CANADIAN JOURNAL OF DENTAL HYGIENE · JOURNAL CANADIEN DE L'HYGIÈNE DENTAIRE

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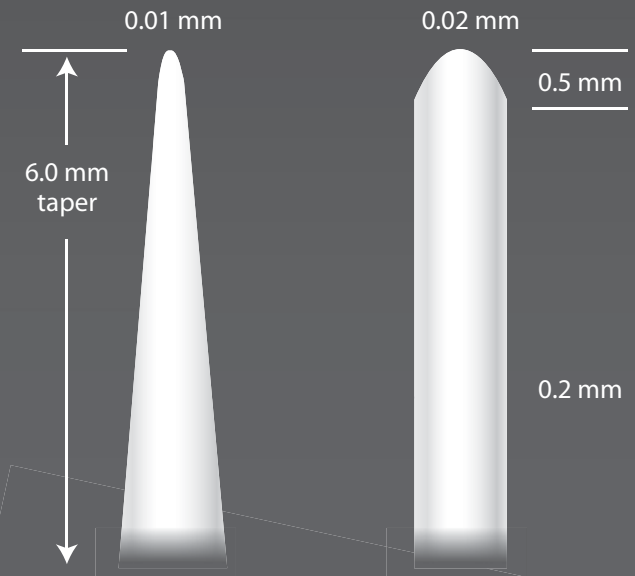

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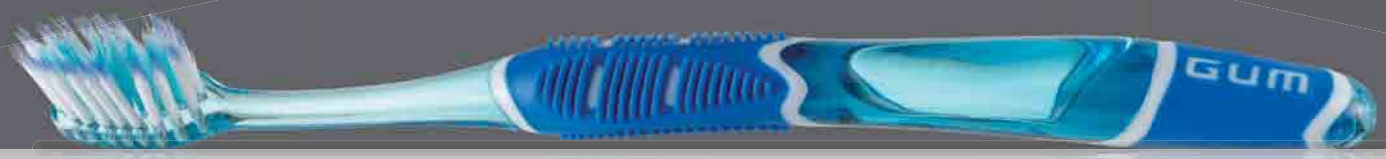

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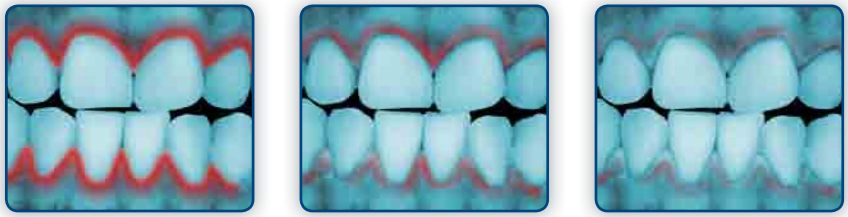

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Supporting dental hygienists to become practice owners

Arlynn Brodie, MHST, BPE, DipPSM, RDH

Over the last decade, many doors have opened to us as dental hygienists to work collaboratively with other health professionals. Likewise, the public is demonstrating an increased support for dental hygienists to work as primary care providers.

Dental hygienists are healthcare practitioners whose area of practice focuses on preventive education and treatment surrounding oral healthcare and health promotion with specialized knowledge of the oral–systemic connection.[1] Dental hygienists working independently in the community can help improve access to care for many of our underresourced populations. Many segments of our Canadian population are medically underserved: the young, the old, the remote, the Inuit, the poor, and the physically and mentally challenged.

CDHA has identified access to care to be an important component to the future of dental hygiene in Canada.[2] Why?

For the profession of dental hygiene to grow, mature, and provide increased access to dental hygiene services, there is a need for dental hygienists to become "players" in the restructuring of Canadian healthcare, and to accept a role in the bigger picture of healthcare delivery in this country. How can this be accomplished?

We can accept the responsibility to:

- Collaborate with other professions on healthcare issues,
- Identify the importance of oral health services,
- Make our services visible to our communities, and
- Make a difference to the oral health of our clients.

More and more, we Canadian dental hygienists are taking the opportunity to challenge ourselves—to digress from traditional practice settings; to push ourselves to go beyond the boundaries of our comfort zone; and to step up to the plate to assume the role of primary healthcare practitioners.

How to decide

Is owning a practice an option for you? I explore this issue from my own practice experience to provide you with an objective look at practice as a primary care provider. It was not long ago when the idea of dental hygienists owning a practice was not even on our radar in Canada. Those who did question the status quo of traditional practice were mocked or thought to be "stirring up trouble". Twenty years ago dental hygienists did not need to ask the question whether providing primary care was a consideration as a career choice. Today, the question is relevant for many dental hygienists to ponder. Practising in a diverse setting as a private practitioner *is* an alternative career choice. Is it an option for every dental hygienist? Not likely, but how do you determine if private practice is a viable option for you?

If you can answer "Yes" to the following questions, then it probably is. Do you have a passion for providing care for clients? Can you envision how the services and activities of dental hygienists can benefit the community, seniors, students, and the general public? Do you have an entrepreneurial spirit? Did you sell lemonade from your driveway as a child? Did you deliver papers or make crafts for resale?

One of the first steps on your road to establishing a practice should be a measurement of your entrepreneurial potential. The basis of research and observations on the characteristics of Canadian entrepreneurs in all industry sectors form the content of this link, www.potentielentrepreneur.ca/client/questionnairenewsection1en.asp

The term "entrepreneurship" has many definitions but usually refers to the undertaking of new initiatives that are innovative and creative. Research into the entrepreneurial personality has shown that most successful entrepreneurs share a group of personality traits and generally view the world with a positive spin, seeking new challenges and opportunities. There are also a number of self evaluation personality/trait questionnaires that can be taken to further assist you in your decision making process. The link, www.outofservice.com/bigfive/ can assist you in determining whether you have the personality for independence.

How to go about it

Many of the remaining questions perturbing dental hygienists relate to the subject of practice ownership.

THIS IS A PEER REVIEWED ARTICLE.
This article is based on one of the CDHA Ends as determined by the CDHA Board of Directors.
Correspondence to: Arlynn Brodie, CDHA President; arlynn@abhygiene.com

Many dental hygienists practising as primary care providers claim the most challenging part of their practice has nothing to do with practising dental hygiene, but everything to do with operating their practice.

Once you have decided you have an entrepreneurial spirit, the next task is to learn something about practice ownership. Where do dental hygienists go to gather credible, reliable information on owning a practice? Provinces have developed province specific guidelines to assist and support you in this. These resources provide excellent checklists for those choosing to work in alternative practice settings (see Table 1). The following reflections and guidelines are intended to help you clarify what being a practice owner entails, and whether it is a career choice for you:

- It is important to assess your current place in your family and working lifecycle. Do you have a supportive network of family or friends that will understand the time commitments you will be putting into your practice? Do you have a clear focus and clarity of purpose for your new venture? It is a good idea to network within your community to find mentors, advisors, and resources. Networking activities such as health fairs, "Women in Business" luncheons, and Chamber of Commerce meetings, all provide the prospective or new business owner with opportunities to dialogue with other entrepreneurs.
- The development of a detailed business plan is an imperative step to the success of your new practice. Completion of a business plan will provide you with all the "need to know" information before you begin. Your business plan is a requirement for securing loans or funding for your business. The link, http://www.canadabusiness.ca/eng/86/4878/ is a fabulous resource and has a breakdown by financial institution.
- Are you financially secure, and can you afford possible initial reductions in your income? What type of business model will you be using for set up—a sole proprietorship, a partnership, or a corporation? The link, http://www.canadabusiness.ca/eng/125/141/ explains clearly the characteristics of each, and is a good reference.
- There are many tax implications and benefits of owning your own practice. Whether you are providing mobile dental hygiene services or operating a practice from a specific site, it is beneficial to be aware of the tax benefits. The link, http://sbinfocanada.about.com/od/taxinfo/a/bizexpenseslist.htm is an excellent resource.
- For your community to understand what oral health services you offer, providing editorials in community newspapers, press releases, positive presence in the community, and face to face involvement with professionals across all health disciplines will illustrate your role as a healthcare practitioner.

Table 1. Province specific guidelines to assist and support primary healthcare practitioners.

British Columbia	http://www.smallbusinessbc.ca/starting-a-business/legal-requirements
Alberta	http://alis.alberta.ca/ec/wo/small-bus.html
Saskatchewan	http://www.enterprisesaskatchewan.ca/startingabusiness
Manitoba	http://www.gov.mb.ca/asset_library/en/business/starting_small_business_mb.pdf
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Newfoundland and Labrador	https://www.nlcu.com/Home/PlanningAndAdvice/StagesInYourBusiness/StartingYourBusiness/
Yukon	http://www.yuwin.ca/links/index.cfm?cat=3&sub=276&fuseaction=onwinlinks
North West Territories	http://www.gov.nt.ca/agendas/business/index.html
Nunavut	http://www.lookupnunavut.ca/business.html

I hope that the resources provided have given you enough "start up" information to kindle some interest in the prospect of practising in a diverse setting. As primary healthcare practitioners, we are advocates for oral health and accept our role to increase access to dental hygiene care across our country.

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Are graduates not prepared for transitioning to practitioner?

Dear editor:

The August 2011 issue of the *Canadian Journal of Dental Hygiene* included short papers from the proceedings at the CDHA National Conference in Halifax this year. As a dental hygiene educator in Ontario, one article[1] drew my attention. I would like the opportunity to respond to this exploratory and descriptive investigation of seven novice dental hygienists in Ontario.

The findings of this study suggest that current dental hygiene graduates are not appropriately prepared for the transition from student to practitioner,[1] certainly challenges me as an educator. This article[1] has sparked substantial discussion and debate among my colleagues. I immediately questioned the interpretation of these results based on seven volunteer dental hygienists, and whether or not these seven participants represent the majority of novice dental hygienists in Ontario.[1] In reading the article,[1] it is not obvious that six are graduates of private schools of which two are non accredited institutions. Also noteworthy is that accredited, community college based dental hygiene programs produce 37% of the graduate dental hygienists in Ontario, according to published NDHCB examination results.[2] One additional factor I have considered is that the published article is the short version, which perhaps does a disservice as this version does not fully explain choices made in the research process, such as how the participants were selected in the first place. I have been unable to obtain the full length version of this article, but am interested to read it.

In order to fully understand the findings,[1] I have read and re-read this study, and have expanded my understanding of qualitative research. I do not question the participants' observations, but do question whether the findings are transferable to the larger population of fresh graduates in transition. However, this is not the intent of the article since the purpose of qualitative research is to describe or understand the phenomenon of interest from the participants' perspective. Therefore, I respectfully remind readers that the results should be interpreted as a collection of observations that are valid to the participants. The observations and the conclusions drawn in this article[1] are reminders to all dental hygiene educators and related decision makers of the numerous challenges we face in providing the educational foundation for future dental hygienists. I extend my thanks to the author and my colleagues for the stimulating discussion; I have learned a lot, and enjoyed the debate.

Sincerely,
Helen Symons, RDH, BSc
Dental Hygiene Educator, Fanshawe College, London, ON
hsymons@fanshawec.ca

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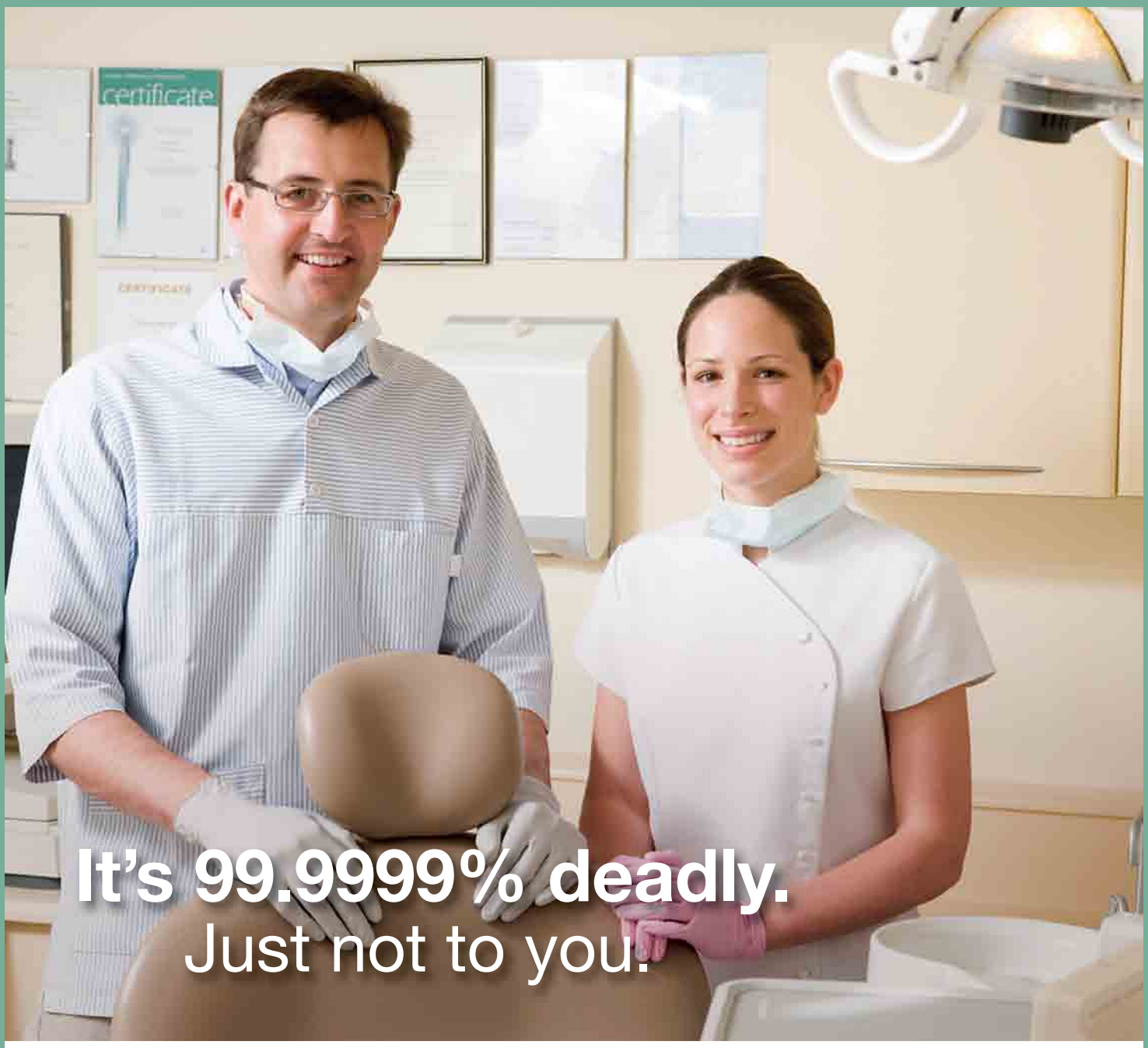

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Scholarship in teaching and learning in dental hygiene education

Dear editor:

The promotion of higher education in dental hygiene is instrumental for the advancement of dental hygiene research, knowledge, and practice; and is vital for the progress of our profession. There must be a clear recognition of the role dental hygiene educators play in influencing educational growth through their own scholarship.

Historically, the understanding of scholarship activity for educators involved the emphasis on production of research and publication.[1] More recently, the notion of scholarship has received increased renewed attention. In the 1990s, Ernest Boyer[1] challenged the restricted and rigid understandings of scholarship with the publication of *Scholarship Reconsidered: Priorities of the Professoriate.* His model of scholarship[1] includes all aspects of the faculty role, and emphasizes teaching as a scholarly endeavour. Boyer adopts four areas of scholarship; scholarship of discovery, integration, application, and teaching.[1] These four areas can be considered to stimulate research and inquiry among dental hygiene educators promoting higher education for our profession. More particularly, I'd like to exemplify how this model can be applied to dental hygiene education.

The **scholarship of discovery** is the traditional practice of engaging in original research to gain new knowledge based on the concept of evidence based practice in dental hygiene.[1] Dental hygiene educators must be challenged to incorporate evidence based inquiry into their own teaching. This includes development of faculty with expert critical appraisal skills required for exploring and expanding knowledge on effective dental hygiene care and its use in healthcare settings.

Discovery of new knowledge often involves integration of theory into practice. The **scholarship of integration** involves linking of diverse facts across discipline boundaries offering interpretations, linkages and new insights on original research.[1] An example of the scholarship of integration in dental hygiene practice can be drawn from the link between oral and systemic health. Dental hygiene faculty may study the impact of an interprofessional approach to patient care that may stimulate faculty to seek higher education to better align themselves among other health professions.

The integration of knowledge may be confirmed through practice and application. The **scholarship of application** involves expanding intellectual knowledge when theory interacts with practice, and practice informs theory.[1] An example of this involves testing research theory in the context of clinical practice. In the aspect of scholarship, faculty must remain current in professional practice, and have a highly developed understanding of the applied clinical experience of their profession. Currently, many dental hygiene faculty members engage in clinical practice and teaching activity. Research in this area may encourage inquiry into practice that is vital to scholarly activity.

Last of all, **the scholarship of teaching** involves educating learners through general knowledge of the field fostering life long learning through critical and creative thinking.[2] With the focus of entry-to-practice educational standards shifting from the diploma to a baccalaureate degree, dental hygiene educators and faculty need to understand the conceptual basis for higher education, and the associated developmental needs and learning styles of the current dental hygiene student. For example, the use of mentorship for both dental hygiene faculty and students in research with development of learning portfolios can promote the scholarship of teaching in dental hygiene.

Boyer's concept of scholarship[1] provides a flexible and credible means of applying research in dental hygiene practice and education, and may serve to stimulate inquiry among dental hygiene educators. Scholarship need not imply a narrow focus on scientific research; rather, it embraces many aspects of dental hygiene teaching and learning.

Sincerely,
Lizelle Tucci
E-mail: elle.tucci@gmail.com

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Growth of the dental hygiene profession

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Growth in a profession is connected to acquiring knowledge and dissemination of that knowledge to its members and the public. Dental hygienists from around the world met to learn from the experts, share their knowledge, and plan for the future in October 2011, at the 2nd North American/Global Dental Hygiene Research Conference held in Bethesda, Maryland, USA. Attendees travelled from many areas of the globe including the United States, Canada, Australia, Europe and Asia, representing dental hygienists from private practice, corporate entities, laboratory and clinical research, undergraduate and graduate dental hygiene programs and professional organizations, such as the American Dental Hygienists' Association and the Canadian Dental Hygienists Association. Particularly exciting for us was to see the future leaders of our profession—the dental hygiene graduate students representing several of the Master of Science degree programs. These students had an opportunity to learn from the experts in the fields of Dentistry and Dental Hygiene, Medicine and Public Health, among other fields, and to learn about their professional journeys. Knowledge was shared and mentoring occurred, one of the hallmarks of a successful conference!

We are happy to share the proceedings of the 2nd North American/Global Dental Hygiene Research Conference through a joint collaboration between the American Dental Hygienists' Association and the Canadian Dental Hygienists Association. If you were at the conference, the proceedings will be a wonderful review of content discussed at the meeting. If you were unable to attend, please read the proceedings from cover to cover! The amount of knowledge in these pages is phenomenal!

As editors, we wish to extend a warm word of thanks to Dr. Ann Eshenaur Spolarich and Dr. Jane Forrest for their commitment to the dental hygiene profession, and for the many hours it took to plan such a great conference. We hope to see you at the next conference!

This joint editorial celebrates the publication of the 2nd North American Dental Hygiene Research Conference proceedings in the two peer reviewed journals, *Canadian Journal of Dental Hygiene* and the *Journal of Dental Hygiene*.

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Plan ahead and participate in the events posted.

Online event	Launched 19 January	On demand webinar	*Shedding new light on oral cancer*	VELscope Vx Enhanced Oral Assessment
Online event	February	On demand webinar	*Elder Abuse series (3rd in the series of three) En français*	CDHA ACHD
Online event	1 February	On demand webinar	*Oraqix®: Needle free anesthesia for non surgical periodontal therapy*	oraqix For better dentistry Dentsply Canada
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Online event	Spring	On demand webinar	*Self initiation: Stop kicking the tires. Take a test drive!*	CDHA ACHD
Online event	Spring	On demand webinar	*Understanding terms of employment. Know your status.*	CDHA ACHD
Online event	Spring	On demand webinar	*Preventing neuromuscular disorders: Repetitive motion injuries, posture and more*	CDHA ACHD

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The 2nd North American/Global Dental Hygiene Research Conference

October 20–22, 2011
Bethesda, Maryland, USA

Left: **Jane L. Forrest**, RDH, EdD
Conference Co-Chair

Right: **Ann Eshenaur Spolarich**, RDH, PhD
Conference Co-Chair

Conference overview and acknowledgments

The 2nd North American/Global Dental Hygiene Research Conference was held on October 20–22, 2011, in Bethesda, Maryland, USA. The three-day Conference provided an opportunity for dental hygiene researchers throughout the USA, Canada, Europe, Asia and Australia to convene and explore commonalities in their research interests, learn from each other about new and ongoing research programs, and foster future collaborations. It is our hope that discussion and interest generated at the conference provided the networking support and intellectual stimulation needed to move our research systematically and purposefully forward. To this end, the purpose of the conference was to:

- Share new knowledge obtained through research investigations
- Explore how to translate research to practice in a meaningful and useful manner
- Increase and diversify the number of individuals engaged in oral health research
- Captivate, advance and nurture a cadre of dental hygiene researchers
- Provide information about valid and useful research tools and resources
- Develop and refine research project conceptualization and grant writing skills
- Provide workshops for 'hands-on' training in manuscript preparation, statistics, clinical research, qualitative research, and searching for best evidence
- Promote the effective use of web-based technology for networking, collaborating, and disseminating research findings

In order to achieve these objectives, a program devoted to a wide range of topics was created. Participants had the opportunity to hear updates on oral cancer research and screening, and the state of the science related to use of lasers in dentistry to enhance their ability to translate this knowledge into education and clinical practice. Participants also were able to meet colleagues who are conducting original research about problems encountered every day in practice in order to improve the quality and type of care we provide to our clients. Opportunities to learn about this research were made through 33 poster and 26 oral presentations.

Another opportunity to network with colleagues with similar research interests was through the 10 different Special Interest Group (SIG) sessions devoted to access to care, caries, clinical dental hygiene practice, educational research, health behaviors, health literacy, oral cancer, oral systemic link, periodontics, and technology. Through the DHNet *Network* Section, we look forward to providing a home base for future discussions and building a critical mass of dental hygienists who can participate in future research activities and projects.

Finally, based on the outcomes from the first conference in June 2009, a program was created to enhance training and skill development on a wide range of topics. Eight different continuing education workshops were specifically designed on the following topics: Grant Writing; Manuscript Preparation and Professional Presentations; Keeping Current: Clinical Decision Support Systems; Overcoming the Fear of Statistics; Getting Started in Clinical Research; Introduction to Preparing a Systematic Review; Design Considerations in Qualitative Research; and, Emerging Science that Influences Practice (bisphosphonate-induced osteonecrosis, tobacco cessation interventions, CAMBRA and its implementation in practice). Over 18 hours of CE credit were offered over the three-day conference.

This conference has required over a year of planning, and we must acknowledge the contributions and support that we have received from many individuals and organizations along the way. First, we thank the Canadian and American Dental Hygienists' Associations for again partnering with the National Center for Dental Hygiene Research & Practice to invite dental hygienists from across the continent to participate in this event. Conference attendees represented 9 countries, including 35 states in the U.S., Canada, Australia, Denmark, Germany, Great Britain, Italy, Japan, the Netherlands, and Sweden. Participants included 22 graduate dental hygiene students; 85 full- and part-time faculty from universities, dental schools, and community colleges; 7 dental hygienists from dental school research

centers and private research companies; 18 full-time dental hygiene clinical practitioners and public health/hospital dental hygienists; 1 government director; 28 hygienists, dentists and leaders representing various industries; 6 professional association representatives; 4 journal editors; and, 3 entrepreneurs/independent contractors.

We thank the members of our Advisory Board* for volunteering their time and talents, for facilitating workshops, and for moderating each of the sessions during the meeting. We also thank our volunteers for managing the registration tables and the many companies who graciously donated copies of their research to share with all of the conference participants to further our knowledge and understanding of their products and services.

Most importantly, we extend our deepest and most heartfelt gratitude to our corporate sponsors, The Procter & Gamble Company, Colgate-Palmolive Company, Philips Sonicare, Discus, a Philips company, Johnson & Johnson, and 3M ESPE. We gratefully acknowledge Hu-Friedy Manufacturing Company for an educational grant to support the attendance of our full-time graduate dental hygiene students. This conference would not have been possible without educational grants from our corporate partners, and we thank them for their kindness and generosity.

1. Current topics in oral cancer research and oral cancer screening

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This is peer reviewed content

Early identification and proper evaluation of suspicious oral lesions offers the oral health practitioner the opportunity to impact our patients' health positively. In this presentation, I will review the available adjunctive methods and devices for the evaluation of suspicious oral lesions. I will review the studies that have analyzed the effectiveness of these approaches in a clinical setting. The adjunctive techniques, which I will discuss, are toluidine blue, tissue fluorescence, tissue reflectance, and brush cytology. At the end, I will discuss the role that genomics might play in the future in diagnosing and predicting the clinical behavior of oral cancer.

Toluidine blue

Toluidine blue is a vital stain that binds to nuclear material, and preferentially stains tissues with high rates of cellular proliferation. Toluidine blue is an effective adjunctive screening tool for identifying premalignant lesions or oral cancer recurrences in those who have already been diagnosed with oral dysplasia or oral cancer. Gray and colleagues reviewed 14 large studies on toluidine blue and found that sensitivity for detecting oral cancer ranged from 40% to 100%, and the specificity ranged from 31% to 92%.[1] Toluidine blue can be associated with a high false positive and high false negative rate. For example, 50% of oral lichen planus lesions were positive and only 42% of dysplasias stained positively.[2] Therefore, the provider must be careful not to overextend the utility of this tool. Although toluidine blue is highly sensitive as a screening tool, it should not be used to rule out malignancy: a scalpel biopsy remains the standard of care. Toluidine blue has also been proposed as a tool to predict progression of oral dysplasia to cancer. In one study, toluidine blue stained lesions with high-risk histologic features, with staining correlated to patient outcome.[3] There is no evidence to support the use of toluidine blue as an oral cancer screening tool for the general population.

Tissue fluorescence

Certain cellular molecules, especially those within mitochondria and lysosomes, absorb the energy from light of specific wavelength. When these molecules move back to their unexcited state, the absorbed energy is released. This energy is referred to as fluorescence emissions. Porphyrins in erythrocytes also contribute to autofluorescence. Oral cancer cells have different autofluorescence emission relative to normal oral mucosa. Technology, such as VELscope, has been developed to capitalize on this difference in autofluorescence between cancer and normal tissue and to use this approach to detect pathologic lesions in the oral cavity. VELscope emits a high intensity light that is blue. Unaffected mucosa fluoresces green, while areas of dysplasia or cancer are darker and do not fluoresce. Indications for the VELscope, according to the manufacturer, are to assist in identifying suspicious oral lesions that may require a surgical biopsy and also to delineate the lesional margins at the time of resection.

To date, there are no rigorous studies demonstrating that VELscope improves oral cancer diagnosis or improves

outcome. While one study of 44 patients reported a sensitivity and specificity of 98% and 100% for identifying oral dysplasia or oral cancer respectively, and was verified by surgical biopsy, all of these lesions were visible with standard incandescent lighting and the majority of them were clinically suspicious.[4] At this time, it is unclear whether VELscope is useful in detecting suspicious lesions that are not visible with white light. Similar to toluidine blue, VELscope should not be used to rule out malignancy in visible lesions.

Tissue reflectance

Chemiluminescence, or tissue reflectance, is an adjunctive screening tool that is used to detect cervical premalignant or malignant lesions. Two systems using chemiluminescence developed for the oral cavity are ViziLite Plus and MicroLux DL. The increased nuclear to cytoplasmic ratio characteristic of squamous cell carcinoma increases light reflectance relative to normal epithelium.

The sensitivity of the chemiluminescence devices for highlighting potentially pathologic lesions is high; however, benign lesions, such as leukoedema and traumatic ulcers, test positive. In the available studies, lesions detected by tissue reflectance were also visible under incandescent lighting.[5–9] Because surgical biopsies were not performed to diagnose all detected lesions in the available studies, actual sensitivity and specificity are difficult to report. It is not clear whether these instruments provide any benefit over conventional oral examination under standard incandescent lighting. Oh and Laskin reported that the use of ViziLite actually made visualizing lesions more difficult due to the distracting highlights it created.[8] At best, tissue reflectance technology can be used as an adjunctive screening tool to the conventional oral examination. A scalpel biopsy of suspicious lesions is required.

Brush cytology

The brush biopsy (Oral CDx from CDx Laboratories) is intended for oral lesions that appear innocuous and would not normally be biopsied by the provider. The brush biopsy is intended to be an adjunct diagnostic tool and not a screening tool. Demonstrating efficacy for the diagnosis of suspicious oral lesions with brush cytology is not easy. The population investigated must have lesions that are not already highly suspicious for malignancy, and all lesions in the population must be subjected to surgical biopsy. The available studies evaluating the brush biopsy are not selective for the target population and include likely or biopsy proven malignant lesions. In most of the available studies, lesions that were reported as "negative" based on the brush biopsy have not been confirmed by a surgical biopsy. In one study, all lesions had both a brush biopsy and a surgical biopsy. The sensitivity and specificity were 92.3% and 94.3% respectively in this study.[10] A false negative rate of 7.7% is unacceptably high for an adjunctive diagnostic tool. A further significant drawback of this study is that lesions highly suspicious for malignancy were included. Therefore, the sensitivity might be lower. The current literature does not strongly support adding the brush biopsy to the diagnostic armamentarium.

Genomics

The human genome project, completed in 2002, was to revolutionize surgery and medicine. Scientists predicted that once the entire human genome sequence was known that many cancers, including oral cancer, would be curable. However, our comprehensive understanding of the human genome has not cured cancer. In this lecture, I will attempt to explain why cancer has proven to be more elusive and complex than we expected and why genomics has not led to a cure. I will present the modest headway we have made in predicting cancer behavior with genomics and show how this knowledge has impacted our understanding of the key elements of oral carcinogenesis including: transformation of normal oral mucosa to cancer, local recurrence following resection, development of second primaries and metastasis to the cervical lymphatics. I will show how state-of-the-art genomics might be used in the future to understand and treat oral cancer.

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2. The state of the science of lasers in dentistry

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Introduction

In the modern surgical therapy of oral diseases there are beneficial applications of minimally invasive surgical techniques, like the use of the laser light, which is able to cut, coagulate or ablate tissues due to its high power density. In general, LASER is an acronym of *Light Amplification by Stimulated Emission of Radiation*, which is light with a high power concentrated in a focused area, i.e. the target tissue. There are special characteristics for the laser light. Laser light is *coherent*, which means that the light is directed in a long distance without divergence, in contrast to the sun or a flashlight. It is *collimated*, which means that the laser light can be concentrated in the target tissue with the highest level of energy in the focus (spot) as well as *monochromatic*, which means that it has only one wavelength. The main part of the laser unit is the *active medium*. It is the "brain" of the whole system, where electrons can be activated for the emission of photons.

According to the active medium, lasers can be classified into: a) using solid active mediums (crystals), i.e. Er:YAG, Nd:YAG, Ho:YAG lasers; b) using fluids, i.e. the dye lasers; c) using gases, i.e. CO_2, He:Ne, Argon lasers; and d) using semiconductors, i.e. diode lasers. Dependent on the used power setting, we distinguish lasers to "soft" lasers using a power setting in mW to W level and to "hard" (surgical) lasers using a power level between W and kW. Moreover, all laser units are classified into five groups according to the laser safety level (1, 2, 3A, 3B and 4 safety class) according to laser properties that damage vital tissues irreversibly or not (skin, retina). Most of the lasers used in medical applications belong to the class 3B or 4, and for that reason, a laser safety officer is requested when lasers are used.

Laser-tissue interactions

There are specific laser-tissue interactions dependent on physical parameters (power, power density etc.), tissue consistency, and laser wavelength. Most important among optical tissue properties are the reflection, absorption, scattering and transmission of the light which take place during laser irradiation. The laser light emission is higher and completely different in the blood vessels, but not in the connective tissue when the wavelength represents the Nd:YAG (1,064 nm) or the diode lasers (980 nm or 810 nm). These tissue interactions are different when the laser wavelength is 10,600 nm (CO_2) or the 2,940 nm (Er:YAG laser).

In a similar way, the CO_2 laser or the Er:YAG laser can be absorbed better by the superficial soft tissues, especially from lesions with light colors, and have a reduced absorption from pigmented lesions. In addition, Er:YAG laser light emission is higher in the enamel, dentin, bone or other calcified tissues, and does not have high penetration depth in comparison to other laser systems. Therefore, the Er:YAG laser is used today for cavity preparation, decay or bone removal and not as often for soft tissue procedures. The penetration depth of the Nd:YAG laser is 3–4 mm in comparison to the CO_2 laser, which has only superficial layer effects at a depth of 0.1–0.3 mm.

Laser applications in dentistry

The characteristic differences in properties of laser wavelengths explain the variable clinical effects of lasers observed in dentistry. When treating oral soft tissue lesions, two different techniques can be used: excision or ablation. The laser beam can be used in a focused way in order to excise the tissue. For ablative techniques, tissue is removed with vaporisation layer-by-layer without the possibility of a histological examination with biopsy. In the case of tissue removal using a laser system, a special informed consent has to be given to the oral pathologist in order to better explain possible structural changes caused by the laser. Because water content in the surface of most oral tissues is high, use of the CO_2 laser may be indicated in most soft tissue surgery cases. This allows a relatively precise incision line with sufficient coagulation properties. Table 1 shows the indications of different laser wavelengths in dentistry.

Table 1. Indications and laser wavelengths in dentistry

Application	Laser system
Cavity preparation	Er:YAG
Endodontics	Nd:YAG, diode, Er:YAG
Calculus removal	Er:YAG, ErCr:YSGG
Epithelial removal	CO_2, diode, Nd:YAG, ErYAG
Drug-induced gingival overgrowth	CO_2, diode
Peri-implant gingival overgrowth	CO_2, diode
Peri-implantitis therapy	CO_2, diode, Er:YAG
Soft tissue tumors	CO_2, diode, Nd:YAG, Er:YAG
Pre-prosthetic surgery	CO_2, diode
Precancerous lesions	CO_2, Er:YAG
Bone removal	Er:YAG, Er,Cr:YSGG
Bleeding disorders	Nd:YAG, diode, CO_2
Bacterial reduction	PDT, diode
Phototherapy	soft lasers

Hard tissue applications/ cavity preparation/ operative dentistry:

Due to high absorption of the Er:YAG laser by hydroxyapatite, cavity preparations can be performed using the correct settings of the Er:YAG laser. However, only small carious lesions can be treated this way today, and unfortunately, this does not take place on a routine basis.

Endodontics

Bacterial reduction in the pulp and canal has been studied using different laser systems. The rapid development of laser technology will make it possible to apply this technology for various endodontic procedures, including the cleaning and disinfection of the root canal.

Periodontology – implant dentistry

Periodontal diseases may be treated in a more simple and effective way. Lasers can be used for calculus removal, de-epithelization, to significantly reduce bacteria in the pocket using different laser systems, as well as photodynamic therapy (PDT) in conjunction with non-surgical and surgical therapy. The potential of this treatment is superior; however, large multicenter studies and randomized controlled clinical trials are necessary to compare this kind of therapy with conventional treatments. Patient acceptance and postoperative healing events should also be evaluated.

Surgical removal of gingival overgrowth has been performed using the CO_2 laser. Use of the CO_2 laser produces a comfortable and easy excision, and drug-induced gingival overgrowth can be excised relatively quickly. Occasionally, use of the high-pulsed CO_2 laser or combination scalpel excision with laser coagulation in a defocused mode for ablation is recommended. Peri-implant soft tissue overgrowth can also be excised without complications using the CO_2 laser. Implant surface irradiation reduces bacteria and may stimulate tissues for bone regeneration as a potential therapeutic advantage for using lasers in the treatment of peri-implantitis. Osseointegration depends upon the laser settings and the selected wavelength used.

Laser phototherapy

Biomodulative effects with lasers of low power have additional advantages and potential applications due to increased cellular activity, cell proliferation and collagen synthesis. These effects have indications for bone and periodontal regeneration, in the treatment of postoperative edema and oro-facial pain, and for improving wound healing mechanisms without complications. However, the exact explanation as to how these effects are produced requires further clarification in the future.

Oral and maxillofacial surgery

For the removal of soft tissue tumors and premalignant lesions, the CO_2 laser may be used easily using a non-contact, focused beam in a continuous wave (c.w.) mode. In most cases, a power setting between 2–6 watts (depending upon the laser unit) is sufficient for most minor surgical procedures. For larger-sized and malignant tumors of the oral cavity, use of the CO_2 laser in an ultra-pulse mode may be more advantageous.

For removal of small soft tissue tumors in the oral cavity, the application of fibre-delivery laser systems, like the diode (810 and 980 nm) or the Nd:YAG laser also can be used. Because of the higher penetration depth of these laser wavelengths, the light direction during surgery has to be under control in order to avoid necrosis or other complications in the surrounding healthy tissues. Such complications can be observed when the laser is applied incorrectly near healthy periodontal tissues.

The laser beam will be in contact with the tissue in order to excise the tumor and to make histological examination possible. Non-contact devices lead only to coagulation of the tumor. This may alter the tissue structure after coagulation of the blood vessels, presenting challenges for the pathologist. The coagulation properties of these devices are excellent, and therefore, they can be used in the treatment of patients with systemic bleeding disorders. Cases of treated premalignant and malignant lesions should be monitored postoperatively to detect possible recurrence.

Suggested resources

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3. An introduction to grant writing: De-mystifying the process

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This workshop, an expansion of a session presented at the North American Research Conference in Bethesda, Maryland in 2009,[1] was designed to provide an overview of important components of writing a clear, concise, and tailored grant application. Topics discussed included: review criteria of significance, approach, innovation, investigators, and environment; as well as grant application components of abstract, specific aims, research questions and/or hypothesis statements including PICO components, background and discussion of theoretical model guiding the research, preliminary studies, biographical sketch, timeline, and budget. Activities highlighted some aspects in the grant writing process. Our goals were to enhance participants' understanding of the grant writing process, cultivate a persuasive approach for addressing the essential components of a well-written grant, and provide insight into how to embark upon a successful, comprehensive grant development process.

Develop a track record

The author of a successful grant application and principal investigator of a grant project must first establish a track record. Experience related to the project and to management of a budget are reasonable expectations for any agency or organization granting funding. The path that we followed is similar and may serve as an example for others.

Develop an area of specialty by focusing on a study topic and acquiring knowledge and experience related to becoming an authority in your area of study. Assure your other work contributes to this goal, for example:

- Volunteer to collaborate with established researchers conducting related studies.
- Conduct small scale/pilot studies in the area of interest, and publish or present results at research meetings.
- Apply for small grants from your institution, associations, foundations, or organizations with similar goals; identify new investigator opportunities.
- Seek opportunities to gain experience with research protocols, personnel management, budgeting, and accounting procedures.
- Choose community involvement and design community-based projects related to your study area and build collaborations or coalitions, versus volunteering for others' priorities. Later, you may want to involve community providers in your grant-funded program.
- Present related oral presentations, scientific papers, and continuing education programs at professional meetings.
- Assure work is directed toward benefitting society rather than solely focusing on advancing the dental hygiene profession.

Writing the successful grant application

The most important lesson we learned on the path to successful grant writing was that writing a clear, concise and focused grant application with good science is *not* enough. The successful application must tell an interesting story *plus*:

- Be tailored specifically to the funding agency's mission. Present ideas that are easy for reviewers to understand, including why the study is significant and feasible.
- Convince reviewers you have the expertise to conduct the planned study and you have the appropriate environment, equipment, collaborators, and budget.[2]
- Prepare a reviewer-friendly application that is well organized and clear to minimize the reviewers' work. Make it easy for them to understand your ideas, locate information within the application and be your advocate. Be specific about what you want reviewers to know and what they need to know.
- Follow application instructions exactly.
- Take advantage of institutional resources for assistance in preparing your application and budget and submitting it as required.
- Contact the funding agency's program officer as needed for information related to the agency's goals and procedures.

All successful projects require planning, development, implementation and evaluation. Start early, seek collaborators and support, and note internal as well as external deadlines. Allow at least three months for writing the application. Consider carefully evaluation criteria to be used by reviewers to score your application.

Most funding entities have similar criteria for evaluating grant applications. The following discussion is based on the review criteria of the National Institute of Health of the U.S. Department of Health and Human Services. These criteria include: significance, approach, innovation, investigator, and environment.[3]

Significance

Your study's significance must be made clear and concise and answer questions such as:

- Does the study address an important problem from the funding agency's perspective?
- If the aims are achieved, how will scientific knowledge be advanced?
- What will be the effect of your study on the concepts or methods that drive the field?

Approach

Your study's approach must answer such questions as:

- Are the conceptual/theoretical frameworks, design, methods, and analyses adequately developed, well-integrated, and appropriate to the aims of the study?
- Are potential problem areas acknowledged and alternative strategies considered?

Innovation

In addressing your study's innovation:

- Specifically state why you believe the proposed research is original and innovative, and offer examples.
- Explain how your project challenges existing paradigms or requires developing new methods, techniques or technologies.

Investigator

In addressing this criterion, answer the following questions:

- Are you appropriately trained and well suited to carry out this work?
- Is the work proposed appropriate to your experience level (and that of your collaborators)? Explain how the proposed study is similar to those you have already completed.
- Does the investigative team bring complimentary expertise to the project?
- Are the contributions of each collaborator delineated?
- Have you included letters of commitment and consultation on appropriate letterhead?

In addressing the environment criterion, answer such questions as:

- How does your scientific environment contribute to the probability of success?
- Is there evidence of institutional support (e.g., a letter stating what your institution will provide)?

Grant application components

Abstract

The abstract, your research summary, may be the only part of your application reviewers read. The best approach is to write it first and revise it last when you know your final application content. The abstract states broad, long-term objectives related to the agency's mission, lists specific aims, concisely describes the research design and methods to achieve aims, and highlights relevance to public health.

Specific aims

The Specific Aims, the most important section of the grant application, should be well focused, not overly ambitious and hypothesis driven. It is critical to write them early, circulate them to your team of experts and incorporate their feedback before writing the rest of the proposal. Usually 2 to 4 aims are the norm.

This section typically includes 3 general sections:

1. The "set-up" paragraph, which explains the relationship between a pressing problem and your research theme. This paragraph should strongly persuade reviewers that the topic is important and worthy of their attention
2. The "specific aims" paragraph starts with a sentence like, "The specific aims of the study are to…. " and then lists the aims. Each aim should allude to the techniques used to achieve each one. In listing the specific aims use active verbs, rather than passive ones.
3. The "hypothesis" paragraph points to a specific problem or area and culminates in the statement of the hypothesis. Quantitative hypotheses contain PICO components: problem/population, intervention, comparison, and outcome.

Participants were provided with an example of specific aims to critique and edit in small groups by applying information discussed.

Background and significance

This section must establish 3 things: the project is important, the science is interesting, and there is a high probability of success. This is not a literature review. Educate the reviewers to your way of thinking. Show how the proposed project builds on previous work and identify gaps in previous knowledge.

Preliminary studies

This section should convince reviewers that you know what you are doing. Show that the work is feasible and that you have completed suitable groundwork.

Biographical sketch

A formatted Biographical Sketch is used to convey information about the qualifications, productivity, and the role of the key personnel involved in the proposed project. It is important to convince reviewers that you are highly qualified to carry out the project. A good biosketch includes a personal statement about the goal of the proposed research and your related experience, employment positions, other experiences and professional memberships, honors, peer-reviewed publications, and previous research support.

Workshop participants listed qualifications they would include in a biographical sketch and worked partners to brainstorm about enhancing their sketch.

Timeline

The timeline needs to demonstrate clearly that you can complete the project in the time allocated, be feasible, and realistic. A visual format is easier for reviewers.

Detailed budget and justification

Itemize and justify direct costs. Denote in-kind support and institutional requirements for indirect costs.

Conclusion

In conclusion, always remember that your application is a work of persuasion. It is not merely a description of the work you want to do. Rather you are making an argument that it is work that needs to be done, and that you are the right person to do it.[4]

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4. Techniques for professional presentation of scientific information

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Scientific presentations whether delivered via posters or Power Point are critical vehicles for disseminating cutting edge research findings.[1] Creating and delivering effective, informative and attention-grabbing presentations is no easy feat. Similar to written manuscripts, scientific presentations must be thoroughly planned, outlined and logically organized. Both the written and verbal elements of presentations are critical to the success of the whole package. The speaking and writing components of successful presentations can be taught, practiced, and cultivated.[2] This workshop will discuss and detail the key elements to consider in the planning and delivery of quality scientific presentations. Topics addressed will include: creating compelling research posters and Power Point "slide shows" that incorporate visual appeal, timely content and enhanced readability; verbal delivery that considers word choice, voice flow and modulation; effective use of nonverbal communication such as eye contact and physical movement; use of approaches that appeal to different learning styles and, last, developing a communication style that exhibits confidence, credibility and an element of fun and lightness to capture and keep the audience's attention.

Researchers who create effective scientific posters for presentation at professional meetings convey information succinctly, attractively and meaningfully. A poster should highlight the key components of a research manuscript; i.e., abstract, introduction/background, methods, results, discussion and conclusions. Attractiveness and readability are two major features of a well-done poster. To create visual appeal, provide different options for information giving that "pull in" the viewer; text should be balanced with photographs, tables, graphs and/or charts. Too much text can be overwhelming and can detract from the key "take home" points. Graphics enable the concise presentation of data. Bulleting is useful for presenting a listing of information, such as delineating steps in a methodology. Font size and style must be considered as well as color. As with power points, too much color or the use of harsh color will deter viewers. Color has an effect on how information projects.[3] Other important elements to address include: judicious use of diverse graphics, incorporating main and subcategories to emphasize the importance of information, grammatical and punctuation parallelism, using spacing to enhance readability and key points, and appropriate color variation. Posters must be titled appropriately and computer printed on high quality glossy paper. Appropriate references and institutional/corporate logos also must be included in the final poster.

Power Point presentations are another means for delivering scientific information. Some describe Power Point as the *prima lingua* of science since its presence in research presentations is ubiquitous.[1] The creation of effective Power Point slides (and handouts), i.e., the written components of an oral presentation, can be achieved through adherence to relatively straightforward yet critical standards or foundational guidelines. These guidelines serve to enhance audience receptivity and learning; they consider slide/content readability, viewer comprehension, and the prudent use of multiple media techniques and movement for maintaining audience interest. A partial listing of elementary guidelines for successful creation of Power Point presentations includes:

- using bullets versus complete sentences;
- keeping slides crisp and simple;
- limiting the amount of content per slide;
- selecting appropriate slide lay-outs;
- using templates that are kind to the eye and help control spacing and printing options; and
- applying unity of design.

Hand-outs are accompaniments to the verbal presentation and offer supplemental information that, for lack of space or other reasons, may not have been included in the slide show. Hand-outs also may reiterate and emphasize key points. They should be professionally printed. Many of the guidelines stated above apply to hand-outs.

The verbal component of the oral presentation is paramount. Power Points should be used for enhancement; the audience can read so the presenter need not and should not read slides.[3] Presenters must be tuned into their audiences. By maintaining eye contact with the audience, the presenter will know if he/she has captured or lost the audience. If attention seems to be waning, a different tactic should be adopted; e.g., voice modulation; a slide that shifts the tone; or the presenter may ask the audience if they understood the previous point.[3] Frequent summarizations or reiterations help hold the audience's attention. Other key speaker rules include:

- beginning the presentation in a manner that establishes rapport;
- honoring starting and ending times;
- speaking slowly and loudly;
- stepping away from the podium, if possible, in a non-distracting manner to help engage the audience;
- using good posture; and
- encouraging, repeating and paraphrasing questions so that all audience members can hear and be engaged.

Givens include the need to know the presentation material thoroughly; having the ability to roll with technological challenges; and, acknowledging others' contributions when appropriate. Ideally, the audience should feel that the presenter is passionate about his/her topic, is enjoying being in front of the crowd, and is able to say "I do not know" when an unanswerable question is posed.

In summary, the research community relies on scientific presentations as a means to disseminate and gather information, to consider new theory and to craft future research to generate new knowledge. Sophisticated technology allows for the delivery of scientific presentations that reach audiences around the world. Visuals, in the form of Power Point and poster presentations, accompany the majority of these presentations. Thus, the researcher of today and tomorrow will benefit from skills in creating effective visuals and in communicating compellingly and professionally.

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5. Writing for publication in scientific journals

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

This is peer reviewed content

Writing and contributing to the scientific literature is necessary for the progression of a profession. The American Dental Hygienists' Association has adopted the National Dental Hygiene Research Agenda which provides direction to dental hygienists on priority research areas that can help advance the profession of dental hygiene. While conducting research is vital to growth of the profession, if investigators do not write and publish the results for public review and critique, it does little to advance the status of the profession.

Writers can contribute to the literature by writing various types of manuscripts. Examples include letters to the editor, case reports, a review of the literature, short reports on a topic of interest, book reviews, systematic reviews and original research. This paper will focus on the publication of original research in a peer reviewed, scientific journal.

When planning to write a paper, it is important to determine the type of publication one wishes to contribute. Dental hygienists have several magazines and journals from which to choose. The journals that will have the most significant impact for moving the professional forward are those that are categorized as scientific, peer reviewed publications. For example, the *Journal of Dental Hygiene*, *Journal of Dental Education*, and *Journal of Dental Research* are all examples of publications that are highly respected and publish results of original research investigations. Publishing in journals that are peer reviewed is important because readers know that the papers have been subjected to a rigorous review process by experts in the field that includes an evaluation of the research methodology, statistics and outcomes for accuracy, content and clarity. Another important aspect of the publication of original research is that it is published in a journal that is accessible via MEDLINE so that readers from around the world can access the article.

Following are guidelines for writing an original research publication for a peer reviewed, scientific journal.[1]

1. The first step is to decide on the journal to which the paper will be submitted. Once this has been determined, it is imperative that the author(s) thoroughly read the *Guidelines to Authors* to ensure that the paper is written in the correct format. When an author fails to adhere strictly to the required format, it is an automatic "red flag" to reviewers that other flaws may exist.
2. Abstract: The abstract is typically written last, but it is placed at the beginning of the manuscript. The abstract should provide a complete overview of the article including the question posed in the study, methodology, results and conclusions. The abstract should provide the major points of the paper.
3. Introduction/Review of the Literature: This section introduces the topic and communicates why the information is applicable or important. It states the problem and reviews the current knowledge related to the subject, points out gaps in the current knowledge, and sets the stage for why the current study was needed. Typically, journals do not require or allow a long introduction or review of the literature, so it is imperative that writers prepare a succinct section that reviews only the most important studies. Many writers think they have to review and include *every* article that has been written on the topic. Reviewers want to know that the writer has included the most important literature. Quantity does not always equal quality when it applies to an introduction and literature review.
4. Methods and Materials: This section should provide the reader with enough detail such that the methodology could be duplicated, including statistical tests used to analyze the data. If the author has conducted a survey, for example, they should provide samples of the questions asked in the questionnaire. Was the survey pilot tested prior to distribution to the test audience? Was it approved by an Investigational Review Board? Is the study set up to get positive results only? Was there a control group, if appropriate, for the methodology? Are subjects randomized in groups so that control and experimental groups are comparable or equal at the start of the study? It is important that studies be designed so that every obstacle that might interfere with getting objective results is accounted for before study initiation.
5. Results: The results section should report the findings from the data collection. Since this section is sometimes difficult for readers to understand, writers should use every available resource to present the results in an understandable and accurate way. Use of tables, charts and figures are one way to provide a visual display of results. Text should be used to emphasize important findings but it should not duplicate what can be found in the tables and figures. Tables and figures should be easy to read and interpret. The reader should not have to refer back to the text of the paper to understand what was presented. Many investigators will have a statistician who will help them with the analysis of results. These experts can be extremely beneficial in helping the author (s) with the writing of this section of the paper.

6. Discussion: The discussion section should bring all of the elements together. It can be one of the more enjoyable parts of the paper to write because the author can provide his/her opinion and or speculate why certain results were achieved. In all other parts of the scientific paper, strict guidelines and content must be adhered to but the author has freedom in the discussion section to have an opinion as well as to suggest future directions for research related to the topic. The discussion section should also compare the results found in the study to previously published papers and speculate why similarities and/or differences were discovered.
7. Summary or Conclusions: The summary and conclusion section should be short and concise. Authors should not reiterate the results section but should briefly restate the problem, procedures and findings. No new information is introduced.
8. Acknowledgements: If an author has received funding for the project, this should be acknowledged in the paper in the acknowledgement section at the end of the summary section. In addition, authors should acknowledge a conflict of interest where one might exist. For example, if the author has received research funding from a corporate entity and one of the authors is a member of that company's scientific advisory board, this must be acknowledged. It is not necessarily a negative implication for the paper, but the relationship should be disclosed.
9. References: Every writer is ethically responsible for ensuring that the references cited are the most current ones available. Occasionally, references are cited from classic studies if no current studies have been conducted. The references should support the theoretical basis for the research results and conclusions.[2] Only original references (not secondary references) should be cited, and they should be references the writer has personally read for accuracy.

Readers rely on references to be accurate and obtainable. Web references should adhere to strict guidelines by the journal and be accessible to the reader. In general, references should be cited from peer reviewed references and not professional magazines. Also, many journals have limitations on the numbers of references that are deemed acceptable. This requirement is typically stated in the *Guidelines to Authors*.

Once the paper has been written, authors should have the paper reviewed by individuals who are either content experts or excellent scientific writers, or both. Many authors make the mistake of submitting a paper for publication without having it critiqued. This oversight can delay the review process.

When a paper is submitted to a journal, the editor will decide if the paper is appropriate to send to peer reviewers. Sometimes papers are returned to authors if the paper is not in the correct format or if the editor does not think the paper is appropriate for the journal. Otherwise the editor will approve for the paper to be sent out for peer review. This process may take several weeks or months. Once the first reviews have been returned to the editorial staff, they are then sent to the authors. Occasionally, papers are accepted on the first attempt but most often, the authors are asked to make revisions to the manuscript. Timelines may be incorporated in the review such that writers need to make the revisions and return it to the journal within a few weeks. If authors do not adhere to the timeline, the paper will be treated as a first submission and sent to new reviewers.

When authors submit revisions back to the journal, it is imperative that they also include a written response back outlining every revision they have made according to the request of the reviewers. This simplifies the process for the reviewers and ultimately expedites the publication process.

Of course, the final reward is seeing the paper published and knowing that a contribution has been made to the scientific literature in the author's field. Although the process becomes easier with time and experience, it is a journey that takes effort. However, the effort is worth it once the author sees his/her paper in the peer reviewed literature. Challenge yourself to become a writer and contribute to the dental hygiene profession.

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CJDH Peer reviewers of 2011

Thank you!

In 2011, the peer reviewed *Canadian Journal of Dental Hygiene* grew in size and stature, attracting manuscripts and contributions from researchers, authors, dental hygienists, and members of the Canadian Dental Hygienists Association; many of their manuscripts, pictures, letters to the editor found their way to print. Behind the scenes were accomplished peer reviewers who volunteered to dedicate their quality time, knowledge and experience to enhance the quality of submissions and authorship through their comments.

CDHA gratefully acknowledges the peer reviews of:

Dr. Ava K. Chow
Dr. Banda Reddy
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Dr. Bonnie Branson
Carol Barr Overholt
Catherine Grater-Nakamura
Dr. Catherine M. Hollister
Dr. Cheryl Westphal Thiele
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Dr. William Montelpare
Dr. Hasan G. Yilmaz
Dr. Norman Zinman
Dr. Zdenek Broukal
Zul Kanji

(shadow reviewer)
Aurora Askew

CDHA is also indebted to the volunteered service by the editorial board in guiding the journal to grow into what 82% of member respondents overwhelmingly rated in the *2011 Membership Survey* as "a very effective communications vehicle."

Dr. Katherine Zmetana, *Scientific Editor and Chair*
Barbara Long, SDT, CACE, RDH
Indu Dhir, AAS, BS, MS
Dr. Laura Dempster
Dr. Leeann Donnelly
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6. Keeping current: Clinical decision support systems

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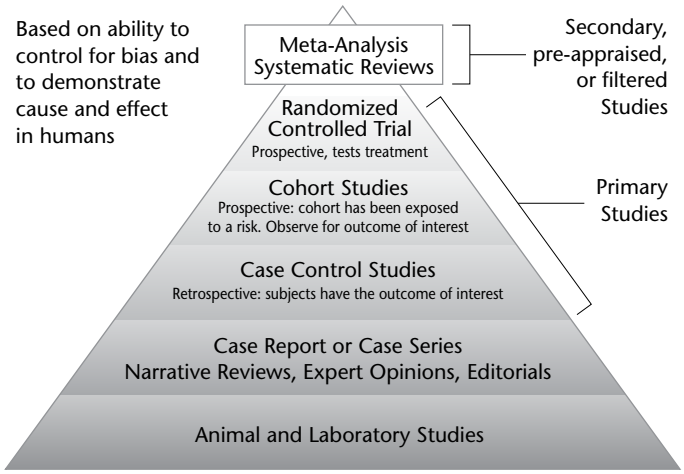
The desire to improve the oral health of patients must start with the clinician's commitment to keep up-to-date with important and useful scientific knowledge. Although the desire may be there, the increase in the number of published articles, new devices, products and drugs has made it nearly impossible to do so. In fact, studies have shown there are widespread discrepancies among practitioners and their ability to stay current, and in some cases those variations are beyond the range of acceptability. Consequently, we now need specific skills to know how to access and critically appraise what we find to see if clinical articles are valid and relevant. The challenge for dental hygienists is to integrate new knowledge whenever it is needed in order to provide the most appropriate care to their patients.

The combination of evidence-based skills and having computers or mobile devices with access to online databases and clinical resources begins to address this challenge. Evidence-based decision making (EBDM) incorporates the skills necessary for life-long learning that are an important part of the decision-making ability to understand, translate and apply relevant scientific evidence to patient care. This goes beyond the skills that most practitioners learned in their formal education. Therefore, this workshop is designed to introduce participants to basic EBDM concepts and skills, and clinical decision support (CDS) resources that can be used in education and practice through using case scenarios.

Figure 1. Hierarchy of Scientific Evidence & Research Designs for Treatment Questions.



Hierarchy of Research Design. Modified from the Evidence Pyramid. Copyright permission granted by SUNY Downstate Medical Center, Medical Research Library at Brooklyn, http://library.downstate.edu/EBM2/2100.htm (4)

EBDM concepts and skills

EBDM is the formalized process of using a specific set of skills for identifying, searching for, and interpreting clinical and scientific evidence so that it can be used at the point of care. The scientific evidence is considered in conjunction with the clinician's experience and judgment, the patient's preferences and values, and the clinical/patient circumstances.[1] Thus, optimal decisions are made when all four components are considered.

It is important to understand research designs and the corresponding level of evidence that results from a research study. For example, knowing the level of evidence helps guide clinicians in locating appropriate research studies and then decide about whether or not they can place confidence in the findings. Since not all evidence is equal, a hierarchy of evidence exists to guide clinical decision making.[2]

The hierarchy consists of two categories of evidence sources: primary, or original research studies, and secondary, or pre-appraised or synthesized publication of the primary/original research. *Pre-appraised* means that the research evidence has undergone a filtering process to include only those studies that are of higher quality, and they are regularly updated so that the evidence accessed through these resources is current.[3] Figure 1 illustrates the hierarchy[4] and the division among the two categories of evidence sources.

The "gold standard" for treatment questions includes the meta-analysis or systematic review (synthesis of 2 or more randomized controlled trials {RCTs} answering the same question). Also considered at Level 1 is an individual RCT. Ideally, this level of evidence is used in preparing clinical practice guidelines. These are followed respectively by cohort studies (Level 2), case-control studies (Level 3), case reports (Level 4) to studies not involving human subjects. Although each level of the hierarchy may contribute to the total body of knowledge, "...not all levels are equally useful for making patient care decisions."[5] As you progress up the pyramid, the number of studies decreases, while at the

same time their relevance to answering clinical questions increases. Recognizing the level of design used to answer a question is important to evidence-based clinical decision-making.

Hierarchy of pre-appraised evidence

To streamline the integration of research into practice and make it more user-friendly for practitioners, clinical decision support (CDS) resources are emerging to simplify access to relevant, usable information. Many of these resources are pre-appraised and are presented in an easy to read format that allows the user to minimize the time needed to digest the information, learn of its clinical application and determine its relevancy to the patient problem or question at hand (Figure 2). "The goal of CDS is to provide the right information, to the right person, in the right format, through the right channel, at the right point in workflow to improve health and health care decisions and outcomes."[6, p.13]

Computerized *Clinical Decision Support Systems* (CDSS) are at the top of the hierarchy[3] and require input of patient-specific clinical variables in order to provide patient-specific recommendations. At this level, the individual patient's electronic health record is automatically linked to a database that can provide the current best evidence for his or her specific circumstances. This assists the clinician by providing suggestions for appropriate care, warning of possible adverse drug events and applying new information through the analysis of patient-specific clinical variables.

If a CDSS does not exist, the next best step is to look for *Summaries*. In dental hygiene and dentistry, these include Clinical Practice Guidelines (CPGs) that are based on a full range of evidence from the lower levels (individual studies/synopses of systematic reviews). Guidelines integrate evidence-based information about specific clinical problems and provide regular updating. CPGs are broader in scope and provide more general care and treatment suggestions than CDSS. CPGs often can be found on the websites of specific associations and organizations including the:

- American Academy of Pediatric Dentistry (http://www.aapd.org/media/policies.asp),
- American Academy of Periodontology (http://www.perio.org/resources-products/posppr3-1.html),
- American Dental Association, Center for Evidence-based Dentistry (http://ebd.ada.org)
- Centers for Disease Control and Prevention (http://www.cdc.gov/OralHealth/guidelines.htm)
- Agency for Healthcare Quality and Research, (http://www.ahqr.gov)
- American Heart Association (http://www.heart.org/HEARTORG/)

If no evidence exists at the *Summaries* level, the next step would be to look for *Synopses of Systematic Reviews*, which can be found in such journals as the *Journal of Evidence-Based Dental Practice* and *Evidence Based Dentistry*. Each journal provides a 1–2 page peer reviewed critical summary of an original systematic review with expert commentary so that the reader is able to determine quickly if it is clinically relevant to the patient.

Figure 2. The 6S Hierarchy of preappraised evidence.

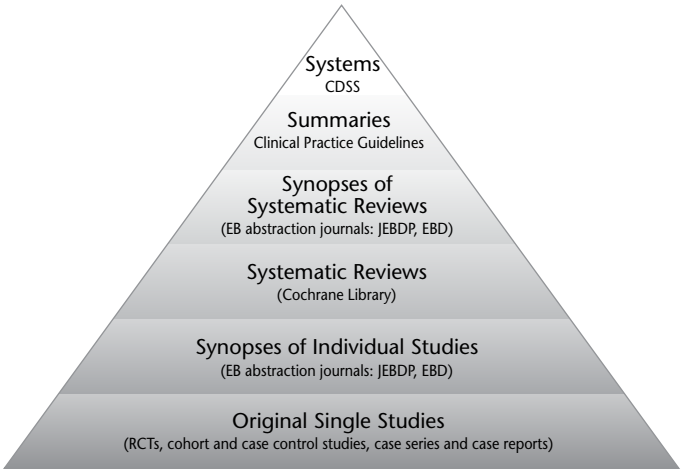


Figure adapted from the 6S Hierarchy of Preappraised Evidence by DiCenso A, Bayley L, Haynes RB. *ACP J Club.* 15 September 2009;151(3): JC3-3.

If no evidence is available at this level, then search for individual Systematic Reviews, which can be found through such databases as PubMed, the Cochrane Library and the American Dental Association's Center for Evidence Based Dentistry. Finally, the bottom two levels relate to primary research studies. A *Synopsis* of single studies can be accessed through PubMed and also found in the evidence-based dentistry journals, and an individual single study also can be accessed through PubMed.

Emerging CDS tools/Use of mobile technology

The infrastructure to support the application of evidence at the point of care is evolving. Not everyone has a computer chairside or is using an electronic record. However, evidence resources can be accessed via the Internet and many important topics for dental hygiene can be found. Having Clinical Decision Support tools can enhance the use of the most relevant clinical evidence in making 'real-time' decisions chairside when they are needed.

CDS includes a variety of printed and electronic tools that make knowledge readily available to help make more informed and individualized health care decisions. Some of these tools include computerized alerts and reminders, drug-dosing calculators, antibiotic management, clinical guidelines, and patient data reports. Having an electronic health record also allows a provider to read quickly legible information in the office and to access the record when away from the office. For example, if a patient calls the office needing a prescription, the patient can be verified as a patient of record, and the health history, treatment record and radiographs reviewed remotely via a smart phone. A prescription can then be called into the pharmacy or an e-prescription sent.

Using alert systems and accessing electronic resources

through the use of mobile devices are becoming the norm. For example, journals will email their Table of Contents, which can be scanned for articles of interest. Sites such as MedScape and PubMed have specific apps for mobile devices, so again, information is at your fingertips 24/7.

Conclusion

Clinicians are inundated with information and struggle to keep current with an ever increasing knowledgebase. The development of evidence-based skills are necessary to enhance the movement of research information to the point of care (chairside) in order to ensure that better treatment decisions are made that will help improve oral health outcomes. The hierarchy of evidence helps the clinician understand research design and the corresponding level of evidence for primary and secondary research. CDS resources also are available that analyze the quality of research and synthesize study results in a precise summary. These emerging tools are designed to streamline the integration of evidence into practice.

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7. Overcoming the fear of statistics: Survival skills for researchers

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ANOVA - hierarchical linear analysis - quadratic function - mixed effects models- sphericity - heteroscedasticity – collinearity - non-parametric tests - a priori - post hoc

Statistics??? Sadistics???

Statistical terminology and formulas typically evoke a natural reaction of distress, apprehension or outright fear in many researchers, both novice and experienced alike. I hear many people say: What do these terms mean? I don't understand this jargon. How do I decide which test to use? What is a power analysis? How do I grow as a researcher when I feel intimidated by statistics? Where can I get help?

Introduction

In the 1800s Benjamin Disraeli, a British Prime Minister, was thought to have quoted that there are "Lies, Damn Lies and Statistics." Some have also attributed this quote to Mark Twain. Even today, the lay public is highly suspicious about statistics and prematurely conclude that all statistics are misleading or distort the truth. Even among clinicians, researchers and scientists there is a general misunderstanding about the meaningfulness, usefulness and shortcomings of statistics in application. I cringe when I hear scientist/clinician researchers state, "The differences between groups were *highly* significant at p=.008. The result of our study proved X causes Y." Inherent in these comments are two common fallacies. The first is that a small p value is evidence of "truth" and the second is that smaller values can be construed as a large effect. In order to understand why these assumptions are fallacies, it is important to know what the p value does and does not represent.

In research, the accepted convention for separating systematic explanations (X causes Y) from chance explanation (sampling error or measurement error) is based on testing the null hypothesis. Sampling error can occur if treatment groups differ simply by chance. Random assignment, the accepted process for assigning individuals to intervention/treatment groups in experimental research, removes procedural bias but it does not *ensure* that groups are equal with respect to all factors that might influence the outcome. Error can also be introduced into the data as a function of how, when, where and by whom outcomes are measured. Because both of these sources of error exist, they introduce doubt that differences between intervention/treatment groups in the outcome (Y) are solely attributable to the intervention (X). This makes it impossible to "prove" that X caused changes in Y.

We can, however, estimate the likelihood that any observed differences between groups are solely based on chance variation or dumb luck – via the null hypothesis. Abelson aptly points out that testing the null hypothesis using statistical tests is a "ritualized exercise of devil's advocacy."[1] The null hypothesis is an artificial argument that

any difference between intervention/treatment groups is due to chance; it also assumes that the treatment has no effect on systematically affecting the outcome. Researchers hope that the likelihood of this is really small. The p value derived from statistical testing provides that estimate – the probability that, assuming the intervention is not effective, the intervention/treatment groups are different due to chance variation. If a small p (conventionally ≤ 0.05) is obtained, then the researcher can reject the assumption of difference likely due to chance and accept the more logical alternative — that differences are likely due to the intervention/treatment. [An interesting note is that the 0.05 was established years ago and has become an accepted standard, although the researcher could just as easily determine 0.1 to be the critical p for determining significance.] Notice in this description that the issue is about making a logical argument based on the most likely explanation.

The second statement, that a smaller p value can be construed as a bigger effect, is fundamentally inaccurate. The p value is strongly influenced by three factors: the magnitude of the effect (effect size measure); the sample size (number of observations in the study); and the amount of variation in the data (commonly the standard deviation). Because sample size drives magnitude of the p value, it is inappropriate to equate it with large effect size. The effect size is a different issue and can be computed two ways – the raw effect size (e.g. difference between group means) or standardized effect size (the raw effect size divided by the standard deviation). From a clinical perspective, it is helpful for researchers to think about raw effect size as the minimally important difference (MID), which is the smallest difference in mean scores that would be considered meaningful. The standardized effect size, which takes into account the amount of variance, is a more valuable index and *can* be used as a measure of importance. Because it is not influenced by sample size and is independent of the measurement scale from which it is derived, it gives an objective estimate of the strength of association between the outcome and intervention/treatment. Common effect size measures include r^2, *eta squared*, *odds ratio* and *Cohen's d*.

The effect of sample size on the *p* value cannot be overlooked when interpreting statistical tests. The sample size has a *direct* influence the magnitude of the p value. A study with 1000 subjects will always have a much smaller p value than a study with 100 subjects, given the same effect size or magnitude of difference between groups. Power of a statistical test — the likelihood of rejecting the null hypothesis when there is a real difference — is largely determined by the number of observations/sample size.

Finally, it should seem intuitive that if there is a large amount of variance in the outcome, the effect size will be smaller and thus the p will be larger. The bottom line is that if researchers want to get a very small p value in a statistical test, they will use a large number of subjects, will attempt to maximize the effect of the intervention and minimize the amount of variation in scores. For example, several years ago a product was developed that appeared to have good antimicrobial properties *in vitro*. The clinical trial used a very large sample size, had very stringent criteria for selection to limit the amount of variation between subjects, and had subjects withhold oral hygiene to maximize the effect of the antimicrobial. The results of this trial showed a statistically significant reduction in plaque (< 0.05) and gingivitis ($< .01$). The study design maximized all factors associated with the p value. Subsequent studies that had a broader group of subjects using the product in addition to brushing failed to show statistical significance.

So, why is it that intelligent individuals are so hasty to equate getting a p value of $\leq .05$ with *truth and meaningfulness*? Is this convention wholly accepted in the scientific community? The answer is, not necessarily. As early as 1978, Carver succinctly spoke out on the "fantasy" of statistical testing to provide *proof* of the hypothesis and then argued for caution in interpreting statistical significance.[2] In 1993, he expanded this premise of caution and added suggestions for logical interpretation of data along with use of the p value, effect size estimate and replication.[3] Since then, standards have shifted towards a more rational application of statistical testing. Probably the best example is the development of the CONSORT Guidelines for publication of clinical trials, The Improved CONSORT statement and guidelines now suggest that researchers provide information about what would be a *meaningful* minimally important difference (MID) in outcome, that this difference be defined in advance and that value be used as the effect size in designing and planning clinical trials.[4] Despite changes in publication standards and improved statistical techniques available via desktop programs, there is still a tendency for clinicians and researchers to fear statistics and make rash judgments about the meaningfulness of statistical analyses.

Humans innately have a need for certainty. When individuals feel uncertain and there are numerous cues to be considered simultaneously, there is a tendency to rely on one-dimensional rule-based decision making.[5] Such is the case with statistical analysis and interpretation. As Carver stated in 1995, multiple cues must be considered in order to derive valid conclusions based on study design, statistical output and exploration of defensible interpretation. Adding to this, clinician/researchers know the importance of statistics in research, but only a small percentage can proficiently conduct analyses and interpret results with confidence. In point, a cross-sectional study of faculty, residents and students at the Mayo Clinic showed that although 87% felt that training in biostatistics was important, only 14.6% felt that they could meaningfully conduct and interpret their own statistical tests.[6] While there are no comparable studies on dental or dental hygiene researchers, anecdotal evidence suggests that few clinician/researchers are comfortable and confident with biostatistics. My personal experience over the last two decades is that, in fact, most regress to a position of apprehension that leads them to abdicate the responsibility to a statistical consultant. In fact, that can be a very good strategy. However, getting a good statistical consult requires a level of understanding, active engagement and advanced preparation.

The goal of this workshop is to help demystify statistical testing and provide realistic strategies that can be used to improve the quality of one's own research efforts and make getting a statistical consult an opportunity for growth and clarity. I will focus on the role statistics play in helping researchers make a cogent, logical and supported argument for any research findings. In and of themselves, statistical analyses provide only one piece of information in the larger puzzle that needs to be considered in making a persuasive argument about the results of a study. Let us start at the beginning and outline the basics of making sound judgments regarding statistical validity in research.

The logic of establishing causality

When attempting to establish whether some treatment/characteristic/intervention causes real change in a given outcome, some basic criteria must be met. At the very least, there must be a logical or biologically plausible relationship between the cause and the outcome. Simply stated, logic must prevail at the most fundamental level.

Let us take a simple example. A researcher is interested in determining if hydrogen peroxide (H_2O_2) is effective in reducing gingivitis. *In vitro* research has demonstrated that H_2O_2 affects gram negative and gram positive organisms though the release of oxygen. So we can say that the first criterion of "biologic plausibility" is met. Second, exposure to the cause must precede development of the outcome. Back to our example of H_2O_2 and gingivitis, we obtain a group of individuals with clinically evident gingivitis (defined as having at least 40% of sites that bleed on probing {BOP}). The subjects are given an H_2O_2 product to use twice daily for three months and BOP is assessed at this point. If change occurs, at least we have met the criterion that the intervention precedes change in the outcome. Third, there has to be an evidence of strength of association. In other words, there is an actual relationship between the suspected "cause" and the outcome. In our example, we also randomly assigned subjects to receive the active product and a sham product without H_2O_2. We observe a reduction in the H_2O_2 group of 15% BOP whereas the sham treatment group shows no change. From this we can estimate the size of the effect using one of the effect size measures discussed earlier. We could also assess a dose-response relationship by having three groups (one sham group that receives product without H_2O_2, one group that receives the product with 3%, H_2O_2 and one group that receives product with 10% H_2O_2). If results show a gradient effect on BOP reduction such that the sham group < 3% H_2O_2 group < 10% H_2O_2 group, good evidence of causality exists because one can link "amount of intervention" with "amount of outcome."

Fourth, and critically relevant to both proper design and statistical testing, is that there has to be a lack of competing explanations. In our example, the study would have to have been designed to standardize other oral hygiene methods (brush, dentifrice, flossing and frequency of rinsing) at a minimum, but there also might be a need to explore the data for other possible explanations such as whether groups were equivalent in amount of gingivitis at the start or differed regarding relevant factors (gender, age, etc) that might impact amount of BOP reduction. Ultimately, the question of whether change in outcome is attributable to factors other than the intervention gets at the degree to which the researcher is willing to confront his/her own confirmation bias. We will address that more in the next section on Comparison.

Lastly, one needs to consider the consistency of the evidence. A single study does not provide sufficient evidence to support causality although it may contribute to the body that will eventually establish "proof." The important question is whether the results can be replicated in different samples, by other researchers and in different settings. In our example, let us say that these results show a clinically meaningful and statistically significant effect favoring the 10% H_2O_2 product compared to both the sham and 3% groups. That would provide preliminary evidence to support causality; however, unless these results are replicated by others using similar methodology, the argument for causality cannot be supported over time.

Comparison

Most, if not all clinician/researchers would argue that good design is fundamental to confidently conclude that X causes Y, irrespective of results from a statistical test. Applying good statistics to poor quality data is like putting perfume on a pig – it might smell better but it is still a pig. Certainly, having a comparison group (or better yet, a control group if possible) is necessary in order to tease apart whether any observed changes are attributable to whatever intervention (or possible causative variable) is being imposed on subjects or might result from other factors. It is through the counterfactual model that we can observe the "effect". If we impose some treatment/intervention on one group of individuals, we must also have a different group of individuals (who are relatively the same) who do not receive the treatment/intervention — any difference we observe between the groups should give us some estimate of the "effect" of the treatment/intervention.

Comparison then is a necessary element for establishing causality of a treatment or other intervention. Statistical tests allow us to decide if the difference between groups is what one would expect simply because groups vary. If it is unlikely that one would simply (by chance) have groups that differed on the target outcome by a certain magnitude, the statistical test will give us an approximate estimation of the likelihood of that event. Now, herein is the rub. While the statistical test (and associated p value) can give us an estimate of chance differences, it is not sufficient. There are always other competing explanations for why the groups might or might not have differed; and these require applied logic and consideration. These can include factors too numerous to mention, but some might include:

- individuals in the respective groups looked the same but differed in subtle ways that we were unable to detect up front (despite randomly assigning them to groups);

- while observing people over time, what we were observing was naturally changing (e.g., aphthous ulcers and healing);
- our measurement strategy was problematic or unequally implemented;
- the study timeline was insufficient to capture real change over time;
- there were missing data because not all subjects were available for all observation periods or some dropped out of the study; or
- there were too few subjects to capture a difference if it existed or there were so many subjects that even a trivial difference would be found to be statistically significant.

The bottom line: hypothesis testing using statistical test gives us one piece of information that is important to a larger decision process—determining the likelihood that some intervention/treatment is causally related to the outcome.

Using statistical tests as part of a logical argument

One of the most compelling books in print today is *Statistics as Principled Argument*.[1] Abelson argues for use of applied logic and good judgment along with hypothesis testing to make good decisions about study results. Like Carver (1993), he posits that for any difference observed in a study, several possible explanations are possible. In this regard, statistics, along with applied logic, can assist the researcher in exploring for and identifying possible alternative explanations. Psychologists have demonstrated repeatedly that people, yes even researchers, are highly susceptible to confirmation bias. Confirmation bias results in people selectively focusing on information that reinforces preexisting beliefs and ideas. Confirmation bias can result in overestimating the influence of systematic factors (like an imposed treatment) and underestimating influence of alternative explanations, including chance. The tendency to jump to the conclusion that an intervention is effective, especially if there is a p value from a statistical test of $\leq .05$, without thoughtful consideration.

Being aware of confirmation bias, recognizing the human tendency to simplify complex decision making and developing a systematic approach to considering results is the hallmark of a good scientist/researcher. Abelson proposes a systematic approach aimed at creating a persuasive argument with the data, statistical analysis and data presentation.[1] Abelson's approach is valuable for consumers of research, but has distinct utility for researchers in the data analysis and writing phases. The approach is based on what he calls the MAGIC criteria. This acronym stands for: Magnitude (think effect size or magnitude of association); Articulation (specificity of detail that might include exploring an observed effect on subgroups or in different contexts); Generality (framing results within the appropriate context or across contexts if possible); Interestingness (given the results, how does this change the field of knowledge); and Credibility (results are conceptually grounded, logical and supported given the methods and statistical analysis). I encourage dental hygiene researchers to get this reference - learning to apply these criteria to one's own research has the potential for improving evidence used in patient care.

It should be obvious at this point that statistics and statistical analyses sit within a much larger topic of "quality of evidence" that includes design, conceptual framework, critical thought, and unassailable logic. Viewed this way, statistical tests should be considered as one of many decision tools that researchers need to derive valid conclusions about their results. Since very few clinical researchers also have the depth of understanding that underlies the field of statistics and biostatistics, they are likely not sufficiently aware of how these tools can be used to their maximal benefit to answer meaningful research questions. Actively seeking out a consultation with a biostatistician with experience in the broad field of health-related research is one of the most effective ways to overcome a fear of statistics.

Getting a statistical consult

Obtaining a statistical consult and power analysis during the design phase of a study is one of the best ways to circumvent problems, maximize efficiency in the research process and reduce one's fear of statistics. There are always competing approaches that change the manner in which the study is conducted and data are analyzed. Addressing these during the planning phase will make the research process much less stressful and will promote high quality research. At our institution, we have a Research and Statistical Consult Service that is available at no cost to healthcare researchers. Many institutions have similar services or have individuals on the faculty who provide comparable services. Check to see what is available to you. Find someone knowledgeable with whom you can discuss your project.

Once you have identified a person or service, prepare for the consult in advance so that you have relevant information at hand. Review the literature relevant to the topic so that you are well prepared for the questions that the statistician will ask during the consult. Be aware that it is not sufficient to do a shallow review of the literature. As you review the literature, be attentive to how results may have changed over time. An interesting observation about study results is that effects often decrease over time. Lehrer suggests that "truth wears off" over time because our illusions about the meaningfulness of various research question declines over time. Paying attention to this and being able to articulate this trend will be important for conducting the power analysis. Having the right estimate of sample size up front will improve the likelihood of planning a doable study and having meaningful results.

In advance, draft an abstract that summarizes the project using the PICO format. In doing so, consider the following:

Population: What is the population being studied?

It is helpful to know as many details about this population in advance. For instance, if the researcher is interested

in targeting a specific condition, what is the prevalence of this condition in the target population? Is there a range of severity that must be considered? What other factors are related to the condition that might influence selection of subjects or design of the study?

Intervention: What is the intervention or exposure variable?

What is the proposed mechanism of action of the intervention or exposure variable? Is there a threshold of intervention or exposure that needs to be considered?

What have previous studies shown with respect to variations in response (effect size) for the intervention? How has the intervention/ exposure variable been defined?

Comparison or control group: What is the most appropriate comparison or control group?

What would comprise an appropriate comparison group? For experimental clinical trials, is there an attention control that could be used in lieu of "no treatment"? If this is an observational study, is there a comparison group that is sufficiently similar to the target group that would allow fair comparisons? For observational studies, selection of the appropriate control or comparison group can largely influence the results.

Primary outcome measure: What outcomes are feasible to measure?

How can the primary outcome be operationally defined? Are there secondary outcomes that should be captured as well? Given these operational definitions, how have these outcomes been previously measured? Is it possible to obtain measurements in a valid and reproducible manner? If using an existing instrument, what is known about using the instrument? Under what conditions can this instrument be used? What is the "unit of measurement" and characteristics of how attributes of the outcome are quantified (measurement scale)?

Approach the consult with an open mind. A good consultation will usually result in modifying some aspects of your original research plan. Be prepared to capture the important recommendations from the statistician — either in writing or audio recording. Clarify any areas that seem confusing at the time. A good consultant will help you identify potential confounding variables that should be controlled either by design or statistically controlled. Make sure you leave with an understanding of how the design, measurement and statistical analysis pieces fit. Once you have drafted a proposal (comprehensive design and analysis plan), get confirmation from the consultant that you have "gotten it right."

During the consult, discuss how you will set up your data set for analysis. The statistical analysis plan, design of the study, capture of confounders, number and type of outcome measures, and statistical software will dictate how your data should be entered. Unless you are completely comfortable with the statistical software and analysis plan, do not do this on your own. There is nothing more frustrating than to have all of your data entered, only to realize that it is not analyzable in that format. Most importantly, enjoy the process. Leave your apprehension at the door and look at the consult as a unique opportunity to engage in creative planning.

Statistics are wonderful tools that help researchers plan, implement and make sense of their data. Effective use of statistics, while grounded in math, really relies on applied logic. Statistical programs manage the computational aspects of the process – but do not overcome bad design and incorrect analyses. Approach the research process just as you would plan a trip to a foreign country, and you can avert the fear of statistics and pain of failure.

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8. Getting started in clinical research

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Research career opportunities and settings are varied and diverse. Areas include public health or epidemiological research, dental hygiene profession-based research, practice-based research, university research programs and corporate research, including basic clinical and product evaluation.

Interestingly, when asked about careers in research, some hygienists associate these opportunities with 'lab jobs' or 'desk jobs', leaving patient contact and clinical experiences behind. Basic science is a very necessary component of clinical research, but for those wanting to utilize their basic science training combined with clinical skills gained during practice, a career in clinical research may be of interest.

Career paths in any discipline have basic building blocks or steps that enhance the journey. For clinical research, the steps include: clinical experience, advanced education, networking and mentoring. In fact, career paths in clinical research for the dental hygienist include the obvious—therapist or examiner—maximizing the clinical experience provided through dental hygiene training and patient care. More advanced roles include sponsor and/or principal investigator, coordinator/manager of the research project, or in the regulatory audit or quality assurance function, usually achieved after further education in the field of clinical research. Formalized educational programs have been created to train individuals from many professions for these roles in clinical research.

There are many educational programs offered for advancement in clinical research. A Google search using 'clinical research training' yielded 18,400,000 results. Programs are varied and are offered at the university level (e.g., full degree or certificate-granting), through private educational services companies, and associations dedicated to clinical research professionals. In the USA, for example, Drexel University offers an online master's degree in Clinical Research Organization and Management and a Master of Science in Clinical Research for Health Professionals, in addition to online certificate programs (http://www.drexel.com/online-degrees/biomedical-degrees/). Other universities and colleges offer similar options. A check of local area institutions is the first search to conduct when investigating further education. One example of an international educational program can be found at The University of Kent, UK (http://www.kent.ac.uk/careers/workin/cra.htm). Private educational services such as Barnett Educational Services (www.barnettinternational.com) offer online training and certificate programs in clinical research.

Two professional organizations dedicated to the support of clinical research professionals are the Society of Clinical Research Associates (SOCRA) (http://www.socra.org/) and the Association of Clinical Research Professionals (ACRP) (http://www.acrpnet.org/). These organizations offer training and certification for Clinical Research Associates (CRA), and Clinical Research Coordinators (CRC). Additionally, these sites offer current lists of available clinical research positions.

Mentoring and networking play important roles in getting started in clinical research. Students can begin by seeking guidance from professors involved in research. Practicing professionals can access information through national dental hygiene websites that contain lists of available mentors. Dental and dental hygiene schools are another source for networking. Schools are involved in conducting clinical trials and may be advertising for clinicians to participate as therapists and research subjects. Another important resource to consider is professional publications. Authors can be contacted to provide guidance as well as offer discussion in their area of research.

Important personal attributes that may help in a successful career in clinical research include strong written and oral communication skills, adaptability, being a self-starter, attention to detail, and good time management skills. Success of a study highly depends upon a variety of people being able to work effectively together, so being a good team player is crucial.

This workshop will provide interactive discussions and presentations by clinical research from academia and private industry. The goals of the workshop are to:

- provide the participant with a good understanding of the roles and responsibilities involved in a career in clinical research;
- explore the process involved in day to day conduct of clinical trials from the perspective of the sponsor and investigator;
- compare and contrast industry and academic research career pathways; and
- learn about Dental Practice-Based Research Networks designed to train clinician investigators to study problems encountered on a daily basis in practice.

Using role play and open discussions, the clinical trial process will be explored from hypothesis inception through publication of results. The workshop format is designed such that attendees will gain an understanding of the skills, roles, and responsibilities involved in all aspects of clinical research. The workshop will be given by three experienced research dental hygienists, each providing her unique perspective on her own career path, discussing the

clinical research process from each of their experiences, and providing insights from the academic, corporate and contract research organization perspectives.

MaryAnn Cugini brings her career experiences in academic and industry research settings to the workshop. She will share her regulatory experience and provide a basic understanding of the importance of maintaining protocol adherence and abiding to the regulatory standards of clinical research.

Having managed clinical trials for several corporate organizations and with independent clinical research organizations as well as academic institutions, Chris Charles will provide her insights regarding selecting and validating research sites and investigators, protocol development and the rigor surrounding conduct of clinical trials, and communication/publication of results.

Janet Kinney will speak about the importance of having clinical experience and good patient management skills prior to commencing a career in clinical research. In addition, she will share how educational training in the area of research methods helps to answer the 'why' questions during the inception, development and conduct of studies. And finally, as a fairly new investigator, Janet will share with the audience her thoughts about the importance of networking and having strong mentors to help guide the newcomer during the early career years.

In summary, getting started in clinical research takes some concerted effort and forethought on your part. Prepare yourself by seeking educational opportunities that train you in the field, and then be proactive about building diverse networks and relationships with experienced people who are in a position to help you achieve your career goals. Once engaged in clinical research, exercise exemplary levels of confidentiality and protection of intellectual property and always be cognizant of your obligation to comply with Good Clinical Practice procedures and behaviors.

Whether you are a just starting a career in clinical research or are a well-seasoned professional, the field of clinical research offers challenging and exciting opportunities allowing for continual growth both personally and professionally.

9. Introduction to preparing a systematic review

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The profession of dentistry has developed a store of specialized knowledge that serves as the basis for decision-making. This knowledge base has evolved over time, as the methods for the creation, synthesis, and dissemination of knowledge have changed. At first, dental knowledge was accumulated and synthesized through experience by itinerant dentists and barber surgeons, and dissemination was limited to master-apprentice arrangements for training new individuals.

As the profession matured in the late 1700s and through the 1800s, texts, journals, and dental schools emerged to aid in the synthesis and dissemination of the knowledge base. But the creation of knowledge did not change radically until the 1900s, when results of formal clinical studies began to supplant experts' opinions as the most valued form of knowledge. As the number of studies on a topic grew, the literature review emerged as an important means for synthesizing the results of individual studies.

In recent years, changes in the synthesis and dissemination of the knowledge base that have been occurring signal the beginning of a new era. The preferred means of summarizing the literature that addresses a particular question topic is now the systematic review, an approach designed to minimize the biases inherent in the review process while at the same time improving the utility of the literature synthesis for the practitioner.

The rationale for systematic reviews

Systematic reviews are designed to minimize the biases that are usually present in traditional literature reviews.[1] The most frequent sources of bias in traditional reviews involve not including all of the relevant studies, and not combining the information from the studies in an objective manner that takes individual study weaknesses into account. In part, these biases arise because traditional reviews of the literature tend not to be well-focused on a specific problem. Traditional reviews tend to be non-specific, and as a result, it is difficult to include and carefully analyze all of the relevant literature on the broad general topic the review purports to address. In addition, bias is likely to arise when the author of a review holds strong pre-existing opinions concerning the topic. It is human nature that decisions about what studies to include and how to synthesize the results will be influenced by these opinions.

Systematic reviews focus on specific clinical questions. This more narrow focus permits a much more careful and complete search and selection process to identify and include all relevant studies that have addressed the question of interest. Because systematic reviews are designed to maximize objectivity, they require the prior determination of search methods, inclusion criteria, and evaluation criteria, which helps reduce the chances of bias in inclusion of articles in the review and evaluation of the strength of included articles.[2]

Steps in performing a systematic review

The initial step in performing a systematic review is the formulation of a clinically relevant key question, which identifies four crucial "PICO" elements. These elements are 1) the Population or patient type, i.e., the individuals or groups for whom an answer is sought; 2) the Intervention, i.e., the treatment or clinical condition of interest; 3) the Comparison, i.e., an alternative treatment or control; and 4) the Outcome. i.e., the measures used to assess effects of an intervention.

The second step is defining criteria for including and excluding studies. These criteria arise from the key question and other considerations, such as study designs, publication dates and languages, and details of treatment procedures. Careful definition of these inclusion criteria, together with the key question, will define the group of individuals to whom the results of the systematic review can be generalized. Criteria for assessing the quality of individual studies are also identified in this step.

The third step in performing a systematic review is designing a search strategy. Since systematic reviews attempt to identify all studies relevant to the key question, the search for such studies should be exhaustive. It characteristically includes searching electronic indices, such as MEDLINE, EMBASE, and more specialized indices depending on the key question. Examination of reference lists of all potentially eligible studies identified in the initial stages of the search is a standard technique and the "gray literature" should also be examined, including dissertations and theses, conference reports, abstracts, and unpublished studies identified through inquiries to colleagues and manufacturers.

The fourth step involves the application of the inclusion and exclusion criteria to determine eligibility for every study identified in the search. Multiple reviewers do this independently and then follow a predetermined procedure for resolving disagreements. A written record is maintained of reasons for exclusion of studies.

The fifth step of a systematic review is abstracting specific information from each included study in a standardized manner. Information includes details of the study design, subjects, methods, and results, along with information

needed to assess the quality of the study. The extraction process is usually performed independently by two reviewers. Where disagreements occur through error, they are corrected. When the problem is a matter of interpretation, a third reviewer may decide, or the authors of the study in question might be contacted for clarification.

The sixth step is the analysis and presentation of results of the systematic review. All extracted data are presented in an evidence table, which facilitates comparison of the included studies. A qualitative summary of these studies, based directly on the evidence table, is usually presented that provides an overview of the designs and findings of the included studies. In most instances, the study results are evaluated for heterogeneity or between-study differences. Depending on the extent of heterogeneity, study designs, and data available in the published studies, the systematic review team may also conduct a meta-analysis of the outcome data.

The final step in the systematic review—interpreting the evidence—is the only step not guided strictly by the review protocol, and the only one where some subjectivity is permissible. Here, the review's limitations and the strength of the evidence are discussed, and applicability of the study results to the clinician is considered. Equally important, the systematic reviewers may identify implications for future research.

Systematic reviews are usually completed by teams, rather than individual authors. An advisory committee composed of both clinicians and researchers with expertise in the topic may be appointed to provide critical commentary concerning the key question, the inclusion and exclusion criteria, the final list of included studies, the completed evidence table, and the draft final report. Such oversight acts as an important additional step in maximizing the likelihood that the review is objective.

It is important to remember that the structure of a systematic review facilitates, but does not guarantee, an objective summary of the evidence for a clinical question. Departing from accepted standards for conducting a systematic review will increase the likelihood that the results will be biased. The reader must then determine if the increased likelihood of bias is sufficient to render the review not useful. Checklists and guidelines are available that can be used to assess adherence to recommended practices and completeness of reporting.[3,4]

Whether the question addressed by the systematic review can be definitively answered by the review is not a measure of its overall quality. Surprisingly, the results of systematic reviews are often equivocal because either the necessary studies have not been done or the quality of the studies is judged to be insufficient to address the clinical question without bias. Thus, from the standpoint of clinical applications, a primary advantage of the systematic review is also one of its greatest frustrations: it not only tells us what we do know, but also what we do not.

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10. Design considerations for qualitative research: Getting at strawberry milk

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Overview

This interactive workshop is designed to build dental hygiene researchers' confidence and skills for effectively using qualitative research methodologies, particularly focus groups and interviews, for oral healthcare research. The presenters' approach incorporates brief highlights of an institutional review board-approved qualitative research plan for, and preliminary findings from, a 2010–2011 Maryland qualitative and quantitative oral health study with pregnant women and parents of young children and also with healthcare providers (dental hygienists, dentists, pediatricians, family practitioners, and nurse practitioners). The study was conducted by the Herschel S. Horowitz Center for Health Literacy at the University of Maryland.

The workshop title refers to how qualitative methods, carefully and sensitively applied, can help researchers deepen their understanding of health beliefs, behavior, and literacy and their origins among healthcare consumers, as well as the healthcare practices and beliefs about patients among healthcare providers including oral healthcare and other healthcare providers. In one focus group the presenters conducted, for example, a young mother described her frustration with her baby's grandmother who refused to switch from chocolate milk in the baby's bottle to more healthful, fruit-based strawberry milk. The workshop addresses how to structure qualitative research to encourage candid, detailed, and authentic responses as well as ways to organize and utilize the findings, especially to help inform oral health education and oral healthcare practice and policy.

Following this workshop, participants will:

- Understand different ways in which qualitative research using focus group and interview methods have been used to support oral health and other health-related studies, and local, state, and national health education programs.
- Understand more deeply some of the primary components of a qualitative research plan, particularly important issues that institutional review boards may not require be addressed in advance, and therefore, can be overlooked or undervalued. In particular, the presenters cover: various aspects of defining the participant audience for focus groups and interviews to support research goals; developing screening criteria and instruments and methods for recruiting participants; deciding where to conduct the research; developing an engaging and productive group or interview guide; "deep listening" moderating and interviewing priorities; keeping track of data; common reporting options for simple qualitative studies; and dilemmas and basic concepts in qualitative analysis.
- Know about professional resources and literature to support qualitative research for a variety of purposes.

Workshop content

During the workshop, the presenters will use a combination of lecture, slides, demonstrations, and audience participation activities to:

1. *Highlight examples of their own and others' use of focus groups and interviews for oral health and other health topics to demonstrate varied use of these methodologies and the information they generate.* Topics include assessing target audience knowledge, awareness, and beliefs about preventing tooth decay and oral cancer in Maryland; gauging response to messages and materials about these and other health topics, including examples from national women's health education and social marketing programs by the Centers for Disease Control and Prevention and the National Institutes of Health; and pretesting survey instruments before they are fully developed and fielded.

2. *Discuss the components of a research plan for focus groups and interviews, with a particular emphasis on some of the overlooked or undervalued aspects of executing research plan components, including:*

a. Defining and recruiting participants for basic focus group and interview research:

You are interested in learning about low income parents' awareness of tooth decay and how to prevent it to inform the development of messages and materials to prevent tooth decay. What do you consider in defining and locating appropriate participants? The presenters will discuss various means, including building partnerships for outreach, such as with local health departments, non-government organizations (NGOs) in communities, and contracting with market research companies and qualitative research consultants. They will address concerns about culturally appropriate screening criteria and recruiting methodologies that will both identify qualified participants and help to discourage "no-shows" and low engagement. Issues and options for providing honoraria for research participants are also covered.

b. Choosing a setting and "setting the stage" for participants:

Where and how do you talk with and/or observe participants? The presenters discuss considerations for

appropriate and convenient settings (in terms of location, transportation, and myriad other details for different types of participants) and creating a comfortable atmosphere for research participants, including the advantages and disadvantages of professional focus group facilities; community locations; people's offices; homes; on conference calls; or online. Logistical issues such as refreshments are covered, especially for oral health and other healthcare-related research studies given nutrition, cultural, and allergy considerations.

c. Developing a focus group or interview guide and choosing a moderator or interviewer:

Why are qualitative instruments called guides? And is the answer important for productive, and useable, data collection? The main elements of the interview guide and types of common questions are covered, with an explanation of critical techniques for putting participants at ease— with the moderator or interviewer, the research topic and questions (e.g., tone, semantics, language, activities), with each other, the presence of recordings and observers—to help encourage honest, in-depth input. It matters.

The advantages and caveats of conducting your own groups, or having students conduct groups or interviews are discussed, as well as understanding the types of services that professional qualitative moderators and interviewers offer. What kind of professional and personal background do these research professionals have? What should you look for? Does personality matter? What about language/culture/race/ethnicity/gender? How much do external consulting resources typically cost in 2011? Where do you find these resources, especially for academic research?

d. Data records, common reporting formats, and dealing with qualitative data:

What are the options and caveats for keeping track of qualitative data? The presenters will discuss audio and video recordings, inviting and training observers and utilizing their field notes, and guidelines for transcribing qualitative research. How do you analyze qualitative information? Can you? The presenters will highlight some of the challenges and basic concepts and products widely discussed today as qualitative research becomes more popular: content analysis, grounded theory, phenomenology, Social Cognitive Theory, and other tools, such as NUDIST software. Examples of qualitative studies published in peer reviewed journals in different fields are noted, including some featuring oral health studies utilizing "only" "notes-based" analyses and themes.

3. Provide participants with opportunities to discuss and debate different aspects of qualitative techniques based on their own experience and research interests, and to ask the presenters questions.

4. Share a wide range of literature and resources regarding qualitative research; professional resources sensitive to the needs of academic researchers as peer-reviewed publications increase openness to qualitative studies; and selected published articles from qualitative studies of possible interest to dental hygiene researchers.

Suggested Resources

1. Krueger RA, Casey MA. Focus groups: *A practical guide for applied research.* 4th ed. Thousand Oaks, CA: Sage; 2009.
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11. Osteonecrosis of the jaw and oral hygiene: A case-control study from CONDOR Dental PBRN

Study authors: Hujoel P, Barasch A, Cunha-Cruz J, Curro FA, Sung AH, Vena D, Voinea-Griffin AE, Beadnell S, Craig RG, DeRouen T, Dasanayake A, Gilbert A, Gilbert GH, Goldberg K, Hauley R, Hashimoto M, Holmes J, Latzke B, Leroux B, Lindblad A, Richman J, Safford M, Ship J, Thompson VP, Williams OD, Yin W for the CONDOR Collaborative Group*.

Presented by: **Philippe Hujoel,** PhD, DDS, MSD, MS

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*Collaboration on Networked Dental and Oral Health Research consists of members of PEARL (Practitioners Engaged in Applied Research and Learning, http://pub.emmes.com/study/pearl/), Northwest PRECEDENT (Practice-based REsearch Collaborative in Evidence-based DENTistry, www.nwprecedent.net), and DPBRN (Dental Practice Based Research Network, http://www.dentalpbrn.org/users/publications/collaborativegroup.asp).

Introduction

The exposure of dead necrotic bone in the oral cavity is commonly referred as OsteoNecrosis of the Jaw (ONJ). Some known causes of ONJ include exposure to radiation, ingestion of radioactive elements such as radium, exposure to phosphorus, or intake of intravenous or oral bisphosphonate medications. It is unclear what factors may prevent ONJ if either medical or environmental exposure is unavoidable.

Oral hygiene was suggested as effective ONJ prevention in the 19th century when the industrial fabrication of matches became associated with a first wave of ONJ cases.[1] The hypothesis that "clean teeth do not decay" was popular in those days. The specific recommendations were to clean the teeth with a small toothbrush with stiff bristles at least once a day with powder (soap with precipitated chalk). Rinsing after each meal and avoiding potential traumatic injury to the teeth, by for instance eating nuts, was also recommended.[2]

The recommendation to practice good oral hygiene has survived the centuries. An expert panel convened by Novartis Pharmaceuticals Corporation reported that for the prevention of ONJ, "patients should be educated on maintaining excellent oral hygiene to reduce the risk of infection."[3] Similarly, the American Dental Association reported that good oral hygiene is the best way to lower the risk for ONJ.[4] To our knowledge, no controlled evidence is available to determine whether oral hygiene is an effective preventive method.

We briefly report here on some preliminary findings of a nationwide case-control study on the etiology of ONJ as it relates to the role of oral hygiene. Three Practice Based Research Networks (PBRNs) funded by the National Institute of Dental and Craniofacial Research designed a common protocol for a case-control study of ONJ.[5] This case-control study collected data on oral hygiene to determine its relationship to subsequent ONJ risk. Information on brushing, flossing and rinsing approximately 5 years before the onset of ONJ was collected. The question on the use of oral rinses was not specific with respect to the ingredients or active agents. A total of 191 cases and 573 controls formed the basis for the primary analyses. In univariate analyses, there was no significant association between brushing, flossing, or the use of oral rinses with ONJ. Patients reporting to brush once or more than 1 time per day versus those reporting not to brush once a day did not have a lowered ONJ risk (OR = 0.84, p-value = 0.69). Patients reporting to floss once or more per day had no reduced odds for ONJ when compared to those not reporting to floss once a day (R = 0.9, p-value = 0.56). Finally, no association was present between the use of oral rinses and ONJ. When comparing those individuals that rinsed 4 or more times a week versus those reporting to rinse 3 or fewer days a week, the odds ratio was 0.95 (p-value = 0.82). After adjustment for confounding variables, no association could be identified between oral hygiene procedures and the prevention of ONJ.

In conclusion, these exploratory findings in this case-control study could not find evidence that oral hygiene plays a role in the prevention of the onset of ONJ. The potential bias associated with recollecting oral hygiene habits is an important weakness of these presented data. Future studies could collect information on oral hygiene habits to either confirm or refute these first evidence-based data on oral hygiene and ONJ prevention.

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12. Dental practice implementation of a point of care electronic referral system for patients who smoke: A Dental PBRN study

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Background

Tobacco use is the leading preventable cause of death in the USA and has been called the number one behavioral health problem. Although one in every five Americans smokes cigarettes, approximately 70% report that they want to quit smoking. There are many public health self-management interventions for smoking cessation that have been found to be effective; however, they are substantially underutilized. As more than half of smokers see a dentist at least once per year, patient referrals at point of care to a self-managed smoking cessation intervention could greatly increase their use.

Methods

We conducted a randomized controlled trial with community-based dental practices testing point-of care referrals of smokers to an interactive, tailored patient education website. Intervention practices referred patients via an electronic referral system (ReferASmoker) and control practices referred patients via a paper-based information prescription. Both control and intervention practices had access to the ReferASmoker website that has resources to assist with tobacco cessation services. The intervention practices, but not the control practices, received feedback about their number of patient referrals and the referral numbers of their peers.

Results

One hundred and one community-based dental practices from 8 states referred close to 1900 patients to a patient education website for the self-management of smoking cessation. Based on estimates by the dental practices, the majority of patients were between the ages of 19 and 64 years, 23% of patients seen in participating practices were African American, and 61% of practices saw patients with private insurance. Control and intervention practices were similar at baseline on all characteristics assessed except control practices had a higher self-reported proportion of African American patients. Based on the project coordinator comments, the ReferASmoker website was easy to use and offered useful resources to assist with tobacco control services.

Conclusions

Providers actively engaged in the program and were willing to refer patients to an online, tailored patient education website. Dental practices found the ReferASmoker tool useful and easy to implement into practice.

13. Current evidence for remineralizing therapeutics in caries management

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Despite years of research directed at understanding the causes of dental caries and the development of preventive therapeutics for the management of dental caries, the population continues to have a substantial burden of disease. Dental caries afflicts almost the entire population by adulthood and is the most common chronic disease of childhood surpassing asthma and other common pathologies.[1] Thus the need to advance our understanding of the dental caries disease process and more effective intervention approaches remains an important undertaking. Traditional approaches to caries management include mechanical plaque control, diet modification, fluorides, antimicrobial agents, sealants and non-fluoride remineralizing therapies. The purpose of this manuscript is to present briefly our current knowledge of this latter group of therapeutics.

The caries process involves an imbalance of acid attack from the metabolic products of oral microbes during carbohydrate consumption and remineralization when the salivary pH becomes more basic and the enamel can take up new calcium and phosphate minerals to replace those lost during demineralization.[2] Saliva is a critical requisite for this process to occur. Its buffering and aqueous properties allow it to help neutralize the acids in the oral cavity and to provide the vehicle necessary to deliver critical ions to the tooth surface and to penetrate into the body of the carious lesion. Fluoride products have long been known to enhance the remineralization process and shown to reduce caries in the population through a variety of different delivery systems.[3] Fluoride ions are highly reactive and when present in the oral cavity, they will interact with partially demineralized enamel crystallites and then attract and react with calcium and phosphate ions available through the saliva and thereby stimulate remineralization. A variety of products are now commercially available that are directed at helping control dental caries by stimulating salivary production, neutralizing the biofilm pH, and/or by enhancing remineralization by supplying bioavailable calcium and phosphate ions.[4] These products can be grouped into several different categories, but there can be overlap with some products using several or all of the above mentioned approaches.

Stimulating salivary flow helps reduce the risk of dental caries. This is currently accomplished for the purpose of caries control primarily through the use of chewing gums and lozenges. There have been numerous clinical studies on the effect of chewing gum on dental caries. Gums with artificial sweeteners when chewed for 10 to 20 minutes 3 to 6 times per day results in reduction in caries compared with control groups that did not chew gum. These types of studies have been completed primarily in children and show a reduction of caries predominantly on proximal surfaces. There are several different polyol sweeteners used in gums and lozenges. There is evidence that gums with xylitol provide great caries reductions compared with sorbitol or combinations of polyols. There is currently no clinical evidence that the addition of xylitol to toothpaste or dental rinses is of any benefit in the management of dental caries.[4]

The ideal remineralizing agent will provide adequate amounts of calcium and phosphate ions to the body of the carious lesion where they are needed and will not readily precipitate on the tooth surface or increase calculus formation. A variety of compounds are currently available that are directed at fulfilling these requirements, including amorphous calcium phosphate (ACP), calcium sodium phosphosilicate, and tricalcium phosphate. Most of these agents are used primarily in combination with other compounds or with fluorides and are available in toothpastes, fluoride varnishes, and chewing gums. Many of these commercially available products have little or no clinical data to support their effectiveness. The most clinical data exists for ACP products and primarily in the ACP complexes that are available in some chewing gums. There is currently no clinical data showing an increased effectiveness over fluoride alone when ACP, tricalcium phosphate or calcium sodium phosphosilicate are added to fluoride varnish.[4,5] There is in-vitro data and, for some products, substantial in-situ data indicating that the addition of these remineralizing compounds can be effective.

Phosphorylated salivary proteins such as statherin are known to help enhance mineral delivery to the tooth surface and provide protection against dental caries. Research on other phosphorylated proteins, such as the milk casein phosphopeptides (CPP), suggests they also could have protective properties. These phosphorylated proteins can help bring the ions that are critical for optimal remineralization to the necessary location of the tooth surface and demineralization site. There are a number of products now available using CPP that is complexed with ACP (CPP–ACP) to enhance remineralization. The CPP–ACP complex is most commonly used in chewing gums and in a topical foam or tooth mousse. The in-situ data shows the CPP-ACP complex will enhance remineralization with and without fluoride. Clinical studies are less convincing, with mostly short-term studies on white spot or early non-cavitated lesions being available at this time. Further, clinical studies are necessary to determine if the CPP–ACP products are effective in preventing clinical caries.

Agents that modify oral pH and antimicrobial agents also are commercially available for caries management. Mouth-

rinse is now available with sodium hypochlorite (0.2% concentration) which is one of the most commonly used disinfecting and bleaching agents used around the world. It also is very basic and might thus assist in neutralizing an acidic oral biofilm. The antimicrobial agent chlorhexidene is available in an oral rinse, and in the USA is available in a concentration of 0.12%. Other antimicrobial agents directed at controlling caries include a chlorhexidene and thymol varnish. The clinical evidence available at this time indicates that the chlorhexidene mouthrinse is not effective against dental caries, and there is no data as to additional caries prevention benefit by adding 0.2% sodium hypochlorite to a mouthrinse. There is some clinical evidence that a chlorhexidene/thymol varnish could be effective in reducing root caries in an adult population, but there is inadequate clinical data that it is effective for preventing caries in children. There are a number of products undergoing testing that will add to our knowledge of how these and new products can be used to help manage dental caries in our patient populations.

Are there risks involved with the use of any of these products? Most therapeutic agents will have some risks of adverse reactions, but for most the risks appear minimal. The elements and ions in the different remineralizing complexes are ubiquitous in the environment and quite safe if not consumed excessively. Chewing gum is not recommended for children under 4 years of age as it represents a potential choking hazard. Milk-derived peptides used in the CPP–ACP products are not recommended for individuals with a known milk allergy. Increased consumption of artificial sweeteners is associated with an increased risk of obesity and diabetes.

Incorporating caries control regimes is predicated on establishing an individual's risk for developing dental caries. There are a number of caries risk assessment tools available (e.g. American Dental Association, American Academy of Pediatric Dentistry, CAMBRA, Cariogram) with all using a variety of indicators to determine an individual's risk. There is no evidence that one system is inherently superior to others, but it is critical that clinicians evaluate as objectively as possible their patients' caries risk status. Indicators such as previous dental caries, fluoride exposure, presence of enamel defects, salivary flow and consistency, dietary habits, as well as many other factors are known to be predictive of caries risk and are thus represented in all of these caries risk assessment approaches. The current evidence shows that fluoride products are the most effective remineralizing agents. In individuals with disease that is not being controlled through more conventional approaches (e.g. hygiene, diet, fluorides, etc.), then adjunctive remineralizing approaches might be of benefit, although the clinical data to support their use is generally lacking. Some of these products could potentially be of benefit for patients who do not want to or who will not comply with prescribed fluoride therapies.

The management of dental caries remains an evolving science with new knowledge regarding the etiology of the disease, new predictive tools, and new therapeutics continuing to change the landscape for the diagnosis and treatment of this highly prevalent disease. There is little question that the clinician should carefully assess each patient's risk for developing dental caries and then direct their preventive and therapeutic interventions in a targeted manner. Understanding that dental caries is an infectious and preventable disease provides the opportunity for oral health care providers to turn the tide on the dental caries epidemic by using their diagnostic skills and then selectively applying appropriate therapies directed at specific aspects of the dental caries disease process. There are numerous new agents on the market and promising new therapeutic approaches on the horizon. Clinicians are and will continue to be challenged with discerning how these agents work and the evidence to support their application in the clinical setting.

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14. Cambra: Development and incorporation into a dental hygiene program

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Background

Caries Management by Risk Assessment (CAMBRA) is becoming the standard of care in the delivery of patient care. CAMBRA is a program for managing dental decay by assessing the patient's risk category and level of caries activity to determine the most effective treatment strategies. Dental caries is treated as an infectious disease that is curable and preventable. Emphasis is on changing the behavior and attitude of patients so that they take an active role in the management of their dental decay.

With thirty years of scientific research on dental caries, Dr. John Featherstone, along with colleagues, laid the foundation for the CAMBRA guidelines and protocols.[1–3] The first guidelines were published in 2003 and are continually being evaluated and revised.[4] A Western CAMBRA Coalition was initiated in 2002 for the purpose of exchanging information about how to incorporate CAMBRA into teaching and clinical practice with representatives from five California schools.[5] The Coalition is continually growing to include representatives from schools across the nation, the dental products industry, the dental insurance industry, government and state licensing boards, dental research and clinical practice.

Recently, a practice-based research project for CAMBRA has been initiated. This project will begin in 2011 with a network of 17 dentists who have been calibrated on the CAMBRA guidelines and protocols. The purpose is to measure patient and provider acceptance of incorporating CAMBRA into clinical practice. The ultimate goal is to gather data to determine if there is scientific evidence to support CAMBRA as the standard of care.

Incorporating CAMBRA into dental hygiene and dental programs can be beneficial for both patients and students. By learning the scientific rationale and gaining practical clinical experience with CAMBRA, students are prepared to practice CAMBRA upon graduation.

CAMBRA protocol development

At the Ostrow School of Dentistry of USC, the Dean requested that CAMBRA be incorporated into the clinical program. First, a committee of one dental hygiene and four dental faculty members was formed to develop a CAMBRA protocol for use in the dental hygiene and dental program. The committee members individually read the scientific research related to CAMBRA and then met to discuss their findings. In addition, committee members attended various CAMBRA meetings and CAMBRA coalitions. Each member summarized key points that could be used to develop the school's protocol.

The committee members adopted the principle that conventional restorative treatment does little to treat the actual etiology of and risk factors leading to dental caries. The dental school will use CAMBRA to diagnose, treat and prevent dental caries from further developing. The diagnostic goals are to determine the 1) risk level for each patient; 2) level of caries activity; and the 3) frequency of exams, radiographs and treatment strategies.

Once the philosophy and principle of CAMBRA were established, the next steps were to set the guidelines and protocol for incorporation into the curriculum and clinic. This included selecting the risk assessment form, determining the treatment strategies for each risk category, determining the products to be used by the patient at home and in the clinic, setting guidelines for recording the information into the computerized patient record, and guidelines for follow up.

The committee adopted a risk assessment form that is a slight variation of Featherstone's form.[3] The modifications include a different format for recording the risk factors and a very specific outline regarding the treatment strategies. Another form was developed to record patient compliance with treatment strategies. The committee made the decision to provide patients at high and extreme risk categories with a take home kit. This kit consists of 16 ounces of 0.12% chlorhexidine, 4 ounces of 1.1% NaF prescription paste, 120 xylitol gumballs, dental floss and a toothbrush. An instruction sheet is included in the kit. Patients with xerostomia are given a non-alcohol chlorhexidine rinse. For patients who have TMJ problems or inability to chew gum, xylitol mints are offered.

Another essential part of the CAMBRA program was establishing the fee, which was based on the patient population and expense of products. The CAMBRA fee includes: the initial risk assessment appointment, a patient home care kit, one fluoride application, oral hygiene instructions, nutritional counseling and the first caries recall exam. Finally, the committee members determined how to educate the students and faculty.

CAMBRA implementation

Education of the dental hygiene students included the principles and techniques for biofilm removal, nutritional counseling, fluoride and antimicrobial therapy, and patient motivation. This information is already incorporated into the dental hygiene curriculum in various courses. In addition to these courses, the Dean, who outlined the scientific basis, provided a one-hour lecture and general guidelines for CAMBRA and three additional hours were presented by a dental hygiene faculty member outlining

the specific details of incorporation of CAMBRA into the clinical program. This education included a one-hour laboratory experience on how to conduct saliva tests.

Education of the dental hygiene faculty included four hours of education: a two-hour presentation by the Dean explaining the importance, scientific evidence and an overview of the program's expectations. This was followed by a two-hour lecture by the dental hygiene faculty committee member explaining the details of incorporating the program into the curriculum and clinic.

In addition to the educational sessions, the protocol for the program is outlined and given to each student and faculty member. Each patient treated in the dental hygiene clinic is assessed and assigned a risk category. The dental hygiene student conducts the initial assessment, which is then reviewed and approved by the faculty member. The information is recorded in the patient's electronic chart.

The following treatment strategies are followed based on the risk assessment level of the patient:

- *Low risk:* oral hygiene education, biofilm control, nutritional counseling, and use of a fluoridated dentifrice 1-2x/day.
- *Moderate risk:* all of the strategies in low risk PLUS using an over-the-counter (OTC) 0.05% NaF rinse daily, xylitol gum or mints (2 pieces 4x/day for at least 5 minutes) and application of 5% NaF varnish (2x/year).
- *High risk:* oral hygiene education, nutritional counseling, xylitol gum, 0.12% chlorhexidine 1x/day for 1 minute, one week per month, replace OTC dentifrice with a 1.1% NaF prescription dentifrice 2x/day.
- *Extreme risk:* same as high risk except use of 0.12% chlorhexidine in water base, a calcium/phosphate paste, and products for xerostomia, such as rinses and gels.

Additional treatment strategies include saliva testing for the high and extreme high-risk categories. Initially, it was decided only to do pH testing and then eventually incorporate a saliva buffering test and bacterial culturing for use as criteria to determine the success of treatment strategies. Fluoride varnish for the high and extreme risk is recommended 3–4 times per year.

When needed, the patient is referred for restorative treatment after home care treatment and instructions have been provided. Radiographs are taken based on the risk assessment level: at 6 months for extreme risk, 12 months for high risk, 18 months for moderate risk, and 24 months for low risk.

The goal is to move patients who are in a higher risk category to a lower risk category. Therefore, follow-up care is essential for evaluation of the patient's progress and to encourage patient compliance. For patients in the high or extreme risk category, the follow up includes: 1) a 2 to 4 week follow up appointment to evaluate compliance; 2) a 4 month appointment to evaluate compliance; and 3) an 8 month caries recall (high risk) or 6 month caries recall (extreme risk).

Incorporating CAMBRA into a dental hygiene program does have its challenges. Key factors to success include support of the Dean, education of the students and faculty, and a patient tracking system. The biggest challenge in our program has been the follow-up care due to lack of follow through appointments with the patients. This problem is due both to patients not keeping the follow-up appointments and to students not scheduling the follow-up appointments. The committee members are meeting on a regular basis to address some of the concerns and determine solutions. Although the scientific evidence for CAMBRA is very compelling, more research on patient compliance and motivation is needed to help insure the success of CAMBRA, especially in the dental school environment.

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Uniform contamination in the dental environment

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ABSTRACT

Purpose: To determine uniform related infection control practices of a group of dental hygiene students, and to compare the results with existing literature related to cross contamination via uniforms in the dental field. **Method:** Online databases, Medline / PubMed, and Google Scholar were searched for papers in peer reviewed journals published on microbial contamination of uniforms in the dental environment. The search resulted in only seven published articles relevant to the topic; six studies and one review. A questionnaire was distributed to students at a Toronto post secondary dental hygiene program, which queried the students' methods and frequency of laundering and sanitizing their uniforms and name tags. It also queried their willingness to use disposable uniforms as an alternative. **Results:** The students' study revealed a lack of attention to the necessity of frequent laundering (19% washed twice a week or more), washing separately (55% washed separately), and of sanitizing name tags (21% disinfected name tags). **Conclusion:** There is an important requirement for raised awareness, standards, protocols and training in the dental environment to minimize the potential for the spread of infection. Further research is recommended in laundering and sanitizing procedures. Schools and hospitals could consider providing disposable uniforms where applicable.

RESUMÉ

Objet : Définition de l'uniformité des pratiques reliées au contrôle de l'infection d'un groupe d'étudiantes en hygiène dentaire et comparer les résultats avec la littérature actuelle sur la contamination croisée par les uniformes dans le champ dentaire. **Méthodes :** L'on a cherché dans les données de base en ligne de Medline, PubMed et Google Scholar des articles de journaux revus par les pairs traitant de la contamination microbienne des uniformes dans l'environnement dentaire. L'on a trouvé seulement sept articles publiés sur le sujet; six études et une revue. L'on a ensuite distribué aux étudiantes d'un programme post secondaire d'hygiène dentaire de Toronto un questionnaire sur leurs méthodes et la fréquence du lavage et de la désinfection de leurs uniformes et de leurs plaques d'identité. On leur aussi demandé si elles accepteraient de porter des uniformes jetables comme alternative. **Résultats :** L'étude auprès des étudiantes a révélé un manque d'attention sur la nécessité d'un lavage fréquent (19 % faisaient deux lavages ou plus par semaine), d'un lavage à part (55 % le faisaient) et de la désinfection des plaques d'identité (21 % la faisaient). **Conclusion :** Il est grandement nécessaire d'accroître, dans les milieux dentaires, la sensibilisation, les normes, les protocoles et la formation visant à minimiser le risque de propagation de l'infection. L'on recommande de faire d'autres recherches sur les procédures de lavage et de désinfection. Les écoles et les hôpitaux pourraient songer à fournir des uniformes jetables le cas échéant.

Key words: name tags, dental students, protective clothing, pathogen transmission, dental clinics, dental high speed equipment, infection control

INTRODUCTION

Cross contamination is the transmission of infectious bacteria and other microorganisms between patients and healthcare workers in a clinical setting such as a dental environment.[1,2] Microbial transmission can be spread directly or indirectly. Direct transmission occurs by contact with oral fluids and blood. Indirect transmission occurs by contact with contaminated equipment, instruments and surfaces, and through the inhalation of airborne pathogens.[3]

Cross contamination has been a prevalent issue in the dental field.[4] Airborne pathogens are transmitted through specific dental equipment, consisting of handpieces, ultrasonic scalers, and air polishers.[4] Aerosols produced by these instruments are composed of blood, calculus, saliva, plaque, nasopharyngeal secretions, tooth components, restorative material and microbes.[4,5] These aerosols contain pathogenic microorganisms that can cause transmission of different diseases and affect the immunosuppressed, including patients, clinicians, staff and other individuals in contact with the exposed persons. Quantity, particle size, pathogenicity of the microorganisms, humidity, temperature, and ventilation are all factors of the infection spread potential of aerosols.[4]

Using an air–water syringe, rotating instrument or ultrasonic scaler can cause the release of 300,000 to 600,000 bacteria from an individual's mouth.[6] Amongst these pathogenic microbes, the species which can be found include, but are not limited to: *staphylococcus aureus*, *pseudomonas*, *acinetobacter*, *micrococcus*, *moraxella*, *alcaligens*.[1,9] These microorganisms can induce rhinitis, allergic alveolitis, asthma, organic dust toxic syndrome (ODTS), tuberculosis, cold, influenza, severe acute respiratory syndrome (SARS), human immunodeficiency virus (HIV), Hepatitis C, and herpetic viruses.[7,8]

Aerosols and splatter created during dental procedures may contain pathogens that can contaminate clinical wear. The clinician's chest, shoulders, face and lower arms are the most heavily contaminated areas. Research has demonstrated that splatter funnels upwards in a circular

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motion targeting the clinician's chest and forearms; pathogens can remain on clothing for up to several days.[9,10] Hepatitis B virus (HBV) contaminated blood, transmitted through clothing, can survive and remain infectious for seven days, even after the blood has dried. Oral and respiratory bacteria can survive on clothing for up to three days, whereas herpes simplex viruses and viruses infecting the respiratory tract can survive on surfaces for several hours.[11]

White coats, jackets, and scrubs (tunics and trousers) are components of a proper uniform, which are identified as attire worn by health professionals in clinical environments.[12] There are many concerns that white coats and uniforms may play a part in transmitting pathogens in clinical settings; however, existing research has not yet confirmed the link.[12,13] Personal protective equipment (PPE) such as protective clothing, eyewear, masks and disposable gloves are worn as a barrier to prevent the transmission of microorganisms between patients and the dental team. PPE may also be a source of transmission of pathogens if infection control regulations are not properly followed. To reduce cross contamination, it has been recommended that short sleeved tunics be worn to eliminate the spread of microorganisms and bacteria. Long sleeved tunics should be avoided as the cuffs brush against the patient, spreading pathogenic organisms.[9] Dental uniforms should only be worn in the dental office, changed daily, and changed immediately when splattered with blood to prevent the spread of bacteria and viruses.[9]

Presently, limited research has been conducted on the cross contamination of dental scrubs, name tags, and white coats. The objectives of this study are twofold: 1) to determine the uniform related infection control practices of a group of dental hygiene students, and 2) to compare the literature related to cross contamination in the dental field via uniforms with the results of the study conducted by the authors.

Review of the literature

It has been observed that the presence of a variety of pathogenic microorganisms on the white coats and uniforms of dental students, faculty members, dentists and other members of the dental environment, is a potential source of cross infection.[13] Dental personnel's clothing can be contaminated with or splattered by blood, aerosol and saliva during dental treatment, and presents a definite risk of infection by various transmissible agents.[9,14]

One small scale study in India, of microbial contamination of the white coats of dental staff in the clinical setting, found that only 61% of participants washed their white coats once a week or more. The remaining percentage of participants washed their white coats less frequently. Grading by the examiner revealed that overall, 16% of the participants had visibly dirty white coats. Comparing the self assessed cleanliness of personal protective clothing resulted in: 80% of the interns, 63% of the graduate students, and 67% of the faculty members considering their white coats to be moderately "clean". This highlighted a clear discrepancy in perception among dental personnel which can lead to an erroneous belief that their white coats were "clean". Cleanliness was not defined in the study, and was therefore subjective. The study performed a thorough clinical examination on white coats perceived to be "clean" by staff; and found them to be contaminated, posing a potential risk of cross infection, especially to weakened, vulnerable, or immunocompromised patients.[13]

Another study, conducted in South India[5] by Acharya et al., was to determine the level and type of microbial contamination present on the white coats of dental personnel in a rural dental setting. A pre-tested questionnaire was distributed to 51 participants, assessing the duration of use of their white coats, frequency of washing white coats, and the practice of exchanging them. The results clearly indicated that there was maximal growth of gram positive organisms (70.8%), and gram negative organisms (12.5%) on the white coats of the faculty, followed by graduates (65.8% gram positive and 10.5% gram negative), then interns (62.5% gram positive and 17.5% gram negative).[5] This study also suggested the use of disposable gowns and the use of proper barrier techniques.

A similar study was conducted by Foley[15] in 1990. It clearly specified that the point of clinical attire, and maintaining its standards, has been an issue for an extended period of time. The program directors of 197 dental hygiene programs in the US were extensively surveyed to find out how the recommendations affect the current clinical attire requirements for dental hygiene students and clinical faculty. The survey indicated that in 77% of the programs that responded, students were required to wear uniforms while working on patients. Only 10 per cent of the programs that responded preferred lab coats or consultation jackets worn over street clothes for their students. In this survey, it was concluded that most of the program directors (68.5%) stated that their clinical instructors were not required to wear the same clinical attire as their students. The majority preferred lab coats over street clothes. Many program directors were ready to consider changes in clinical attire because of the concern over infection control. The possible changes as per this survey were:

(1) switching from uniform to surgical gowns or scrubs,
(2) changing to disposable gowns, and
(3) utilizing a laundry service for lab coats and scrubs.[15]

Another retrospective study was done by Foley[16] in 1994 to assess the clinical attire requirements in dental hygiene programs, and to compare them with the requirements described in the 1990 survey. Checklist questionnaires were mailed to the directors of 211 dental hygiene programs in the USA and Puerto Rico in October 1993. Questions were asked regarding clinical attire requirements for students and faculty, including uniforms, gowns, lab coats, masks, protective eyewear, shoes, hair coverings, and laundry management. Long sleeved lab coats, disposable gowns and washable surgical gloves had increased in use. In most instances, face shields were worn with face masks, and laundry services were being provided by the faculty. However, most students continued to be responsible for their own laundry after being instructed to follow stringent guidelines taught by the faculty. It was concluded that dental hygiene programs appeared to be complying with infection control guidelines in their

Table 1. Publications used in this article.

Study	Year	Region/country of study	Topic discussed	Study type	Findings
Priya et al.	2009	India	Microbial contamination of white coats of dental staff in clinical settings.	Questionnaire	61% of the staff washed their coats weekly, and what they considered "clean" was still contaminated.
Acharya et al.	2010	South India	Aerosol contamination in a rural university dental clinic in South India.	Study	A high percentage of bacteria resided on white coats in the dental setting. Coats (60.8%) are washed once a week rather than every day.
Qureshi et al.	2005	North West England	How frequently do dentists change into a clean set of clinical clothing?	Cross sectional questionnaire based survey	To improve cross infection control, dental surgeons need to increase frequency of changing into a clean set of clinical clothing.
Foley ES	1990	USA	Current clinical attire requirements for dental hygiene students.	Questionnaire survey	Surgical gowns and scrubs worn by only 5% of students.
Foley ES	1994	USA and Puerto Rico	Update on "Clinical attire requirements in dental hygiene programs."	Retrospective study	Long sleeved lab coats, disposable gowns, and washable surgical gowns increasing in use by both faculty and students.
Wilson et al.	2007	London, England	Uniforms: an evidence review of microbiological significance of uniforms and uniform policy in prevention and control of healthcare associated infections. Report to department of health (England).	Review of published literature	All components of laundering contribute to the removal or killing of microbes on the fabric.

selection of clinical attire for both students and faculty. Comments of program directors indicated that they planned to change their clinical attire requirements to comply with all Occupational Safety & Health Administration (OSHA) regulations and recommendations.[16]

Qureshi et al.[9] investigated the types of clinical clothing worn by dentists in 2005, and how frequently dentists changed into clean sets of clinical clothing. The questionnaire developed was aimed at investigating the types of clothing worn for upper and lower body protection, and how frequently it was changed. Of the total respondents, 90% of general dental practitioners (GDPs) and 99% of the Dental Defence Agency (DDA) dentists reported wearing some form of clinical clothing to protect their upper body. Less than 50% of both groups reported changing clothes on a daily basis.[9] Only 36% of GDPs and 96% of DDA dentists removed their clinical clothing before leaving work.[9] This survey studied and could not determine any significant difference between the attitudes of the two groups towards the role that clinical clothing plays in cross infection, professionalism, and comfort. This survey strongly recommended that to improve cross infection control, dental surgeons needed to improve the frequency of changing into a clean set of clinical clothing.[9]

Wilson et al. reported to the Department of Health (UK), following systematic search and quality assessment of the published literature.[12] This study[12] was conducted to establish current knowledge on the role of healthcare workers' uniforms as vehicles for the transfer of healthcare associated infections. Wilson et al. identified seven previous studies, published between 1996 and 2005, for quality assessment.[12] All of the studies confirmed that the uniforms of nurses and healthcare practitioners became contaminated with microorganisms.[12] This study[12] also established that the important parameters regarding the role of bleach were not examined in most of the studies.

A list of all the publications that the authors used to write this paper can be found in Table 1.

STUDY

Purpose

The study was conducted by a group of seven dental hygiene students on their fellow students at a Toronto dental hygiene program. The purpose of the study was to evaluate the uniform washing routine of dental hygiene students and practitioners in the dental environment, and then, to evaluate the results in the context of previous similar studies. In order to assess the students' awareness of infection control and the importance of wearing clean uniforms in the dental setting, a multiple choice format questionnaire (Table 2) was devised as a means of establishing a basis for comparison. Analysis of the questionnaire results may then be used to help determine common protocols for protective clinical attire and barrier techniques to reduce cross contamination.

Methods

For the purposes of this study, uniforms were defined as: *clothing worn by dental care practitioners for everyday use in clinical environments*. The multiple choice format

questionnaire (Table 2) was pre-tested by the research group to evaluate the survey. In order to obtain a meaningful response, it was necessary to develop a survey that was concise, and relevant in terms of questions. It was distributed to all the students from all three semesters (127 students). At the time the study was conducted, all participants wore dental uniforms as part of the protocol at the school. The participants were asked the frequency, and method of disinfection of their uniforms and name tags, and their willingness to use disposable uniforms. The responses were deliberately unsigned to protect the anonymity of individuals. Questionnaires were to be deemed invalid if any questions were left blank, or corrupted, or if the participant answered in their own words, rather than by selecting one of the prescribed options. Responses from students in all three semesters were combined to show the statistical trends, and were sorted by age group.

Table 2. Questionnaire distributed to dental hygiene students.

QUESTIONNAIRE

1. How often do you wash your uniform: (tick one)

Daily	2–3 times a week	Weekly	Fortnightly	Monthly

2. Do you wash your uniform separately from other household clothes? Yes / No
3. Do you ever use bleach to disinfect your uniform? Yes / No
4. Would you be willing to use a disposable uniform? Yes / No
5. Do you disinfect your name badge? Yes / No
6. Your age: _____

Results

Of the 127 dental hygiene students surveyed, 8 questionnaires were returned invalid (6.3%); the remaining 119 responses were considered valid and used in the analysis. The largest proportion of the respondents was between the ages of 18–25, representing 66% of the students. The 34+ age group represented 9% of the total sampled population (Table 3).

Table 3. Respondents by age group.

Age	Respondents	%
18–25	79	66%
26–33	29	24%
34+	11	9%
All ages	**119**	

The students' responses on frequency of uniform washing are compiled in Table 4, and Figure 1. 19% of the total respondents washed their uniforms more than once a week. A clear trend towards weekly washing could be seen across the age groups, with 61% of all the students washing weekly. Nine per cent of the students washed fortnightly, and 10% monthly. Overall, the 34+ age group was more likely to wash their uniforms more than once a week (27%), and the 18–25 age group was the most likely to perform their washing less than weekly (26%).

The students' responses on uniform washing methods are compiled in Table 5 and Figure 2. The last question in the questionnaire (Table 2) was in regards to students disinfecting their name tags. It was revealed that 79% of students do not disinfect their name tags. Of the total respondents, 45% of the students did not wash their uniforms separately. The students (34+) were the most likely to wash their uniforms separately from other household clothes (73%) and disinfect their name tags (27%). The use of bleach was distributed in fairly equal parts among the age groups; however, students in the 18–25 age group were more likely to use bleach (46%).

The students' responses on willingness to use disposable uniforms are compiled in Table 6 and Figure 3. The overall trend was that the majority of the students (62%) were unwilling to use disposable uniforms. However, the 34+ age group was more willing to use them than the other age groups.

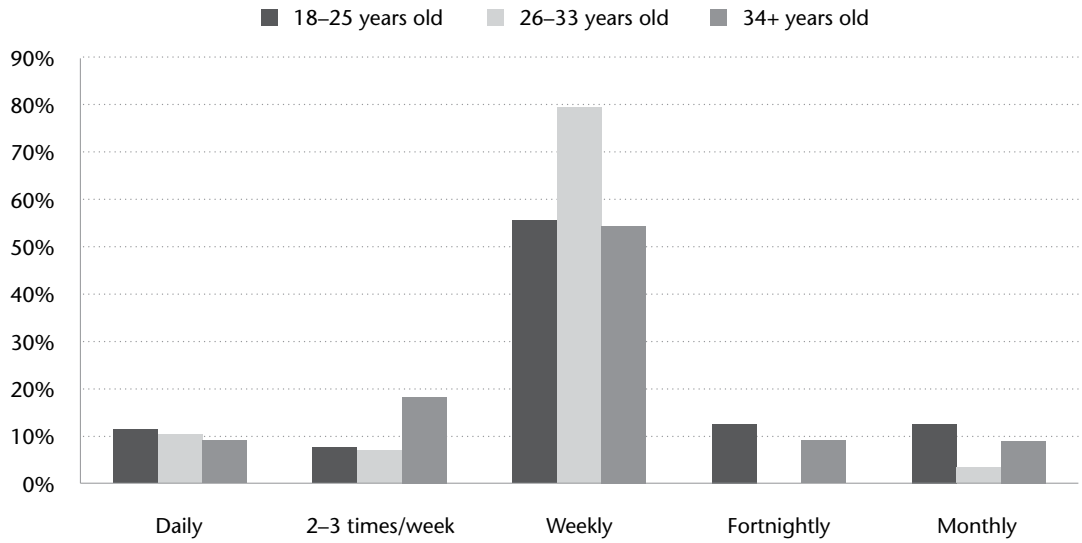
Discussion

The results of the survey indicated that most students at the college were generally aware of uniform cross contamination, in line with college infection control protocol. The college faculty appeared to be carefully monitoring changes in Centers of Disease Control and Prevention

Table 4. Uniform washing frequency by age group (n) and (%).

Age	Respondents	Daily		2–3 x /week		Weekly		Fortnightly		Monthly	
	n	n	%	n	%	n	%	n	%	n	%
18–25	79	9	11%	6	8%	44	56%	10	13%	10	13%
26–33	29	3	10%	2	7%	23	79%	0	0%	1	3%
34+	11	1	9%	2	18%	6	55%	1	9%	1	9%
All ages	**119**	**13**	**11%**	**10**	**8%**	**73**	**61%**	**11**	**9%**	**12**	**10%**

Figure 1. Uniform washing frequency by age group (%).



(CDCP) recommendations, and is implementing program changes as needed.[17]

The survey results concluded that 81% of the students washed their uniforms once a week or more, 10% washed them monthly, and 9% fortnightly (Table 4). This indicated that majority of the students were aware of the importance of infection control protocols. However, students work in the clinic on an average of two or three times per week. As the college guidelines recommend, uniforms should be washed after each use (i.e., more than once a week). Despite the protocol, only 11% of students washed their uniforms after each use (daily).

These results are consistent with the results of Acharya et al. and Wilson et al., both of which highlighted the importance of laundry frequency as part of effective disinfection protocol.[5,12]

When the data were analyzed according to the separate age groups; it was observed that 79% of the students in the 26–33 age group washed their uniforms weekly. In comparison, only 56% of the students in the 18–25 age group washed their uniforms weekly (Table 4).

The results indicated that only 11% of the students washed their uniforms daily, and 8% washed them two or three times per week; therefore the college infection control protocol was not being achieved.

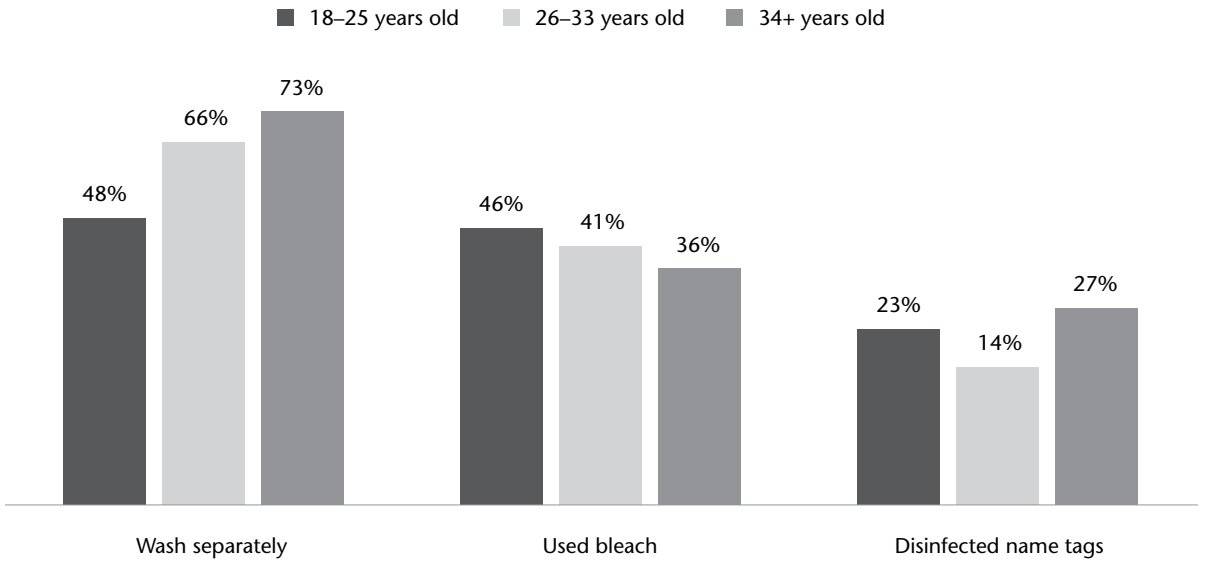
Uniform disinfecting methods surveyed in our questionnaire (Table 2) included parameters such as: washing uniforms separately, using bleach for the uniforms and disinfecting the name tags. Washing of uniforms, separately, rather than with the regular laundry, was not well supported by the results, as only 55% of the students stated that they wash their uniforms separately, indicating a lack of understanding that pathogens may reside on the uniform (Table 5). The results of Qureshi et al.[9] indicated that microbes in the splatter resides on the uniform, which therefore should be washed separately. Consequently, improved measures need to be implemented to increase the awareness of dental hygiene students, as 45% still wash their uniform with their regular laundry (Table 5).

The report prepared by Wilson et al.[12] discussed the importance of bleach as a disinfectant during the laundry cycle. The results of this study's questionnaire indicated a lack of awareness of the college protocol, as only 44% used bleach as a disinfectant (Table 5). This indicated that not all students were aware of the importance of bleach in the disinfection procedure for uniforms (Table 5).

Table 5. Uniform washing and disinfection methods by age group (n) and (%).

Age	Respondents	Wash separately		Used bleach		Disinfected name tags	
	n	n	%	n	%	n	%
18–25	79	38	48%	36	46%	18	23%
26–33	29	19	66%	12	41%	4	14%
34+	11	8	73%	4	36%	3	27%
All ages	**119**	**65**	**55%**	**52**	**44%**	**25**	**21%**

Figure 2. Uniform washing and disinfection methods by age group (%).



A major finding of this study concerned name tags. Dental professionals are required to wear name tags while dealing with clients in a clinical setting, and they are often not covered by barriers during procedures.[18] The results indicated that surprisingly few students were aware of its importance in cross contamination, as 79% of the students admitted to not disinfecting their name tags as part of the disinfecting process (Table 5). This can only lead us to speculate that at the time of the survey, the students may not have been fully aware of the disinfection protocol, and may not have been aware of the risk of pathogenic transmission by means of name tags, or if they were, they may have underestimated the risk, or chosen to ignore it.

The final part of the survey on the use of disposable uniforms supports the findings of studies by Foley[15,16] and Qureshi et al.,[9] where the importance of disposable uniforms in dental settings is discussed. Of the 119 respondents, 62% did not agree to using disposable uniforms as part of the disinfection protocol (Table 5).

A number of limitations became evident in undertaking this study which may have either skewed the results, or affected the conclusions of the study.

First, improvements could be made to the questionnaire (Table 2). The wording in places could be made clearer, or more specific, to avoid ambiguity. For example, a few comments were received about using the term "daily". It was suggested the phrase "after each use" be used instead, as students did not treat clients every day, so it was not necessary to wash their clinical attire every day. Also, the term "uniform" could be replaced by "lab coat and scrubs", as scrubs are often coloured, whereas lab coats are usually white, and therefore separate washing and bleaching may be required. The question on disposable uniforms could be rephrased to ask the participant if they would prefer the option of disposable uniforms, rather than query their willingness to use them. The age field should not have asked their specific age, but instead should have offered a choice of the three age group ranges that were used in the results. This may have decreased the number of surveys deemed invalid, because some participants were reluctant to provide their specific age. An optional "Comments" section could be added at the end for participants' feedback, in addition to the answers.

Second, the scope of the survey could be increased. Members of staff and faculty who work in the clinic could have been included. Also, questionnaires could have been mailed or emailed to graduates of previous semesters, now qualified and practising the profession.

Third, the possibility of having a sample selection of lab coats analysed for pathogens, both "clean" and "dirty", would bring focus to the study findings. The results currently only give statistics on the disinfection techniques of the participants, and not of their efficacy.

Figure 3. Students willing to use disposable uniforms by age group (%).

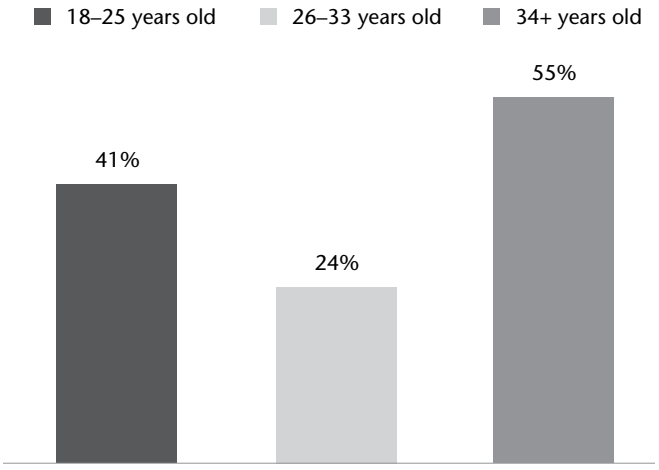


Table 6. Students willing to use disposable uniforms by age group (n) and (%).

Age group	Respondents	Willing (n)	Willing (%)
18–25	79	32	41%
26–33	29	7	24%
34+	11	6	55%
All ages	**119**	**45**	**38%**

CONCLUSION

The decontamination of dental hygienists' uniforms is an important aspect of the infection control program, yet is often neglected, or not entirely understood. Therefore, education on the issue of cross contamination through uniforms and name tags has to be further explored by both students and registered dental hygienists. It is also advised that students be educated to use a more stringent laundering regime, so that they encompass professional habits and minimize the presence of pathogenic microbes on their uniforms which could be transmitted to other environments.[13]

The consequences of cross contamination from wearing uniforms and white coats in public and non clinical areas such as canteens, libraries, public transport and the home, should be further emphasized by the CDC, OSHA as well as by dental and dental hygiene regulatory bodies.

This study highlighted the importance of uniform cross contamination and disinfection protocol, and the lack of current published studies in Canada, as areas of concern for Canadian dental hygienists, meriting further attention. New research, taking into account previous studies worldwide, is recommended in both the dental and medical fields. Supplementary research on the scale of cross contamination through uniforms in the dental care environment, and statistical data on the risk factors posed by contaminated uniforms are greatly needed to minimize the risk for the spread of microorganisms and infection. Additional studies with a larger representative sample size, examining the exact means of contamination and cross contamination are also suggested.

The issue of uniform contamination by dental care providers should be addressed in the healthcare field. Schools and hospitals that train dental students should consider providing freshly laundered uniforms for students, or provide students with disposable uniforms where applicable.

Finally, it became evident in our study that there were no current published Canadian studies available for comparison on the topic of uniform contamination in the dental field. Having results from other Canadian studies would have helped identify any trends in uniform cross contamination over time, or any shortcomings and risk factors in disinfection procedures, such as name tag disinfection, highlighted in our study. Comparison with studies conducted in other countries will enable Canadian dental hygienists comprehend that uniform contamination is a prevalent issue worldwide as well as provide them with information on the associated risks. Dental hygienists should remain vigilant in their efforts to reduce the risk of cross contamination, and to control the spread of potentially infectious microorganisms.

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Caffeine as an adjuvant to common over the counter analgesics for postoperative dental pain: A scoping review

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ABSTRACT

Background: Caffeine is one of the most commonly consumed ingredients in the world. It has been an additive in analgesics for years, but its role as an analgesic adjuvant is unclear. Optimal pain management with safe and effective analgesia is crucial in the dental field, and if caffeine is an effective analgesic adjuvant, this cost effective drug combination can be considered in clinical practice. **Objective:** To identify the literature on the effect of caffeine as an adjuvant to OTC analgesics for postoperative dental pain. **Method:** A scoping review method was used: 1) identifying the research question 2) searching for relevant studies; 3) study selection; 4) data extraction; and 5) collating, summarizing and reporting the results. **Results:** A total of ten studies were included from CINAHL, Medline, PubMed and Embase. Clinical trials demonstrated an increased efficacy of analgesic effects and results from the meta analyses and systematic reviews were weakly positive or inconclusive. Contradictory results may be due to the dose dependent response of caffeine, the concentration–response curve theory, different pain types and intensities, and the different pharmacological effects of the co-drug. **Conclusion:** The effect of caffeine as an adjuvant to acetaminophen, ibuprofen, and aspirin for postoperative dental pain remains unclear. However, there is some evidence that caffeine enhances the analgesic effects under certain conditions. Further research is needed to determine the appropriate effective dose ratio of the caffeine–analgesic combination for each analgesic and for each pain source and intensity.

RÉSUMÉ

Contexte : La caféine est un des ingrédients les plus communs consommés dans le monde. C'est un additif aux analgésiques depuis des années, mais son rôle d'adjuvant analgésique n'est pas clair. La gestion de la douleur optimale avec un analgésique sécuritaire et efficace est cruciale dans le domaine dentaire et, si la caféine est un adjuvant analgésique efficace, cette combinaison rentable de médicaments peut être considérée en pratique clinique. **Objectif :** Repérer la littérature traitant des effets de la caféine en tant qu'adjuvant des analgésiques en vente libre pour la douleur dentaire postopératoire. **Méthode :** Un examen de grande portée a été effectué : 1) identification des questions de recherche; 2) recherche des études pertinentes; 3) sélection des études; 4) extraction des données; 5) collation, résumé et compte-rendu des résultats. **Résultats :** En tout, dix études ont été tirées de la base de données CNIAHL, Medline, PubMed et Embase. Les essais cliniques ont démontré une hausse de l'efficacité des effets analgésiques et des résultats des méta analyses, et les revues systématiques ont été hebdomadairement positives ou peu concluantes. Les résultats contradictoires furent peut-être attribuables à une réaction dépendant de la dose de caféine, à la courbe théorique concentration–réponse, au type et à l'intensité de la douleur et aux différents effets pharmacologiques du co-médicament. **Conclusion :** L'effet de la caféine en tant qu'adjuvant de l'acétaminophène, à l'ibuprophène et à l'aspirine pour la douleur dentaire reste incertain. Toutefois, certaines données indiquent que la caféine rehausse les effets analgésiques sous certaines conditions. D'autres recherches s'imposent pour déterminer le rapport approprié et efficace entre la caféine et l'analgésique dans la combinaison pour chaque source et intensité de douleur.

Key words: caffeine; analgesics; analgesic adjuvant; OTC drugs; NSAIDs; acetaminophen; ibuprofen; aspirin; postoperative pain; scoping review

BACKGROUND

Caffeine is one of the most commonly consumed dietary ingredients throughout the world. It is naturally found in coffee beans, cacao beans, kola nuts, guarana berries, and tea leaves.[1] The most prominent sources of caffeine are coffee and tea. Soft drinks, energy drinks, and chocolate are also common sources of caffeine.[1] Moderate caffeine consumption is considered safe — <400 mg/day for healthy adults.[2] However, studies show a negative association with the incidence of type 2 diabetes mellitus. Excessive caffeine intake can have negative health effects on children and pregnant women.[1,2] Commonly known positive effects of caffeine include physical endurance, reduction of fatigue, enhancement of mental alertness, and assisting in weight loss and management.[1] Less known is the possible analgesic adjuvant effects of caffeine in pain relief medi-

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cations. Caffeine has been an additive in analgesics for many years, but its efficacy in analgesics is still uncertain.

The topic of effective analgesics is important in the dental field because many dental procedures, especially surgical interventions, involve some measure of discomfort and pain. Optimal pain management is crucial for the care and treatment of anxious dental patients. Although surgery is not in the scope of dental hygiene practice, some dental hygiene therapies can have postoperative discomfort or pain. Therefore, dental hygienists should be aware of the effective types of pain management recommended for postoperative pain. The profession of dental hygiene continues to move forward with a more comprehensive approach to health and knowledge and, in this particular area, could contribute further to this advancement. While dental hygienists in Alberta have the authority to prescribe a limited schedule of drugs, they cannot prescribe analgesics.[3] However, dental hygienists must be aware of the over the counter (OTC) medications that clients may use.

Acetaminophen is a commonly used analgesic in controlling pain after periodontal or oral surgical procedures.[4] Unlike ibuprofen and aspirin, it is devoid of anti inflammatory activity and is well tolerated because it lacks many side effects such as gastric ulceration, inhibition of platelet function and hypersensitivity reactions.[4] Ibuprofen is one of the most widely used non steroidal anti inflammatory agents (NSAIDs) and is an effective analgesic for postoperative oral pain. This common OTC analgesic has a dose–response relationship within the range of 50–400 mg and appears to be one of the safest among the NSAIDs in current use.[5] Aspirin is a common over the counter NSAID and analgesic that can also be used for dental pain.[6]

Pharmacology of caffeine

Drug metabolism

When caffeine is administered concomitantly, anti nociceptive effect is increased but there is no significant change of NSAID plasma concentrations.[7] It has been suggested that the anti nociceptive effect of analgesics by caffeine is not likely due to a pharmacokinetic interaction but rather a pharmacodynamic one.[8]

Zhang[7] has hypothesized that caffeine is a non selective antagonist of adenosine receptors and aids in the blockade of adenosine A1 and A2 receptors in several physiological systems. Zhang has further suggested that adenosine A2 receptor antagonism results in COX-2 inhibition.[7]

Analgesic actions of caffeine

It has been suggested that caffeine has its own intrinsic analgesic effects[7,9], but some evidence has shown that caffeine alone does not produce any analgesic effects such as in the Forbes et al.[6] study. Zhang[7] also found that caffeine may induce central cholinergic analgesia. Caffeine's influence on mood resulting from the stimulant properties has also been considered a source of pain relief.[7,9]

Studies have shown that like most drugs, caffeine has a dose-dependent response.[7–10] The dose dependent response reaches a maximum at the plasma concentration of 100μmol/L and then declines as the concentration of caffeine is further increased.[7] Granados-Soto and Castaneda-Hernandez[8] point out that caffeine co-administration with paracetamol (acetaminophen) produces a parallel shift of the sigmoidal concentration–response curve to the left where the "y" axis is the analgesic effect. The responses can be divided into three zones; where zone two will yield increased analgesic effects, zone one has low concentrations, and zone three has high concentrations where a ceiling effect is reached. If the caffeine concentration falls within either zone one or zone three, there will be no potentiation of analgesic effect.[8] It is therefore possible to understand why caffeine augments the effect of analgesics in some, but not all, cases.

Dental hygienists can certainly recommend OTC medications, and if caffeine increases the analgesic effects of pain medications, then recommendations for this cost effective drug combination can be considered in clinical practice. The purpose of this review was to identify the extent and nature of the literature concerning the effect of caffeine as an adjuvant to OTC analgesics for postoperative dental pain.

METHOD

This study is a scoping review. A scoping review identifies the "scope" or the extent and nature of the literature in a field of interest. It can be described as a study that aims to rapidly map the key concepts, main sources, and types of evidence available underpinning a research area.[11] It can also be used to identify gaps in the literature and needs for future research. This type of review also stands out because of its transparency in the search and selection process.[11] We limited our search to key electronic databases that we considered likely to index studies of the type we were seeking. We did not conduct extensive hand searching, nor did we perform quality assessment because these strategies are not typical of scoping reviews.

The main steps were: 1) identifying the research question; 2) searching for relevant studies; 3) screening citations and abstracts and study selection; 4) data extraction, and 5) collating, summarizing and reporting the results. This process was not linear but iterative.

Identifying the research question

The prevalence of caffeine consumption among many clients in private practice ignited interest in the effects of caffeine on oral health. Initial searches of the literature on this topic resulted in a broad range of findings. Three common OTC analgesics (acetaminophen, ibuprofen, aspirin) were chosen to examine their appropriateness for safe and cost effective clinical practice. The research question guiding this study was: what is the extent of the literature on the effects of caffeine as an adjuvant to common OTC analgesics for managing postoperative dental pain?

Searching for relevant studies

The databases selected were CINAHL, Medline, Cochrane Library, PubMed, and Embase as we deemed these the most likely sources of studies on our topic. We collaborated with a reference librarian to develop the search strategy. Search terms combined with caffeine included: postopera-

Table 1. Search strategy and results.

Database	# Citations
CINAHL	56
Medline	151
Cochrane Library	0
PubMed	143
Embase	151
Total	**501**

Search terms

- combinations used: caffeine AND postoperative, caffeine AND oral surgery, caffeine AND dental pain, caffeine AND acetaminophen, caffeine AND paracetamol, caffeine AND aspirin, caffeine AND ibuprofen, caffeine AND analgesic adjuvant
- MeSH headings and subheadings, truncations, and mapping were adapted as appropriate for the various databases.

tive, oral surgery, dental pain, acetaminophen, paracetamol, aspirin, ibuprofen and analgesic adjuvant. The Boolean operator 'AND' was used to combine the paired search terms. The search was limited to English language publications and publication date from 1990 to 2011. See Table 1 for the search strategy and results.

Abstract screening and study selection

RefWorks software was used to remove duplicate citations. The remaining titles were reviewed by the first author and non relevant titles were excluded. Abstracts remaining underwent detailed screening by all three authors, guided by the inclusion criteria. Screening of studies relevant to the research objective was guided by the following inclusion criteria: key word 'caffeine' in the study title with the type of analgesic examined (acetaminophen/paracetamol, aspirin, ibuprofen, or nonsteroidal anti inflammatory drugs) or with the term "analgesic adjuvant"; English language and publication date from 1990 and later; specific study types (randomized clinical trials, reviews, or meta analyses); type of pain (included dental/oral pain); and studies mainly examining the analgesic effects of caffeine as an adjuvant. Studies that focused on the safety of caffeine were excluded. One review study[8] was not included in the tables because it generalized its findings and focused mainly on the pharmacology of caffeine as an analgesic adjuvant.

Data extraction or charting

Data were extracted related to authors, study design, analgesic and analgesic adjuvant comparisons, type of pain, and overall effects. Number of participants was included for randomized controlled trials.

Collating, summarizing and reporting the results

A narrative description of the main results is presented. The results are categorized based on the type of analgesic studied (acetaminophen, ibuprofen, aspirin, or all three). Given the research objective, our intent was to summarize the results based on whether caffeine is an effective analgesic adjuvant to the three common OTC analgesics for dental pain.

RESULTS

A final total of ten articles were selected for inclusion in our review. Figure 1 contains a flow chart of the search and retrieval process. Data extraction is presented in Tables 2 and 3. Table 2 lists the individual clinical trials that examined caffeine as an analgesic adjuvant for dental pain. Table 3 lists the systematic reviews and meta analyses that investigated caffeine as an analgesic adjuvant for various types of pain, including dental pain.

Acetaminophen–caffeine combination

Zhang and Po[12] demonstrated that the acetaminophen–caffeine combination has only weak effects that are not clinically significant, and concluded that there was weak support for the use of caffeine to add to the analgesic effect of acetaminophen. Because ibuprofen has better analgesic efficacy than acetaminophen, Rashwan[4] investigated whether adding caffeine to acetaminophen would increase its analgesic efficacy compared with ibuprofen alone. Results indicated that there was no statistically significant difference between the two groups at all periods and that the reduced analgesic efficacy of acetaminophen–caffeine compared with ibuprofen during the last hours could be attributed to the small dose of caffeine at 30 mg.[4] This study suggested that caffeine potentiates the analgesic efficacy of acetaminophen and that the combination is an efficient replacement for ibuprofen in the management of

Figure 1. Flow chart of search and retrieval processes.

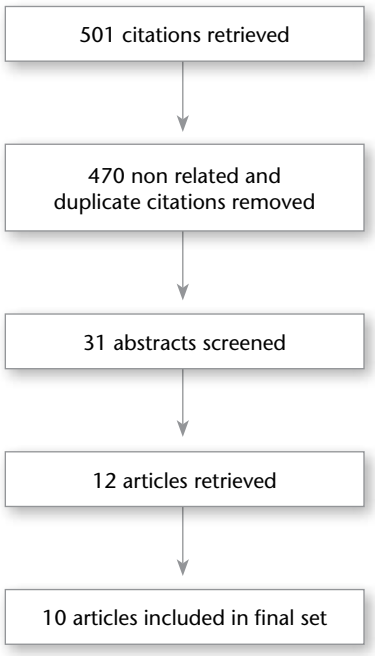

Table 2. Randomized clinical trials (RCTs) that investigated the analgesic adjuvant effect of caffeine in dental pain.

Study	Design	Comparisons	No. of participants	Source of pain	Effect of caffeine as analgesic adjuvant
Rashwan[4] (2009)	Double blind crossover pilot RCT	acetaminophen 500 mg–caffeine 30 mg vs. ibuprofen 400 mg	15	open flap debridement (periodontal surgery)	+
McQuay et al.[10] (1995)	Double blind parallel RCT	ibuprofen 200 mg–caffeine 50, 100, 200 mg vs. ibuprofen 200 mg, 400 mg	161	3rd molar surgery	+
Forbes et al.[14] (1991)	Double blind parallel RCT	ibuprofen 100, 200 mg–caffeine 100 mg vs. ibuprofen 50, 100, 200 mg	298	3rd molar surgery	+
Forbes et al.[6] (1990)	Double blind parallel RCT	aspirin 650 mg–caffeine 65 mg vs. aspirin 650, 100 mg	350	3rd molar surgery	+
+ increased efficacy of analgesic					

postoperative oral pain, especially in patients with gastric ulcers or bleeding tendency.[4] A recent meta analysis[13] supports Rashwan's findings[4] that acetaminophen 1000 mg with caffeine 130 mg is effective in the management of pain. Not only is this combination effective, it is also safe because caffeine does not produce any increase in oxidative metabolism of therapeutic concentrations of acetaminophen; the hepatotoxicity of overdoses of acetaminophen results from its oxidative metabolism.[13]

Ibuprofen–caffeine combination

Forbes et al.[14] and McQuay et al.[10] have demonstrated a positive analgesic adjuvant effect for caffeine 100 mg in combination with ibuprofen in third molar surgery pain. However, there is contrasting evidence to these findings in Po and Zhang's[5] meta analysis. Only one out of the three head to head comparisons reported showed that the combination was superior to ibuprofen alone.[5] It is important to note that the McQuay et al.[10] study was not included in this meta analysis because of the difference in their method of reporting results that used median responses rather than means.[5]

Aspirin–caffeine combination

Forbes et al. showed that an aspirin 650 mg–caffeine 65 mg combination was statistically superior to aspirin 650 mg alone for hours of 50% relief among patients who had severe baseline pain.[6] A systematic review by Zhang and Po questioned the clinical significance of those results and concluded that caffeine exerts no discernible additional analgesic effect when added to aspirin.[15] This review mentions anecdotal comments claiming that caffeine exerts a mood elevating effect, but states that if such an effect is real, it is not translated into a detectable analgesic effect.[15]

Caffeine in combination with each of acetaminophen, ibuprofen and aspirin

Two systematic reviews compared caffeine combined with each of the three common OTC analgesics with the analgesics alone and both found inconclusive results.[7,9] Zhang has suggested that actual doses of analgesics and caffeine can influence the analgesic adjuvant effects of caffeine, and doses that are either too low or too high lead to no analgesic enhancement.[7] Although overall results were inconclusive in Sawynok and Yaksh as well, the results appear to be more positive for dental pain.[9] They note that caffeine produces subtle changes in affect and mood, which is an important insight into the amelioration of pain. However, they conclude that this "influence on mood reflects on the stimulant properties of caffeine" and a distinct effect remains to be seen.[9(p.75)]

DISCUSSION

Individual clinical trials have demonstrated that caffeine increased the efficacy of the analgesic examined.[4,6,10,14] However, inconclusive results were found in some meta analyses[5,12,13,15] and systematic reviews.[7,9] A review of the pharmacology of caffeine from these studies suggests that the specific mechanism of action of caffeine as an analgesic adjuvant or analgesic alone still remains unclear. On the other hand, it provides possible explanations of why there are inconclusive results.

Contradictory results seen in the studies may be due to the dose dependent response of caffeine and the concentration–response curve theory.[8] Zhang[7] suggested that discrepancies in caffeine's analgesic effects can be possibly due to different sources of pain because of the differing pathophysiology. For example, tooth extraction pain is partially of neuropathic origin whereas migraine may

Table 3. Systematic reviews and/or meta analyses that investigated the effect of caffeine as an analgesic adjuvant in various types of pain.

Study	Comparisons	Type of pain	Overall effect of caffeine as analgesic adjuvant
Palmer et al.[13] (2010)	caffeine–paracetamol (acetaminophen) vs. paracetamol alone	dysmenorrhoea, headache, postpartum, dental	+
Zhang[7] (2001)	Caffeine containing analgesics (paracetamol/ acetaminophen, aspirin, ibuprofen) vs. the analgesics alone	headache, postpartum, dental	Inconclusive
Po, Zhang[5] (1998)	ibuprofen vs. in combination with caffeine or codeine	dental, episiotomy, other postoperative	Inconclusive
Zhang, Po[15] (1997)	aspirin vs. in combination with caffeine and codeine	dental, episiotomy, other postoperative	0
Zhang, Po[12] (1996)	paracetamol (acetaminophen) vs. in combination with caffeine and codeine	dental, episiotomy, postpartum uterine cramp, and other postoperative	+ (but weak; results not statistically and clinically significant)
Sawynok, Yaksh[9] (1993)	Caffeine containing analgesics (aspirin, acetaminophen, ibuprofen, morphine) vs. the analgesics alone	headache, postpartum, dental surgery, postoperative	Inconclusive (results appear to be more + for post dental surgery pain due to the severity of the pain)
+ increased efficacy of analgesic; – decreased efficacy of analgesic; 0 no effect of analgesic			

relate to vascular function. Thus, specific types of pain should be considered when investigating the analgesic adjuvant effects of caffeine, including effects on soft tissue pain or discomfort as may result from dental hygiene therapy. Sawynok and Yaksh[9] state that it is likely that several factors such as the dose of caffeine, the pain state and intensity, and the characteristics of action of the co-drug may influence the activity of caffeine as an analgesic adjuvant. This might explain why the meta analyses examining only caffeine–acetaminophen[12,13] yield more positive analgesic results than ones with only caffeine–ibuprofen[5] and caffeine–aspirin.[15] This makes sense as each individual drug has different pharmacological effects and as a result, may act differently with the caffeine.

It is therefore reasonable to accept that caffeine increases the analgesic efficacy of some analgesics, but only in certain pain states and at certain dose ratios.[7–9] Moreover, by using caffeine as an additive and keeping the analgesic concentrations relatively low, side effects of the analgesics, especially from ibuprofen and aspirin, are reduced.[8] Further research is required to determine the effective dose ratio for each caffeine–analgesic combination for each pain state. Zhang[7] recommends better designed studies and suggests that results are inconclusive, possibly due to small sample size in individual trials, pooling based on few studies, and insufficient statistical power. Further studies on a larger sample size and using higher doses of caffeine to reach a better drug combination efficacy were also recommended.[4] Another gap in the literature is the insufficient studies on various sources and types of dental pain from different procedures, including dental hygiene treatment. Most sources of dental pain in the studies were from third molar extraction surgery. Studies using caffeine from another source, such as in coffee or tea, may be applicable and cost effective in clinical practice because of the prevalence of caffeine in diet, but this would be difficult because the dose of caffeine and the confounding additives in these beverages would have to be considered and precisely controlled.

For dental hygiene practice, studies are needed to determine the best clinical effects from caffeine as an adjuvant to the common analgesics for post intervention pain considering that the overall consumption of caffeine for that individual is within the appropriate total daily intake. Recommending analgesics with a caffeine adjuvant may be beneficial to patients who have increased bleeding tendency and gastric ulceration because of the reduction in NSAIDs side effects. There was no evidence that patients should discontinue their consumption of caffeine when they are using acetaminophen, ibuprofen, or aspirin.

More research is warranted from a dental perspective in this topic as there is a lack of studies on various types of oral pain from dental procedures other than third molar extraction surgery.

Limitations of this scoping review were the short time frame (three months) and the scope of our searches. Searching was limited to only key electronic databases presumed most likely to produce reliable results; extensive hand searching was not performed. It is possible that additional databases and hand searching may identify additional studies. As mentioned earlier, studies dated before 1990 and non English language publications were excluded. Furthermore, quality assessment was not performed on included trials and key informants in the field were not contacted. The inclusion of systematic reviews did mean that quality assessment had been included as part of the conduct of those peer reviewed studies.

CONCLUSION

Overall, the findings regarding the effectiveness of caffeine as an analgesic adjuvant to acetaminophen, ibuprofen, and aspirin for postoperative dental pain appear to be inconclusive or weakly positive. However, it is suggested that caffeine potentiates the analgesic effects of some analgesics under certain conditions and doses. Further research is needed to determine the appropriate effective dose ratio of the caffeine–analgesic combination for each analgesic and for each pain source and intensity.

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Comparison of interdental brush to dental floss for reduction of clinical parameters of periodontal disease: A systematic review

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ABSTRACT

Background: Daily oral biofilm disruption by clients is recommended by oral health professionals to prevent oral diseases and to maintain optimal oral and overall health. Since periodontal diseases and caries are prevalent interproximally, the adjunctive use of interdental aids is highly recommended. **Objectives:** To evaluate the effectiveness of interdental brushing as an adjunct to toothbrushing for the primary outcome of interproximal gingival bleeding and a secondary outcome of interproximal plaque. **Methods:** Only randomized controlled trials were included. Studies were included irrespective of publication status and language. Hand searching was conducted in two peer reviewed journals, with references mined. Pharmaceutical companies that develop and manufacture interdental brushes were also contacted for unpublished or ongoing clinical trials. Sixty-two studies were retrieved from the literature with seven studies meeting the inclusion/exclusion criteria. Forest plots and Chi-square tests were used to determine the presence of heterogeneity. Random effects model, relative risk and 95% confidence intervals were used in the analysis. **Results:** Four studies were included in the meta analysis for bleeding outcome. Although some heterogeneity was present among the studies, the interdental brush groups demonstrated statistical significance for reducing interproximal bleeding compared to the dental floss groups, p = 0.003. Plaque outcomes were analyzed using seven studies, with interdental brush demonstrating statistically significant differences to dental floss, p = 0.024. **Conclusion:** Interdental brush is an effective alternative to dental floss for reducing interproximal bleeding and plaque in clients with filled or open embrasures.

RESUMÉ

Contexte : Les professionnels de la santé buccale recommandent la désorganisation quotidienne du biofilm oral par les clients afin de prévenir les maladies buccales et maintenir la meilleure santé buccale et générale. Vu la prévalence interproximale des maladies périodiques et des caries, on recommande vivement l'utilisation d'appoint d'aides interdentaires. **Objectifs :** Évaluation de l'efficacité du brossage interdentaire comme ajout au brossage des dents pour les résultats primaires du saignement gingival interproximal et un résultat secondaire de plaque interproximale. **Méthode :** Seuls les essais contrôlés et randomisés ont été inclus. Les études ont été inclues indépendamment de la nature de la publication et du langage. La recherche manuelle a été menée par deux journaux revus par les pairs avec une mine de références. Les compagnies pharmaceutiques qui développent et manufacturent des brosses interdentaires ont aussi été consultées sur les essais cliniques non publiés ou en cours. Soixante-deux études ont été retrouvées dans la littérature avec sept études répondant aux critères d'inclusion ou d'exclusion. Les tests Forest plot et Chi-square ont été utilisés pour déterminer la présence d'hétérogénéité. Un modèle d'effets randomisés, de risque relatif et d'intervalles de confiance de 95 % ont servi à l'analyse. **Résultats :** La méta analyse sur le résultat du saignement comprenait quatre études. S'il y avait une certaine hétérogénéité dans les analyses, les groupes de la brosse interdentaire montrèrent des différences statistiquement significatives concernant la réduction du saignement interproximal, comparativement à ceux de la soie dentaire, p = 0,003. L'analyse de la plaque qui en a résulté a fait l'objet de sept études qui notèrent que la brosse interdentaire montrait des différences statistiquement significatives en regard de la soie dentaire, p = 0,024. **Conclusion :** La brosse interdentaire est une alternative efficace à la soie dentaire pour réduire le saignement et la plaque chez les clients ayant des embrasures remplies ou ouvertes.

Key words: oral self care aids, interdental products, gingival bleeding, oral biofilm, plaque index, oral hygiene

INTRODUCTION

Periodontal disease, which is a large family of pathological conditions affecting the supporting structures of the teeth, is a common oral ailment seen in dental hygiene practice.[1] Established oral biofilms, commonly known as dental plaque, cause and exacerbate gingival inflammation.[2–4] If left untreated, periodontal disease may lead to tooth loss.[5]

Periodontal therapy usually consists of professional debridement and client oral self care. Professional scaling and root planing have been shown to reduce the clinical parameters of gingival bleeding and mean pocket depths by removing the subgingival bacterial population and rendering the environment significantly less pathogenic; however, the microflora gradually shift back to a pathogenic supportive environment over three months.[6] Daily oral self care to control the supragingival plaque

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may assist in slowing or reducing the shift to a pathogenic environment.

Client acceptance of daily toothbrushing is high, but not of dental flossing.[7–9] Toothbrushes are unable to penetrate intact interdental areas,[10,11] where periodontal disease is prevalent,[12] necessitating the use of an interdental device. However, clients do not dental floss daily because it is difficult to use.[13,14] The interdental brush has been identified as a potential, suitable alternative to dental floss for interdental cleansing in other studies because of its ease of use and client acceptance, which may enhance daily compliance.[14,15] Since study results on the effectiveness of interdental brushes have been mixed, a systematic review is needed to provide the oral health clinician with evidence based guidelines.

The purpose of this systematic review is to determine the effectiveness of the interdental brush with toothbrush compared to dental floss with toothbrush in addition to professional debridement for the primary outcome of reducing reducing interproximal gingival bleeding. A secondary clinical outcome, reduction of dental plaque, is also examined since dental plaque is the etiological factor for periodontal diseases.[4] This systematic review will provide the dental hygiene practitioner with evidence based guidelines for recommending oral interdental self care aids to specific clientele for the prevention and treatment of periodontal disease.

Why it is important to do this review

There are many interdental oral self care products available, with dental floss being the most commonly recommended to clients by oral health professionals. However, client compliance with dental flossing is low because it is challenging to use; therefore, it is important to determine the effectiveness of interdental brushes, which have been shown in some studies as being easier to use. Although Slot et al.[16] conducted a systematic review on interdental brushes, the search was restricted to two databases; this review expands the search to include non English databases. The comparison groups in Slot et al.'s review[16] included toothbrushing alone as well as other interdental aids, whereas this review will focus on studies that used toothbrushing with dental floss as a control group to provide clinicians with a direct comparison. The aim of this interdental brush systematic review is to provide oral health professionals and clients with evidence to make informed decisions about their oral health.

OBJECTIVE

The primary objective of this systematic review is to evaluate the effectiveness of interdental brushing as an adjunctive aid to toothbrushing to dental flossing and toothbrushing for the reduction of gingival bleeding, a clinical manifestation of gingivitis. The secondary objective is to evaluate the reduction of dental plaque.

The review focuses exclusively on the comparison of interdental brushes to dental floss, the latter that is often used as the gold standard comparison in periodontal research.[17]

METHODS

Criteria for considering studies for this review

Types of studies

Randomized controlled trials, including split mouth and crossover trials were included. Studies without randomization or those not indicating method of randomization were excluded. Studies were included irrespective of publication status and language.

Types of participants

Participants were adults, 18 years and older, regardless of gender, race, socioeconomic status, geographical location, and setting or time of intervention, presenting with clinical signs of gingivitis and some periodontitis as determined by gingival indices and probing depths. All participants had sufficient sites to accommodate the interdental brushes used in the studies.

Studies were excluded if participants:

1. were taking antibiotics,
2. were taking drugs associated with gingival overgrowth,
3. were taking drugs associated with gingival bleeding,
4. had systemic health conditions such as diabetes, rheumatic fever, hepatic or renal diseases,
5. had orthodontic appliances,
6. and/or were pregnant.

Types of interventions

The review included all studies comparing interdental brush to dental floss as adjuncts to toothbrushing. Studies that used antimicrobial agents such as chlorhexidine or essential oils were included only if data on the control groups, or groups that did not use any antimicrobial agents, were available. Interventions were self performed and were nonsupervised after the initial- and mid-study oral hygiene instructions. Participants were required to use the interdental brush and/or dental floss for a minimum of four weeks to be included in this review. In studies that were longer than four weeks, the final endpoint was included in the analyses.

Types of outcome measures

Primary outcome: Bleeding indices.

Secondary outcome: Plaque indices.

Search methods for identification of studies

A comprehensive search, irrespective of language was conducted *of the literature* from January 1966 to February 2011 to identify relevant studies.

Electronic searches

The following databases were searched for broad coverage of English and non English studies on interdental brushes: National Library of Medicine, Bethesda, USA (PubMed Medline 2006 to 2010), Cumulative Index to Nursing and Allied Health Literature, Ipswich, USA (CINAHL, 1966 to 2010), The Cochrane Collaboration Central Register of Controlled Trials (CENTRAL, 2006 to 2010), Web of Science, New York, USA (1990 to 2010) and LILACS via Bireme, Sao Paulo, Brazil (1982 to 2010).

Searching in each database considered variations in controlled vocabulary and syntax rules. A combination of controlled vocabulary and free text terms were used (see Search terms).

Search terms

The following terms and their variations were used to search the databases:

- For intervention: Interdental brush*, interproximal brush*, proxabrush, proxybrush, interspace brush, oral hygiene products, dental care products, dental devices, dental care, mouth care, oral care, oral self care, oral self care habits, oral hygiene*, oral hygiene methods, oral hygiene equipment, oral hygiene supplies.
- For clinical outcomes: Dental plaque, dental plaque control, dental plaque prevention, dental biofilm, oral biofilm, plaque index, gingival index, bleeding index, clinical attachment loss (CAL), gingivitis, gingivitis prevention, gingivitis control, inflammation prevention, inflammation control, periodontal disease, periodontal disease prevention, periodontitis, periodontitis therapy, clinical effectiveness, clinical efficacy, patient education, patient compliance, patient acceptance.

Other searches

In addition, hand searching was conducted in the *Journal of Clinical Periodontology* from 1974 to 2010 and references were mined from all the studies collected in the searches. Hand searching in the *Canadian Journal of Dental Hygiene* was also conducted from 2005 to 2011 and their references mined. Pharmaceutical companies that develop and manufacture interdental brushes were also contacted for unpublished or ongoing clinical trials.

Data collection and analysis

Selection of studies

Two members of the team independently selected papers based on title and abstract, followed by a full text review to determine whether the paper met the eligibility criteria (Figure 1, Table 1). Any disagreements between reviewers for paper inclusion/exclusion were resolved through discussion. The statistician was consulted in cases of doubt about data extraction and data analysis.

Data extraction and management

Two members of the team extracted data and any disagreements were identified and resolved through discussion. The members were not blinded to the included studies' authors, interventions, or results.

The following data were extracted:

1. Study design, date, and duration of study
2. Participants — sample size, inclusion/exclusion criteria, demographics
3. Intervention — type of floss and interdental brush, duration of intervention, oral hygiene instructions or not, compliance assessment, length of follow up
4. Outcomes — method of assessment, type of indices used, timing of measurement

Additional data such as ethical approval, sample size calculations, inter/intra examiner calibration, and funding sources were extracted.

Risk of bias

Risk of bias was assessed based on sequence generation, allocation sequence concealment, blinding, incomplete outcome data, selective outcome reporting, and other issues. Blinding of examiners was considered important, as participants due to the nature of the comparisons could not be blinded. For crossover designs, further risk of bias assessments included whether the design was suitable for the intervention being studied, the risk of carry over or spill over effects, and appropriate statistical analysis.

Risk of bias data is recorded with the source of information and a judgment of low, high or unclear risk of bias. The assessors were not blinded to the studies' authors, journals or results. Two assessors conducted the risk of bias independently.

Measures of treatment effect

Since the bleeding indices in the included studies were binary measures of bleeding present or absent, risk ratios were used. Plaque indices were ordinal scales, so mean differences were used in statistical tests. Mean and standard deviations are presented for completeness.

Unit of analysis

The participant or groups of measuring sites within individual participants was the unit of analysis.

Missing data

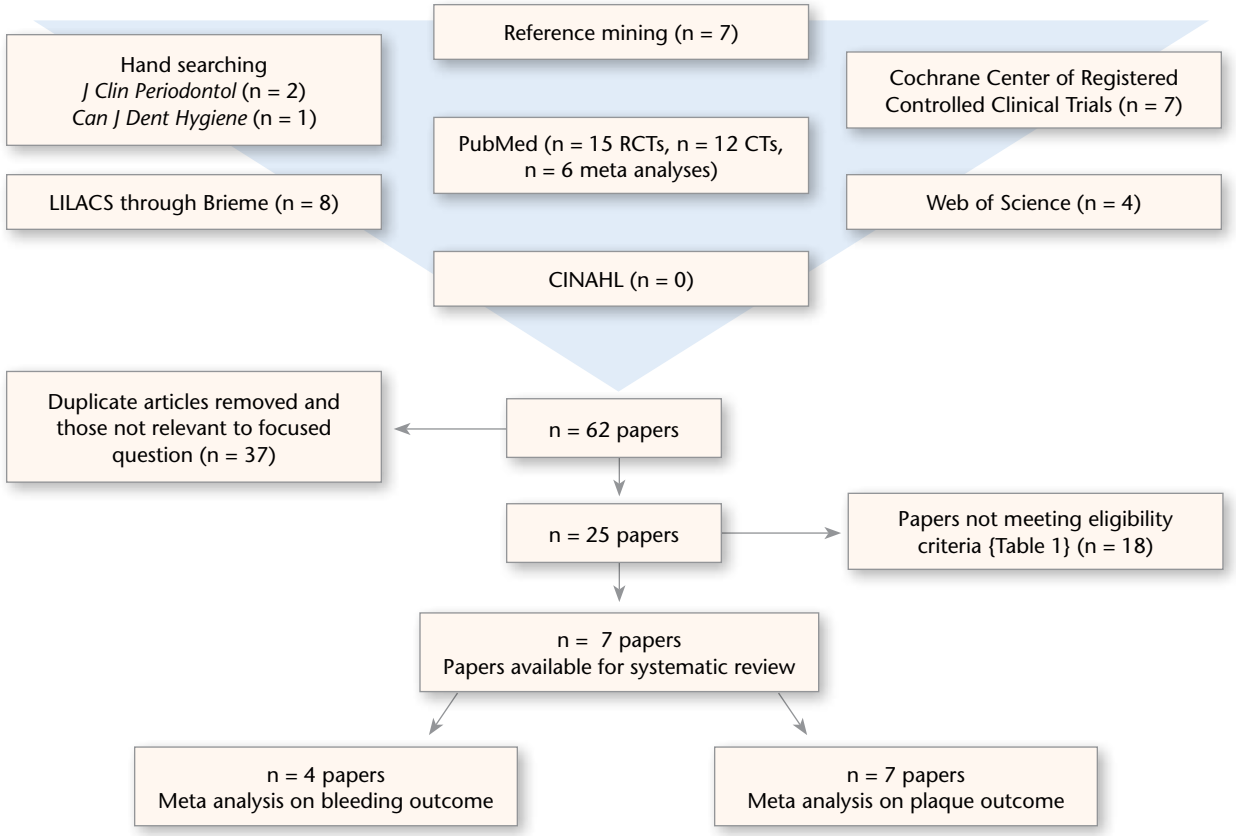
Standard deviations are often missing in summary data, but this did not result in the study being excluded. Where possible, authors were contacted for the missing information. However, if missing data could not be retrieved, then the analysis only included the available data. Potential impact of the missing data is addressed in the Discussion section of the systematic review.

Assessment of heterogeneity

Included studies are assessed for heterogeneity by the type of therapy, control group, and outcomes measured. Studies were descriptively assessed for study design, study length, number of subjects, subjects' age range, subjects' periodontal status, gender, tobacco use, professional debridement prior to intervention phase, and measured clinical outcomes (Table 2).

The use of Forest plots will assist with the assessment of heterogeneity. Studies in the Forest plot graphically demonstrate treatment effects in each study as well as the overall effect determined by the meta analysis. Studies that appear to be homogeneous will be tested by Q test (Chi^2), with a $p < 0.10$ as being interpreted as significant statistical heterogeneity. However, the Q test has low power for identifying heterogeneity if the number of included studies is small. In this situation, the I2 test will be used to determine the magnitude of heterogeneity. A higher percentage indicates that heterogeneity is likely present rather than by chance. For example, 75% to 100% would represent considerable heterogeneity, but 0% to 40% may

Figure 1. Number of papers found in search.



not. Heterogeneous studies are not included in the meta analysis, but are described instead.

Assessment of reporting biases

Bias may occur within study and between studies. Within study bias occurs when the outcomes reported in the published study differ from the outcomes stated in the research protocol or the methods section of the study. Study authors will be contacted in cases of reporting bias for clarification. Depending on the number of included studies (usually more than 10 studies),[18] a funnel plot of effect estimates against their standard errors may be created to determine possible publication bias.

Data synthesis

Only studies with low or unclear risk of bias that report the same outcomes are included in the meta analysis, and a minimum of six studies is required. However, since the test for heterogeneity may not be sensitive enough to detect for heterogeneity, a random effects meta analysis was conducted for robustness. Relative risk and 95% confidence intervals were used in the analysis.

RESULTS

Description of studies

See Table 1 for excluded studies and rationale and Table 2 for brief description of the included studies.

Results of search

The search strategy resulted in 62 potential papers based on titles with or without abstracts (Figure 1). Duplicate papers and papers not relevant to the research question were removed, yielding 25 papers for full text examination. Upon full text examination by two independent reviewers, 18 papers were deemed not meeting the inclusion criteria (Table 1). Some studies had intervention periods of less than four weeks,[19–25] some did not have dental floss as a comparison group,[26–29] others did not have interdental brush as the intervention but instead used toothpicks or brush picks,[11,30,31] one study compared dental floss to rubber tip stimulator and thus, did not have the interdental brush as an intervention,[32] and the remaining studies were reviews.[17,33,34] The final number of studies included in this review was seven (Figure 1). Since the number of studies included was low, a funnel plot was not conducted because there are not enough data points to indicate whether the scatterplot will be symmetrical or asymmetrical.[18]

Included studies

Of the seven studies included, three were parallel RCTs,[35,36] three were split mouth RCTs,[37–39] and one was a crossover design.[14] Two of the parallel RCTs had four[17] or five arms,[36] but data extraction focused on the interdental brush and dental floss arms for this review. The Kiger et al.[14] study, which was a three way crossover, did

Table 1. Studies subsequently excluded on full text examination.

Authors and year	Study design	Reason for exclusion
Bergenholtz, Bjorne, Vikström: 1974	• Crossover • 8 weeks	No interdental brush intervention; toothpicks.
Bergenholtz, Olsson: 1984	• Crossover • 2 weeks per trial	Intervention phase less than 4 weeks.
Galut: 1991	• Literature review	Review; no data available.
Gjermo, Flötra: 1970	• Parallel RCT • 2 to 4 weeks (3 mini RCTs)	Intervention phase less than 4 weeks.
Hofer, Sahrmann, Attin, Schmidlin: 2010	• Split mouth randomized • 1 day	No dental floss comparison; interdental brush used to assess for bleeding only.
Mauriello, Bader, George, Klute: 1987	• Crossover RCT • 3 weeks per trial	Intervention phase less than 4 weeks.
Nayak, Wade: 1977	• Parallel RCT • 2 weeks	No dental floss comparison; rubber cone stimulator instead.
Rösing, Daudt, Festugatto, Oppermann: 2006	• Split mouth RCT • 1 time use	Intervention phase less than 4 weeks.
Rossow: 1992	• Retrospective cohort survey of daily, sometimes, never use	No interdental brush intervention; toothpick compared to dental floss.
Schmage, Platzer, Nergiz: 1999	• Split mouth RCT • 1 week	Intervention phase less than 4 weeks.
Slot, Dörfer, Van der Weijden: 2008	• Systematic review	Review
Tu, Jackson, Kellet, Clerehugh: 2008	• RCT statistical analysis	Exploration of statistical analysis of Jackson et al. paper. Results previously reported.
Vogel, Sullivan, Pascuzzi, Deasy: 1975	• Parallel RCT • 33 days	No interdental brush intervention.
Wærhaug: 1976	• In vitro	No dental floss comparison.
Wolffe: 1976	• Cross over RCT • 1 week per trial	Intervention phase less than 4 weeks.
Wolff, Joerss, Rau, Dörfer: 2006	• In vitro	No dental floss comparison. Comparison of triangular and round interdental brushes only.
Yamamoto, Hasegawa, Sueda, Kinoshita: 1975	• Parallel RCT • 1 week	Intervention phase less than 4 weeks.
Yankell, Emiling: 2002	• Parallel RCT • 4 weeks	No interdental brush intervention; brush picks.

not include washout periods between interventions. Professional debridement prior to the intervention phase varied from none or minimal supragingival scaling to a "thorough" debridement. Participants in all included studies received oral hygiene instructions at baseline and often midway through the study. Participants were instructed to use the interdental brush and dental floss once a day. All studies, except Kiger et al.[14] described participant compliance assessments, which ranged from phone calls, written reminders, self reported logs to amount of product used.

Participants had some level of periodontal disease, ranging from gingivitis to moderate to severe periodontitis. Some studies only included participants who were non-smokers[36,38,39] and two studies identified their participants as smokers or non smokers.[17,35] Except for Yost et al.[17] and Christou et al.[37], female participants outnumbered male participants in the included studies.

Excluded studies

Eighteen articles were removed from the review because they did not meet the inclusion criteria such as intervention phase less than four weeks,[19–25] missing interdental brush intervention,[19,30–32] missing dental floss comparison,[26–29] or study was a review article.[17,33,34] Additional studies were excluded if the risk of bias was high (see Table 3).[17]

Allocation

Allocation or randomization is a mechanism to allocate interventions to participants. Adequate randomization

Table 2. Overview of the studies included in the data analysis.

Authors and year	Methods	Participants	Interventions	
Christou, Timmerman, Van der Velden, Van der Weijden: 1998	• Design: split mouth RCT • Length: 6 weeks • Measurements: Baseline 6 weeks	• Randomized n = 26 • Completed n = 26 • Mean age: 37.4 Range: 27–72 Males and Females = 14 and 12 • Oral health status: Moderate to severe periodontitis, no previous periodontal treatment. Minimum 3 teeth/quad. PD ≥ 5mm, BOP, radiographic bone loss, minimum recession, overt inflammation	• Baseline professional debridement: some supragingival scaling in test sites, but no subgingival scaling • Intervention: interdental brush + toothbrush • Control: waxed dental floss + toothbrush • OHI: hands on and take home written instructions • Compliance assessment: 1 week phone call, 3 week visit to dental hygienist	
Imai, Hatzimanolakis: 2011	• Design: split mouth RCT • Length: 12 weeks • Measurements: Baseline 6 weeks 12 weeks	• Randomized n = 33 • Completed n = 30 • Mean age: 32.3 Range: 19–53 Males and Females = 10 and 20 • Oral health status: Gingivitis Non smokers	• Baseline professional debridement: 2 weeks prior to baseline • Intervention: interdental brush + toothbrush • Control: waxed dental floss + toothbrush • OHI: baseline and week 6, hands on • Compliance assessment: self reported log and product use at weeks 6 and 12	
Ishak, Watts: 2007	• Design: split mouth RCT • Length: 4 weeks • Measurements: Baseline 4 weeks	• Randomized n = 11 • Completed n = 11 • Mean age: 43.6 Range: 33–56 Males and Females = 3 and 7 • Oral health status: Gingivitis to moderate Periodontitis Non smokers	• Baseline professional debridement: supragingival scaling only • Intervention: interdental brush + toothbrush • Control: dental floss + toothbrush • OHI: baseline and hands on and written instructions • Compliance assessment: self reported diary sheet	
Jackson, Kellett, Worthington, Clerehugh: 2006	• Design: parallel RCT • Length: 12 weeks • Measurements: Baseline 6 weeks 12 weeks	• Randomized n = 88 • Completed n = 77 • Mean age: not reported Range: 26–75 Males and Females = 31 and 46 • Oral health status: Chronic periodontitis 29 smokers 48 non smokers	• Baseline professional debridement: scaling for 10 minutes only • Intervention: precurved interdental brush + toothbrush • Control: non shredding dental floss + toothbrush • OHI: baseline and week 6 oral instructions and patient leaflets • Compliance assessment: at 2 weeks, written reminder and at week 6 verbal reinforcement	
Jared, Zhong, Rowe, Ebisutani, Tanaka, Takase: 2005	• Design: parallel RCT, 5 arms • Length: 4 weeks • Measurements: Baseline 2 weeks 4 weeks	• Randomized n = 162 • Completed n = 152 • Mean age: 36.38–42.20 Range: not reported Males and Females = 60 and 92 • Oral health status: Minimum of one interproximal space of 1.0 mm exhibiting bleeding Non smokers	• Baseline professional debridement: none, only rubber cup prophylaxis • Intervention: interdental brush without gel (gp 3) • Control: easy through dental floss + toothbrush (gp 4) • Other Interventions: interdental brush + cetylpyridinium chloride gel + toothbrush (gp 1); interdental brush + placebo gel + toothbrush (gp 2); toothbrush alone (gp 5) • OHI: baseline hands on • Compliance assessment: self reported log and return used/unused materials at weeks 2 and 4	

	Outcomes	Source of funding	Notes
	• Bleeding: BOP to base of pocket with 65 g controlled force probe (PPBI) and • WHO probe along gingival margin at 60° to long axis of tooth (ABI) • Plaque: Volpe modification of Quigley–Hein index • Probing depth: 65 g controlled force probe • Results: interdental brush removes significantly more plaque than dental floss ($p < 0.05$) • Interdental brush significantly reduces probing depths compared to dental floss ($p < 0.05$) • No differences for bleeding	• State scholarships: Foundation of Greece • Enta-Lactona B.V. for toothbrushes and interdental brushes	• Examiner blinded • Type II to III embrasures • Patients reported "more problems with dental floss. Interdental brush felt more efficacious"
	• Bleeding: Eastman bleeding index • Plaque: modification of Silness and Löe • Results: no difference for plaque • Interdental brush significantly better for bleeding reduction compared to dental floss ($p = 0.01$)	• Canadian Foundation for Dental Hygiene Research and Education • Enterprise Dentalink Inc provided the toothbrushes and interdental brushes	• Examiner blinded • Type I to II embrasures • Patients preferred interdental brush "ease of use and convenient"
	• Bleeding: BOP to base of pocket with 0.25 N hinged constant force probe • Plaque: visual examination with confirmation of presence with flossing • Results: no difference for plaque and bleeding	• Oral self care products provided by GlaxoSmithKline, UK	• 10 sites in each quadrant/participant examined by blinded examiner • Type I to III embrasures • Patients prefer interdental brushes because "simpler to use"
	• Bleeding: Eastman bleeding index and BOP • Plaque: modified Silness and Löe • Relative interdental papillae level: occlusal/incisal edge to interdental col of papillae in mm • Results: interdental brush significantly better for plaque reduction ($p = 0.008$) • No difference for Eastman bleeding index at week 12 ($p = 0.07$) and BOP ($p = 0.23$)	• Oral self care products provided by • Colgate-Palmolive: toothbrush, dental floss, toothpaste • Dentsply: dental instruments • Dental Health Boutique, Oral Healthcare, Leatherhead, UK, for interdental brushes	• No control force probe used in BOP • Third molars excluded except where they functioned as second molars • Type II to III embrasures
	• Bleeding: BOP and Van der Weijden modified. Bleeding on marginal probing method • Plaque: Turesky modification of Quigley–Hein index • Gingival: Lobene • Results: no difference for plaque. Interdental brush more likley to reduce bleeding, but not statistically significant	• Study financially supported by Sunstar Inc, Japan, manufacturer of the interdental device	• Participants who had SRP within last month excluded or excessive interproximal calculus • Third molars excluded • Preference for maxillary site versus mandibular site • Type I to II embrasures

Table 2. Overview of the studies included in the data analysis *(concluded)*.

Authors and year	Methods	Participants	Interventions	
Kiger, Nylund, Feller: 1991	• Design: 3 x 1 month cross over Randomized single blind • Length: 12 weeks • Measurements: Baseline 4 weeks after each intervention introduced	• Randomized n = unclear • Completed n = 30 • Mean age: unknown Range: unknown Males and Females = 20 and 10 • Oral health status: perio maintenance pats with open embrasures	• Baseline professional debridement: "thorough prophylaxis" • Intervention: interdental brush + toothbrush • Control: dental floss + toothbrush • Other interventions: toothbrush alone • OHI: baseline detailed oral hygiene instructions • Compliance assessment: none described	
Yost KG, Mallatt ME, Liebman J: 2006	• Design: parallel RCT, 4 arms • Length: 6 weeks • Measurements: Baseline Week 6	• Randomized n = 128 • Completed n = 120 • Mean age: male 35.1, female 39.6 Range: male 19–57, female 18–63 Males and Females = 37 and 83 • Oral health status: Minimum mean plaque index 1.5 Minimum mean gingival index 1.0 Able to floss 108 non smokers 12 smokers	• Baseline professional debridement: prophylaxis to remove supragingival calculus and plaque • Interventions: G-U-M Go-Betweens (interdental brush) • Controls: dental floss • Other interventions: flossers soft picks • OHI: baseline instruction and supervision • Compliance assessment: self reported diary checked at week 3	

occurs when a participant has an equal chance of being placed into the intervention or control group regardless of the examiner's preference and/or participant's characteristics. Examples of adequate randomization methods are using computer generated random number lists, coin toss, or throwing dice. The randomization process should be clear and detailed to reduce potential selection bias of participants into specific study arms. Jackson et al.[35] and Imai and Hatzimanolakis[15] had clearly identified the randomization process, but the remaining studies were unclear in spite of stating the sequence allocation was randomized among the participants.

Allocation concealment, which refers to the method used to implement the sequence such that foreknowledge of next allocation is unknown was adequate in two studies,[38,39] unclear in three studies,[14,35,36] and not done in the remaining two studies.[17,37]

Blinding

An examiner and/or participant is considered "blinded" when it is unknown whether the participant is in the experimental or control group. Blinding the examiner and participant reduces potential bias, especially when the study measurements are subjective, such that one cannot interpret results in a manner that one thinks or hopes should be occurring. In periodontal studies, gingival and plaque indices are subjective interpretations of data observed by the examiner. For example, if an examiner believes intervention A is better than B, there may be intentional or unintentional subjective interpretation of the gingival colour, contour, consistency, texture, amount of bleeding and plaque on the tooth with sites treated by product A performing better than those by B. Lack of examiner blinding may have undue influences on the study results.

In six studies,[14,17,35,37–39] the examiner was blinded, which reduced the examiner bias for collecting and interpreting the bleeding and plaque scores. Although Jared et al.[36] stated the study was single blinded, there are no details as to how they kept the examiner blinded. It was not possible to blind the participants due to the different design of the oral self care products, but this may not have affected the bleeding and plaque indices as compliance for both products was high in the studies.[14,17,35,37–39]

Incomplete outcome data

Incomplete data refer to participants who drop out of the study and data exclusions from the statistical analyses. To reduce bias, one must consider the reasons for the dropouts. For example, a participant moving away would be considered a justifiable reason, and would not adversely affect the study in terms of bias compared to a participant who withdrew because of adverse effects from the intervention.

Reasons for loss of follow up or exclusion of data from analyses were provided in five studies,[35,36,37–39] but were missing or unclear in two studies.[14,17] In the Kiger et al.[14] study, data were missing on soft tissue trauma and loss of tooth substance among groups and it was unknown if dropouts occurred. In regards to our review, this would not have significant effects on the comparison of interdental brush to dental floss outcomes. The Yost et al.[17] study was missing standard deviations in the results and the contacted author was unable to provide them. Eight participants withdrew after randomization in the Yost et al.[17] study, but there are no details for the withdrawl. In the other five studies,[35–39] loss of participant follow up was usually due to participants beginning antibiotic therapy or for health or family related issues, which were not product related, and thus, would not impact the study outcomes.

	Outcomes	Source of funding	Notes
	• Bleeding: not measured • Plaque: Turesky modified Quigley–Hein (1970) and Wolffe index (1976) • Gingivitis: Löe and Silness (1965) • Soft tissue trauma: Weaks (1984) • Loss of tooth substance: Lie and Meyer (1977) • Results: interdental brush statistically signficantly better than dental floss for interproximal plaque reduction (p = 0.0208)	• Study supported by Oral-B laboratories, manufacturer of products	• Sites as unit of analysis • Type III embrasures • No wash out period • Patients find "dental floss more difficult and technically demanding in spite of repeated instructions. Interdental brush easier and more comfortable"
	• Bleeding: Eastman bleeding index • Plaque: Benson modification of Quigley–Hein index • Gingivitis: Silness and Löe gingival index • Other: soft tissue examination, no details provided • Results: no statistical difference for Eastman bleeding and plaque indices	• Study supported by Sunstar Americas, manufacturer of the products tested	• Participants with minimum of mild gingivitis, but having at least 5 embrasures that will accommodate interdental brush

Selective reporting

Selective reporting is when authors choose to publish outcomes based on the identified best results creating potential bias in the results' interpretations. For example, choosing the best time point to report the positive result and failing to discuss the other time points, choosing analyses that support a positive outcome such as final end point comparison of products (X vs Y) versus change from baseline to end point for each product (X changed from baseline to end point and Y changed similarly, but there is no direct comparision of X to Y at endpoint), or collecting data but not reporting it. To assess possible selective reporting, published studies were compared to their published protocols and missing data that appeared to be collected were clarified with the authors.

Five studies[35–39] were considered low risk for bias in regards to selective reporting as they reported the results mentioned in the study's methods. The sixth study, by Kiger et al.[14] mentioned that soft tissue trauma and loss of tooth substance was evaluated, but there were no statistical tests conducted nor quantitative results provided, that may possibly indicate selective reporting. However, Kiger et al.[14] provided means and standard deviations for the plaque scores and so this study was included for the plaque analysis. Similarly, Yost et al.[17] mentions a soft tissue examination in the methods section, but does not follow up with any outcomes in the results section. The contact author for the Yost et al.[17] study was unable to provide the soft tissue data.

Other risk of bias

Other potential sources of bias that may influence the study results are inappropriate influence of funders, inappropriate co-interventions, cross contamination such as lack of washout period for crossover studies, and unbalanced baselines across groups. Although many studies received some in-grant support from pharmaceutical companies such as receiving complimentary products for the trial, it was not clear in some studies[14,17,36] whether there was undue influence as some of the authors were affiliated with the pharmaceutical company. The other four studies[35,37–39]stated the authors had no affiliation with the pharmaceutical company and/or were supported through independent grants.

Effects of intervention

Bleeding

Bleeding is a clinical sign of active gingival inflammation and was an assessed outcome in six studies.[17,35–39] The bleeding score was determined by probing to the base of the pocket with a force controlled probe,[35,37,39] stimulating the gingival margin at a 60 degree angle using the probe,[36,37] and/or using a wooden toothpick inserted four times horizontally into the interproximal area as in the Eastman Bleeding Index.[17,35,38]

Since the Yost et al.[17] study did not include standard deviations, it was removed from further statistical analyses. The Jared et al.[36] study was also removed from further statistical analyses since the bleeding scores were given in frequencies and raw scores could not be verified. The bleeding outcome measurements in Ishak and Watts[39] were clarified by contacting the corresponding author. The bleeding scores were based on the presence or absence of bleeding in 10 sites per side of mouth (the study was split mouth) and the statistical unit was sites.

In the remaining studies (Table 4), Christou et al.[37] did not report any statistical difference between interdental brush and dental floss at six weeks, but instead noted that both products reduced bleeding over time. In contrast, Jackson et al.[35] demonstrated statistically significant

Table 3. Risk of bias.

Study and Risk of Bias (Low, High, Unclear)	Item	Judgment	Description
Christou, Timmerman, Van der Velden, Van der Weijden: 1998	Adequate sequence generation?	Unclear	"…use of dental floss was randomly assigned to the left or right half of the mouth and the use of interdental brush to the other side."
Risk of bias: Low	Allocation concealment?	No	No indication of how sequence was implemented to ensure that randomization was not contrived.
	Blinding? Researcher assessed outcomes	Yes	"Performed in absence of the examiner, keeping these recordings blind throughout the study."
	Blinding? Self reported outcomes	No	Level of comfort, perception of efficacy, and any problems reported by participants who were not blinded.
	Incomplete outcome data addressed?	Yes	No loss to follow up. Sites not accessible for interdental brush and dental floss were excluded from analysis.
	Free of selective reporting?	Yes	All outcomes stated in Methods section were addressed in Results. No protocol available.
	Free of other bias?	Yes	Independent grant to fund study. Enta-Lactona supplied toothbrush and interdental brush.
Imai, Hatzimanolakis: 2011	Adequate sequence generation?	Yes	"Randomization of products to left or right side of mouth was determined by a flip of coin by the study organizer."
Risk of bias: Low	Allocation concealment?	Yes	Randomization by coin flip, such that interdental brush assigned to either left or right side of mouth.
	Blinding? Researcher assessed outcomes	Yes	"Only the examiner, who was unaware of the product randomization throughout the study, collected the clinical measurements at baseline, 6, and 12 weeks."
	Blinding? Self reported outcomes	No	Self reported compliance log by non blinded participants.
	Incomplete outcome data addressed?	Yes	Reasons for loss of follow up "moderate to severe periodontitis, not enough bleeding sites, too many missing teeth, require premed antibiotics, no longer interested, family emergency, began antibiotic therapy during study."
	Free of selective reporting?	Yes	All outcomes stated in Methods reported in Results. Study followed research protocol.
	Free of other bias?	Yes	Research grant from CFDHRE; toothbrush and interdental brush supplied through intermediary distribution company.
Ishak, Watts: 2007	Adequate sequence generation?	Unclear	"…use of interdental brush was randomly assigned to left or right half of the mouth." "For left-handed subjects, the random assignation was reversed to allow for any effect on manipulation."
Risk of bias: Low	Allocation concealment?	Yes	"A statistician who was not directly involved in recruiting patients generated the randomization sequence."
	Blinding? Researcher assessed outcomes	Yes	"All measurements were carried out at baseline and one month by one experienced examiner (TW), who was blinded."
	Blinding? Self reported outcomes	No	Self reported diary and questionnaire.
	Incomplete data addressed?	Yes	No loss to follow up.
	Free of selective reporting?	Yes	All outcomes stated in Methods were reported in Results. No protocol available.
	Free of other bias?	Yes	All materials supplied by GlaxoSmithKline, UK, so no preference of interdental brush over dental floss and researchers based in Kings College, Dental Institute London.

Table 3. Risk of bias *(continued)*.

Study and Risk of Bias (Low, High, Unclear)	Item	Judgment	Description
Jackson, Kellett, Worthington, Clerehugh: 2006	Adequate sequence generation?	Yes	Computer generated random numbers and 4 allocation envelopes labelled for gender and smoking habit.
Risk of bias: Low	Allocation concealment?	Inadequate	4 allocation envelopes labeled for gender and smoking habit.
	Blinding? Researcher assessed outcomes	Yes	"Patients were randomly allocated to floss or interdental brush group by research assistant…At all times, the hygienist examiner was unaware of the group to which the patient was allocated."
	Blinding? Self reported outcomes	Unclear	Not reported.
	Incomplete outcome data addressed?	Yes	Reasons for loss to follow up given. "Not have the required number of sites…Prescribed antibiotics during study…failure to complete 3 visits, periodontal-endodontic lesion requiring emergency treatment…." Not likely to affect results.
	Free of selective reporting?	Yes	No protocol available. All outcomes stated in Methods reported in Results.
	Free of other bias?	Yes	Dental equipment and oral self care products supplied by 3 different companies, which the authors have no affiliation.
Jared, Zhong, Rowe, Ebisutani, Tanaka, Takase: 2005	Adequate sequence generation?	Unclear	Block randomization based on baseline dental plaque scores.
Risk of bias: Unclear	Allocation concealment?	Unclear	No indication of how block randomization done to implement sequencing of allocation.
	Blinding? Researcher assessed outcomes	Unclear	"Single blind" No details on how they kept the single examiner blinded.
	Blinding? Self reported outcomes	No	Self reported logs of number of times using product, if cleaning deviated from group to which they were assigned, and details of any symptoms experienced by some groups who were not blinded. Only blinding in the two groups testing interdental brush with active and placebo gels.
	Incomplete outcome data addressed?	Yes	Loss of follow up "9 withdrew prior to baseline and one dismissed due to health issues. None were product related." Unlikely to affect results. Bleeding in percentage, no mean or standard deviation.
	Free of selective reporting?	Yes	No protocol available. All outcomes stated in Methods reported in Results.
	Free of other bias?	Unclear	3 of the 6 authors are affiliated with Sunstar Inc, Japan, which provided "generous financial support" for the research.
Kiger, Nylund, Feller: 1991	Adequate sequence generation?	Unclear	"…each subject received…random assignment to one of three treatment groups by a separate investigator." No indication of how sequence generation done.
Risk of bias: Unclear	Allocation concealment?	Unclear	"…assignment to one of three treatment groups by a separate investigator." No indication of how this was done.
	Blinding? Researcher assessed outcomes	Yes	"Clinical examiner had no knowledge of which study group patients were assigned to at any time."
	Blinding? Self reported outcomes	No	No indication of self reporting, but nature of products precludes subject blinding.
	Incomplete outcome data addressed?	No	Missing data on soft tissue trauma and loss of tooth substance among groups; only descriptive information. Unknown if dropouts occurred.
	Free of selective reporting?	No	No indication of statistical parameters, e.g., alpha and beta levels set apriori, total number of sites, confidence intervals.
	Free of other bias?	Unclear	Industry supported study. No wash out periods between interventions.

Table 3. Risk of bias *(continued)*.

Study and Risk of Bias (Low, High, Unclear)	Item	Judgment	Description
Yost, Mallatt, Liebman: 2006	Adequate sequence generation?	Unclear	"…randomly assigned to one of the four test products…"
Risk of bias: High	Allocation concealment?	No	No indication of who assigned subjects to each group and how this was done.
	Blinding? Researcher assessed outcomes	Yes	"The subjects used their assigned product in a separate area to maintain examiner blinding…"
	Blinding? Self reported outcomes	No	Self reported diary of compliance.
	Incomplete outcome data addressed?	Unclear	"…128 meeting all the study criteria to be enrolled and randomized. …8 subjects dropped after randomization with remaining 120 completing the study." No details on loss of follow up subjects. Missing standard deviations in Tables; can only estimate on bar graphs. Request sent to corresponding author for standard deviation.
	Free of selective reporting?	No	Oral soft tissue examination not found in Results section, but mentioned in Methods. No protocol available.
	Free of other bias?	No	No indication of smokers distribution within the 4 groups, which may affect bleeding and gingivitis indices. Statistical tests used are unsuitable. Industry supported study.

differences between interdental brush and dental floss at week six ($p < 0.05$), but these differences failed to reach significance at week 12 ($p = 0.07$). Imai and Hatzimanolakis[15] demonstrated that the interdental brush reduced bleeding better than dental floss at week six, $p = 0.035$, and at week 12, $p = 0.001$ for bleeding interproximal sites, but post hoc analyses at the subject level indicated that interdental brush was better than dental floss for bleeding reduction only at week 12, $p = 0.01$.

Although the Forest plot into the effects of bleeding had overlapping confidence intervals, the test of heterogeneity of the studies, $I^2 = 59.72\%$ and Q (df = 3) = 8.1308 with $p = 0.0434$ (Figure 2), which is statistically significant, indicated there may be heterogeneity present among the studies. However, a meta analysis was conducted using the random effects model, which is considered robust enough to identify statistical significance. For the bleeding outcome, the random effects model with a corresponding estimate of the treatment effect being 0.08, $p = 0.003$ indicated that interdental brushes reduced the bleeding index scores compared to dental floss.

Plaque

Dental plaque was assessed in seven studies[14,17,35–39]; however, different plaque indices were used (Table 5). Most plaque indices were ordinal scales, but varied in number of categories. There were three modifications of the Quigley and Hein index: Volpe modification,[37] Turesky modification,[14,36] and Benson modification;[17] and two studies used modified Silness and Löe.[35,38] Ishak and Watts[39] simply counted the number of sites that presented with disclosed plaque as determined by its presence on dental floss.

Results for plaque outcome varied across the studies. Four studies demonstrated statistically significant differences between interdental brush and dental floss for plaque reduction[14,35–37] and the other three included studies did not.[17,38,39]

Since the forest plots indicated that the studies were homogeneous as demonstrated by the overlapping confidence intervals, the $I^2 = 34.26\%$, and the Q (df = 5) = 6.4860, $p = 0.2618$ (Figure 3), a meta analysis was conducted. The random effects model with corresponding estimate of treatment effect of 0.13 yielded a p-value of 0.024 indicating the statistically significant reduction in plaque index scores for interdental brush as compared to dental floss.

DISCUSSION

Summary of main results

The meta analyses for bleeding and plaque outcomes indicate that the interdental brush is better than dental floss for reducing bleeding and plaque between 4 and 12 weeks.

Overall completeness and applicability of evidence

The literature was searched broadly up to early 2011 to include all randomized clinical human trials comparing interdental brush to dental floss with a minimum of a four week intervention phase to provide evidence for oral health practitioners and clients/patients. Pharmaceutical companies that develop and market interdental brushes and dental floss were also contacted as possible sources of unpublished studies.

Table 4. Bleeding index at the end of each study.

Study	Interdental brushes			Dental floss			Mean difference (SD)
	n (Subjects)	Mean	Standard deviation	n (Subjects)	Mean	Standard deviation	
Christou et al.: 1998	26	0.83	0.18	26	0.86	0.15	0.03 ± 0.05
Jackson et al.: 2006	43	0.1	0.11	44	0.16	0.17	0.06 ± 0.03
Ishak et al.: 2007	10	5.6	4.79	10	8.1	5.06	2.5 ± 2.2
Imai, Hatzimanolakis: 2011	30	0.08	0.02	30	0.2	0.04	0.12 ± 0.01

Table 5. Plaque index at end of each study.

Study	Interdental brushes			Dental floss			Mean difference (SD)
	n (Subjects)	Mean	Standard deviation	n (Subjects)	Mean	Standard deviation	
Christou et al.: 1998	26	2.15	0.99	26	2.47	0.86	0.32 ± 0.26
Jackson et al.: 2006	43	0.72	0.37	44	0.96	0.40	0.24 ± 0.08
Jared et al.: 2005	30	2.02	0.77	29	2.23	0.83	0.21 ± 0.21
Ishak et al.: 2007	10	6.7	2.36	10	8.1	3.84	1.4 ± 1.43
Kiger et al.: 1991	30	0.51	0.28	30	0.62	0.33	0.11 ± 0.08
Imai, Hatzimanolakis: 2011	30	1.26	0.24	30	1.28	0.22	0.02 ± 0.06

Quality of evidence

Quality of evidence was fair to good with studies having blinded examiners to reduce subjective data collection, generating adequate allocation of subjects to experimental groups, addressing incomplete data, and being relatively free of selective reporting. Any affiliation or in-grant aid from pharmaceutical companies were disclosed and explained such that it is unlikely that the manufacturers of the dental products had significant influence on the study results interpretation.

Potential biases in review process

The team consisted of members who could read other languages as well as colleagues who could be called upon to interpret studies published in languages other than English, which reduced potential study selection bias during the searching and eliminating processes. However, the potential risk of publication bias, in which only positive results papers are published, is present. The team members are not affiliated with any dental product manufacturer or pharmaceutical company and thus, do not have a vested interest in a specific outcome for this systematic review. One author included a study of her own, but the other authors independently assessed the study for inclusion/exclusion and risk of bia assessments and the study was subsequently included in the systematic review.

Agreements and disagreements with other studies and reviews

In the literature, the bleeding and plaque outcomes varied from no statistically significant difference between interdental brush and dental floss to statistical significance. For example, the systematic review by Slot et al.[16p.258,261] did not demonstrate statistically significant differences between interdental brush and dental floss for gingival bleeding reduction, but this review did. Slot et al.[16] included studies that used the interdental brush only once, as well as other interdental aid comparisons compared to this review which only focused on comparisons between interdental brush and dental floss that had been used for a minimum of four weeks by the participants. Single use interventions may not allow the gingival tissues enough time to heal and thus, revert to non bleeding status.[6]

The differences in individual study results may be attributed to differing study designs and protocols. For example, studies[17,35–37,39] that did not include professional debridement and/or only supragingival scaling prior to the intervention phase did not demonstrate differences between interdental brush and dental floss for the bleeding indices. Subgingival calculus is associated with increased gingival bleeding;[40] therefore, it may be hypothesized that the effect of subgingival calculus on gingival health overshadowed the beneficial effects of interdental oral self care by the participants and any small differences between the products' efficacy. For example, Imai and Hatzimanolakis[15] performed supra- and sub-gingival debridement on all participants, and thus, the results demonstrated that the interdental brush was statistically significantly better than

Figure 2. Forest plot for bleeding index.

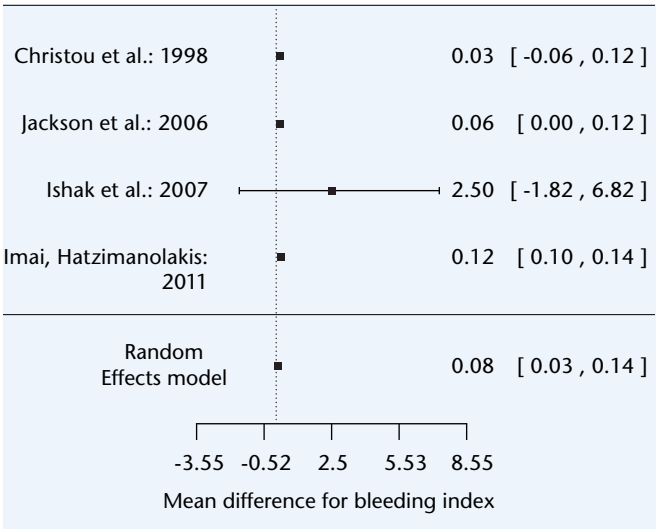
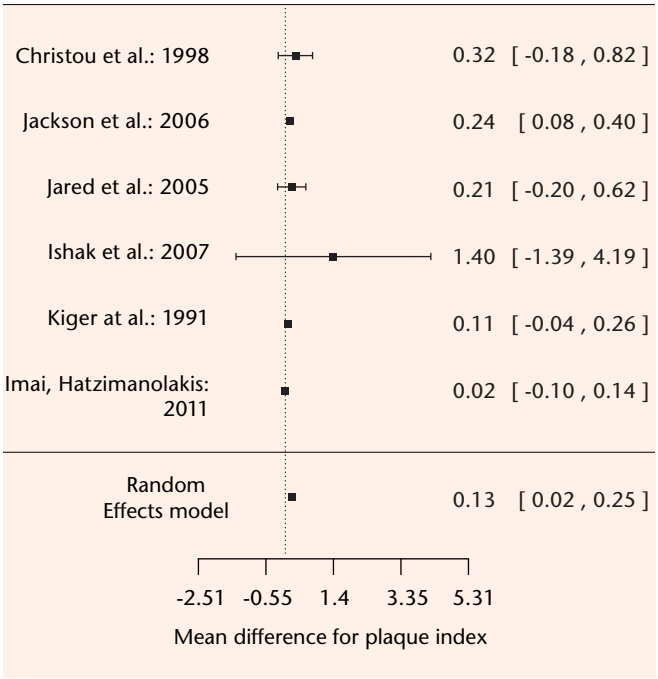


Figure 3. Forest plot for plaque index.



dental floss for bleeding reduction compared to Christou et al.[37] that only provided supragingival scaling and found no differences between the products.

The variation in plaque outcomes may be attributed to the participants' gingival health status. In studies[17,36,38,39] with participants that had gingivitis to moderate periodontitis—and thus, possibly smaller embrasure spaces—the plaque outcomes were not significantly different between interdental brush and dental floss. In comparison, participants with severe and/or chronic periodontitis—and thus, anticipated larger embrasure spaces—demonstrated statistically significant differences for plaque reduction with the interdental brush outperforming dental floss.[14,35,37] As periodontium support is lost through progressive periodontal disease, the invaginated interproximal root surfaces are exposed. Appropriatedly selected interdental brushes fill the embrasure space and extend their bristles into the invaginated surfaces; thus, removing and disrupting the interproximal oral biofilm unlike dental floss which only disrupts plaque on the line angles.[19,28,41–43] In the Slot et al.[16] review, it was concluded that the interdental brush had higher plaque reductions than dental floss; however, this was only noted with two studies using the Silness and Löe plaque index, one study of which used the interdental brush once on each participant. In this current review, the same study[35] as that used in Slot et al.'s[16] review showed positive results with interdental brush over dental floss using the Silness and Löe plaque index. In addition, this review found that Christou et al.[37] and Kiger et al.[14] which used a modification of Quigley and Hein plaque index, also demonstrated interdental brush superiority. In all three studies, the participants had large, open embrasures and therefore, it is proposed that it is not the plaque index that is influencing the plaque outcomes, but rather the participants' oral anatomy.

CONCLUSIONS

Implications for practice

Interdental self care is important for disrupting the oral biofilm and maintaining oral health. Although dental flossing is a common interdental cleansing method for clients with type I embrasures, where interdental papilla fill the interdental space, its effectiveness is dependent on the client's technique and motiviation to floss daily.[44] Motivation is closely linked to the client's perceptions of a product's ease of use.[44] Oral self care techniques that are easy to perform are more likely to be implemented in a daily routine than techniques that require significant dexterity and effort to achieve results.[44]

Interdental brushes were preferred by study subjects because it was easier to use.[14,37–39] Although the interdental brush was noted to bend and buckle, study participants preferred the one handed method and time efficiency compared to the efforts required for dental flossing.[14,37–39]

In the past, interdental brushes were available only in large diameters and were thus, suitable for clients with open embrasures. However, the newer interdental brushes are available in diameters that can be accommodated in most type I embrasures.[15] This systematic review supports the interdental brush as an effective alternative to dental floss for clients with interproximal gingival inflammation, and provides the oral health clinican with evidence based guidelines to support oral self care recommendations for their clients (Figure 4).

Implications for research

Further research is needed to:

- Develop an accurate and reliable dental plaque index for assessing interproximal plaque, especially in type I embrasures where visibility is limited and for incorporating the recent developments in oral biofilm maturation and its effects on gingival inflammation.

Figure 4. Practice guidelines for the client with interdental inflammation.

- Investigate other interdental aids' effectiveness in type I embrasures as viable alternatives to dental floss for clients who lack dexterity.
- Study long term compliance and effectiveness of interdental aids to address the Hawthorne Effect on the short term results and observe hard and soft tissue adverse effects.

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Declarations of interest

The authors are not affiliated with any dental product or pharmaceutical company.

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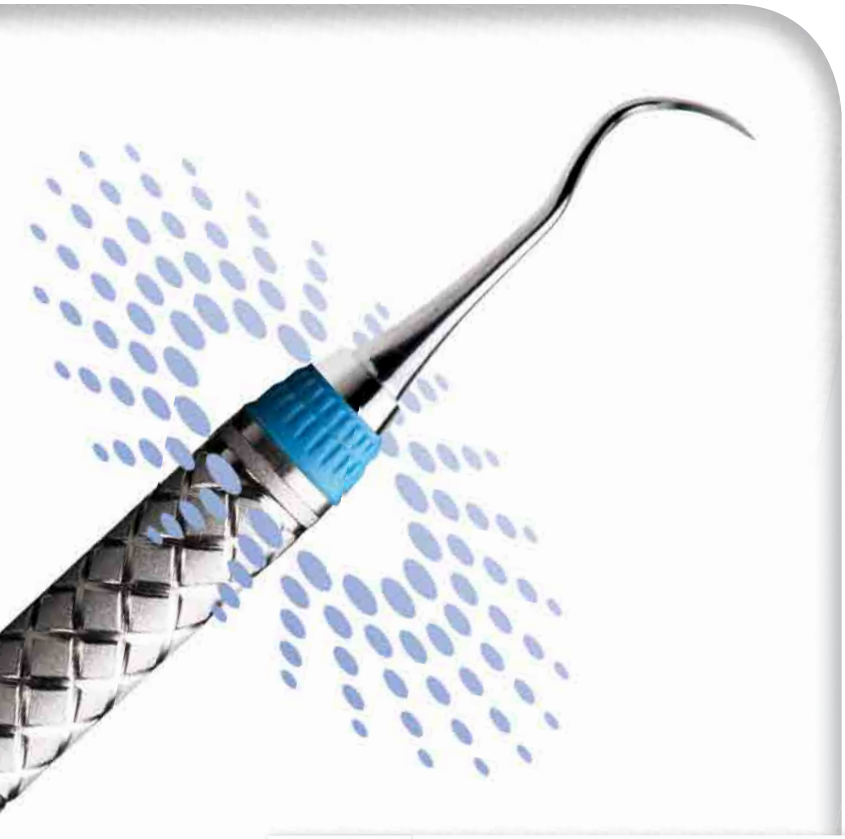

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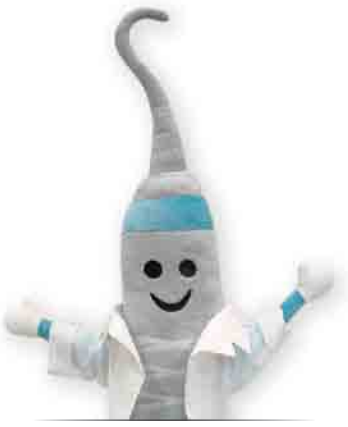

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