complementary and Alternative Medicine<http://nccam.nih.gov>

Food and Drug Administrationwww.fda.gov www.cfsan.fda.gov

Websites

American Botanical Council (publishes Herbalgram)

American Holistic Medical Association

Consumer Labs - Independent testing on herbs/supplements

Food and Nutrition Information Center

HerbMed

Herb Research Foundation

Lexi-Comp, Incorporated

Medline

Medline Plus

Mosby

Pubmed

Pubmed - screened for alternative medicine

RxList Alternatives

WebMD

Brochures

American Society of Anesthesiologists. Phone: 847-825-5586. "What You Show Know About Herbal Use and Anesthesia."
"What You Should Know About Your Patient's Use of Herbal Medicine." www.asahq.org.

Journals and Newsletters

Herbalgram - The Journal of the American Botanical Council and the Herb Research Foundation - published quarterly (\$50/year = four issues) Phone: 800-373-7105 www.herbalgram.org

Self Healing - Andrew Weil, MD newsletter - Phone: 1-800-523-3296 www.drweilselfhealing.com

Books

LaValle J Krinsky D, Hawkins E, Pelton, R, Willis, N. Natural Therapeutics Pocket Guide. 2nd ed. Hudson: Lexi-Comp, Inc., 2003.

Skidmore-Roth L. Mosby's Handbook of Herbs and Natural Supplements. 3rd ed. Littleton: Mosby, 2006.

Wynn RL, Meiller T, Crossley HL. Drug Information Handbook for Dentistry, 11th ed. Hudson: Lexi-Comp Inc., 2006.
Brinker F. Herb Contraindications and Drug Interactions. 3rd ed. Sandy: Eclectic Medical Publications, 2002.
Hobbs C. Herbal Remedies for Dummies. Foster City: IDG Books Worldwide, 1998.

Journal Full Issues and Articles

The Journal of the American Medical Association - Volume 280, No. 18 - November 11, 1998. Entire issue devoted to comprehensive alternative medicine research and editorials.

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