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FEBRUARY 2017 · VOL. 51, NO 1

**Ultrasonic instrumentation instruction in Canadian
dental hygiene programs**

**Re-exposure rates of digital intraoral images taken
by undergraduate dental hygiene students**

Effectiveness of early pediatric dental homes

Therapeutic oral rinsing, Part 2

**Interprofessional education
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The *Canadian Journal of Dental Hygiene* is the official peer-reviewed publication of the Canadian Dental Hygienists Association (CDHA). Published in February, June, and October, the journal invites submissions of original research, literature reviews, case studies, and short communications of scientific and professional interest to dental hygienists and other oral health professionals. Bilingual *Guidelines for Authors* are available at www.cdha.ca/cjdh.

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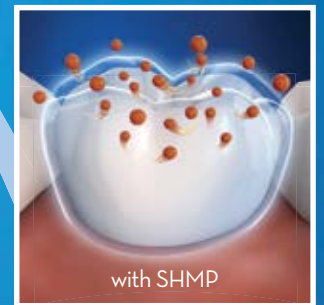
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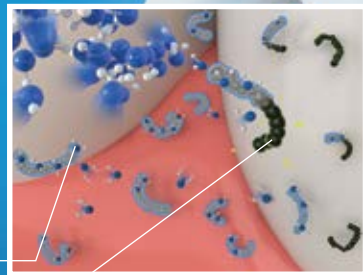
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Celebrating dental hygiene research and Canada's 150th birthday!

Salme Lavigne, PhD, RDH

Happy New Year to all of our readers! 2017 will go down in history as a very special year as Canada celebrates its 150th birthday as a nation. For Canadian dental hygienists, this year will be equally special as they will have a unique opportunity to interface and network with dental hygiene practitioners, researchers, and educators from around the world who will gather in Ottawa from October 19 to 21 to explore advances in dental hygiene research and practice. The theme of this global conference is “Translating Knowledge to Action” and thus calls on all practitioners to join key national and international dental hygiene researchers to learn how to interpret the knowledge gleaned from the most recent research findings.

This opportunity is being presented by the Canadian Dental Hygienists Association in partnership with the US National Center for Dental Hygiene Research and Practice (NCDHRP), which brings researchers, educators, and clinicians together to develop and conduct studies that address national dental hygiene research priorities. NCDHRP is housed at the Herman Ostrow School of Dentistry at the University of Southern California. It was founded in 1993 and has, to date, hosted 3 major North American dental hygiene research conferences, all of which have been held in Bethesda, Maryland. International attendance at these conferences has been growing exponentially, with researchers from as far as Japan, Australia, and Europe participating. We are indeed fortunate to welcome such an impressive array of experts to Canada's capital.

You may think that this conference is just for researchers and educators, but nothing could be further from the truth. The grassroots clinicians are the ones for whom the researchers conduct their research! The growth of a profession relies on its knowledge base and its ability to utilize that knowledge in practice. Dental hygiene is not a static discipline. Practice techniques and models of care are dynamic; new discoveries about the causes of disease, disease progression, treatment, and prevention



Salme Lavigne

are constantly being made. Staying on top of new findings is essential for the better care of our clients. Have you ever been intimidated by research articles that you read in journals? Would you like to understand how to incorporate the latest research findings into your daily dental hygiene practice? If so, then you should consider attending the conference in Ottawa this fall. You will learn how research investigations are conducted, how to translate research findings and implement them into practice, how to explore the most current research being conducted in oral health, and how to search for the best evidence.

If you are a young faculty member and are wondering how to conduct research, come and learn from the experts! Conference sessions will highlight how to conduct research, how to analyse your findings, and how to successfully publish your results. Hands-on training workshops will also be offered on scientific writing, literature searching methods, editorial review, publishing, teaching research methods, and more. These will all be presented in a collaborative and welcoming atmosphere enabling participants to get to know the experts as well as one another.

Finally, seasoned researchers will benefit from not only sharing their own research through poster and oral presentations, but also from the opportunity to network with other key dental hygiene researchers and practitioners. The submission deadline for abstracts is March 31; please consult the www.cdha.ca/2017conference for details. These types of conferences provide the very best collaborative opportunities for developing new ideas and building liaisons for future research.

No matter whether you are a clinician, educator, researcher or community health dental hygienist, the connections you can make when interacting with dental hygienists from around the world will be limitless and mind-boggling. Events such as this one do not come up

often, so I hope that you will consider taking advantage of this wonderful learning opportunity. Please join us in Ottawa to help celebrate the profession of dental hygiene and 150 years of Confederation!

“Twenty years from now you will be more disappointed by the things you didn’t do than by the ones you did. So throw off the bowlines, sail away from the safe harbor, catch the trade winds in your sails. Explore. Dream. Discover.”

– Mark Twain

ISSUE AT A GLANCE

In addition to a short communication by Zul Kanji, Diana Lin, and Carrie Krekoski on the importance of interprofessional education for collaborative practice (pp. 42–48) and part 2 of the Canadian Dental Hygienists Association’s position paper on therapeutic oral rinsing by Joanna Asadoorian, this time focusing on non-commercially available products (pp. 30–41), the journal is delighted to showcase the following research.

Asadoorian J, Botbyl D, Goulding MJ. Ultrasonic instrumentation instruction in Canadian dental hygiene programs: Perspectives of program directors on curricular elements. *Can J Dent Hyg.* 2017;51(1):7–15.

Ultrasonic instrumentation technology and technique have evolved rapidly over the last 15 years. As a result, it can be challenging for dental hygiene programs and their faculty to ensure that the most contemporary approaches are being taught and reinforced throughout all elements of educational programming. This study explores ultrasonic instrumentation curricula in Canadian dental hygiene programs from the program directors’ perspectives. The results demonstrate that dental hygiene programs have done well in making both traditional and contemporary ultrasonic equipment available to students during their education. However, shortfalls in the amount of curricular hours, timing, content, technique, application, and calibration of ultrasonic instrumentation education in dental hygiene curricula are evident. Careful reviews, modifications, and future evaluations of ultrasonic curricula within all aspects of Canadian dental hygiene programming are warranted.

Pachêco-Pereira C, Brandelli J, Senior A. Re-exposure rates of digital intraoral images taken by undergraduate dental hygiene students. *Can J Dent Hyg.* 2017;51(1):16–22.

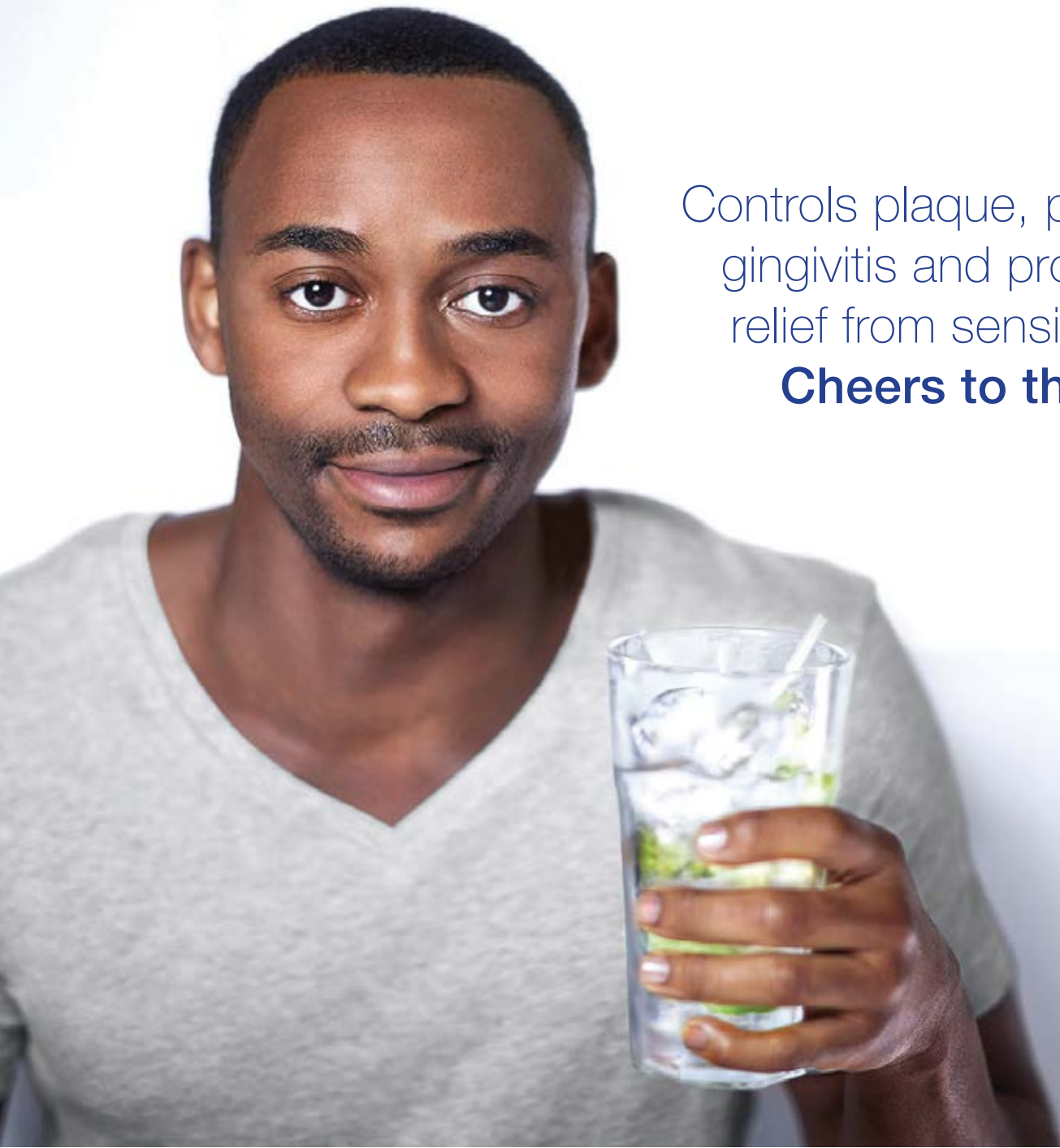
This study investigated the frequency of intraoral radiographic retakes by dental hygiene students over the course of one academic year using 2 different digital x-ray systems (direct sensors and PSP plates). Trained instructors decided when retake images were required. Periapical and bitewing radiographs had similar retake rates of 5.6% and 6.9%, respectively. Image receptor positioning errors (either too far forwards or backwards) were the most common causes of retakes overall. For periapical radiographs, the apical areas of the roots being “cut off” occurred more often when a direct sensor was used compared to a PSP plate. In order to reduce re-exposure rates and thus client dose, the most common errors that cause radiograph retakes should be identified and addressed in schools and clinical practice.

VanMalsen J, Compton SM. Effectiveness of early pediatric dental homes: A scoping review. *Can J Dent Hyg.* 2017;51(1):23–29.

The dental home is a concept similar to the medical home in which there is an established practitioner–client relationship and care is comprehensive, continuously accessible, and family centred. Current guidelines recommend that children should have a dental home no later than age one to help maintain good oral health and educate families that cavities are preventable. This scoping review of the literature on the clinical effectiveness, behavioral outcomes, and cost effectiveness of early pediatric dental homes reveals that children with a dental home early in life tend to have less dental decay and may also have less gingivitis and plaque. These children may also seek more preventive dental care, have diets that are less cavity causing, and have lower treatment costs. Though research generally supports the early pediatric dental home as an effective practice to improve oral health, there are considerable limitations to these studies. Further research is needed to find ways to optimize children’s oral health and confirm these benefits.



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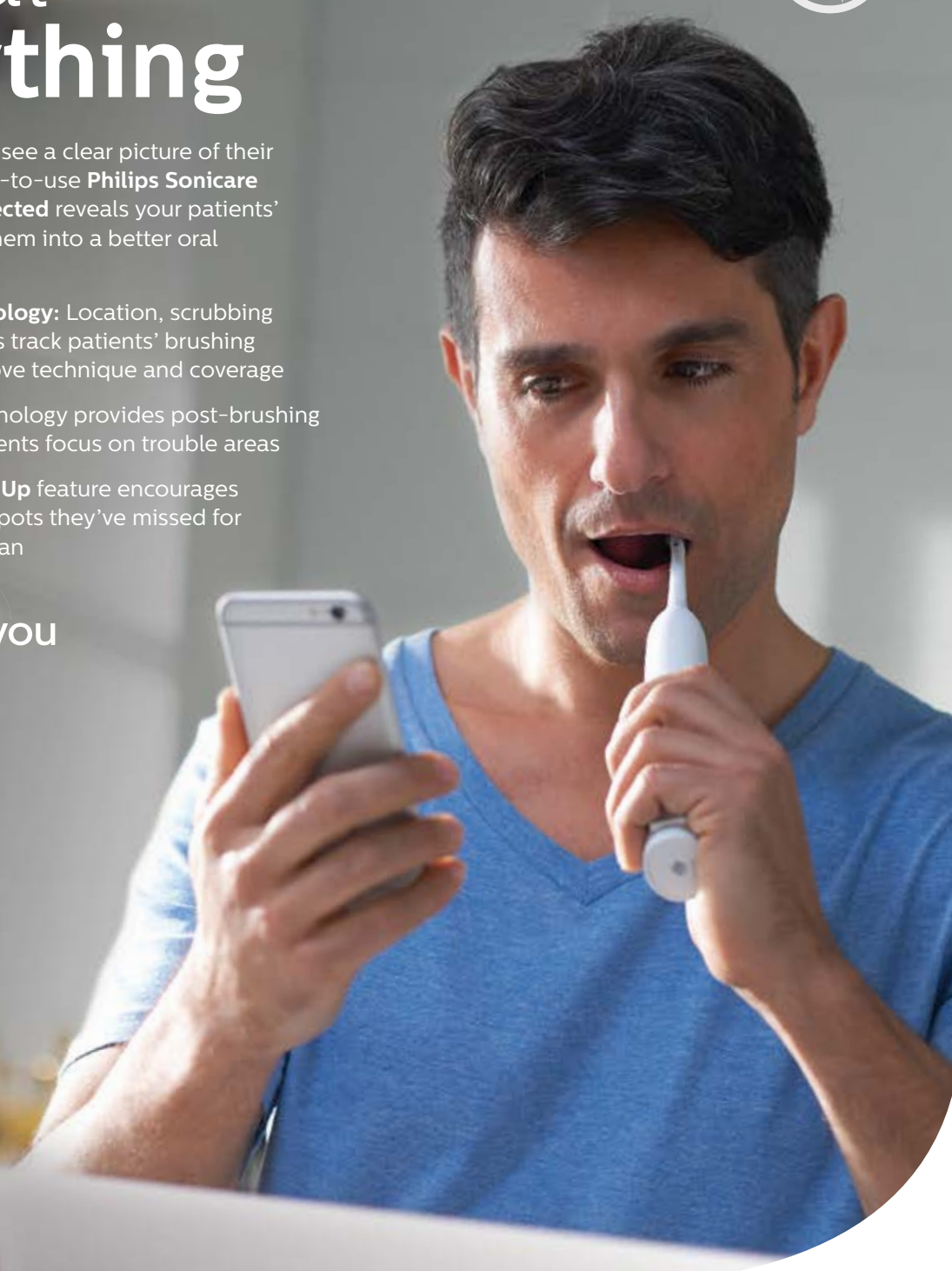
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Ultrasonic instrumentation instruction in Canadian dental hygiene programs: Perspectives of program directors on curricular elements

Joanna Asadoorian^{*}, PhD, RDH; Dani Botbyl[§], RDH; Marilyn J Goulding[†], MOS, RDH

ABSTRACT

Objectives: Contemporary ultrasonic instrumentation technology has improved its clinical utility due to enhanced subgingival access, disruption of biofilm, and debridement of light deposits. However, it is unknown if dental hygiene curricula in Canada have kept pace with this progression. This study explores dental hygiene ultrasonic instrumentation curricula from program directors' perspectives.

Method: All 40 Canadian dental hygiene program directors were invited to participate in a survey of their ultrasonic instrumentation curricula through an electronic questionnaire. The survey instrument was designed specifically for the study and included closed- and open-ended questions on ultrasonic instrumentation curricular elements. Statistical and thematic analyses were conducted. The study received ethics approval from the University of Manitoba. **Results:** Of the invited Canadian dental hygiene program directors, 19 (47.5%) completed the survey and reported a range of available ultrasonic equipment, both purchased and borrowed. The use of magnetostrictive technology was most common. The instructional hours devoted to ultrasonic instrumentation theory and preclinical and clinical training ranged from 2 to 20 hours, 0 to 12 hours, and more than 20 hours, respectively. Timing of the introduction to ultrasonic instrumentation education in the curriculum varied widely. Additionally, a considerable reliance on guest speakers (90%) and textbooks (95%) was observed. Student evaluation was mostly based on observation, with and without examination (21%, 36%) primarily without the aid of assessment rubrics (21%). While criteria for ultrasonic use were client based, some aspects of the criteria were not grounded in current theory. Program or course objectives related predominantly to theoretical knowledge as opposed to clinical skills. **Conclusions:** While appropriate ultrasonic technology is available to dental hygiene students, there are some deficiencies in Canadian dental hygiene ultrasonic curricula, such as a lack of evidence-based, contemporary approaches to ultrasonic instrumentation instruction. The authors recommend careful reviews, modifications, and future evaluations of ultrasonic curricula within all aspects of Canadian dental hygiene programming.

RÉSUMÉ

Objectifs : L'utilité clinique de la technologie ultrasonique contemporaine s'est améliorée grâce au meilleur accès sous-gingival, à la perturbation du biofilm et au débridement des légers dépôts. Cependant, on ignore si les programmes d'études d'hygiène dentaire au Canada ont progressé au même rythme. La présente étude explore le programme d'études sur l'instrumentation ultrasonique en hygiène dentaire en fonction de la perspective des directeurs des programmes. **Méthode :** Les 40 directeurs de programmes canadiens d'hygiène dentaire ont été invités à remplir un sondage par voie électronique au sujet de leur programme d'études sur l'instrumentation ultrasonique. Le questionnaire a expressément été conçu pour l'étude et comprenait des questions fermées et ouvertes sur les composantes curriculaires en matière de l'instrumentation ultrasonique. Des analyses statistiques et thématiques ont été effectuées. L'Université du Manitoba a fourni l'approbation déontologique pour l'étude. **Résultats :** Parmi les directeurs de programmes canadiens invités, 19 personnes (47,5 %) ont répondu au sondage et ont signalé qu'une variété d'équipement ultrasonique peut être achetée ou empruntée. L'utilisation de la technologie magnétostrictive était la plus commune. Les heures d'enseignement consacrées à la théorie sur l'instrumentation ultrasonique et à la formation préclinique et clinique varient de 2 à 20 heures, de 0 à 12 heures et plus de 20 heures, respectivement. Le meilleur moment pour introduire l'enseignement de l'instrumentation ultrasonique au programme d'études varie considérablement. De plus, une grande dépendance à l'égard des conférenciers (90 %) et des manuels scolaires (95 %) a été observée. L'évaluation des étudiants était surtout fondée sur l'observation, avec ou sans examen (21 %, 36 %) principalement sans l'aide de grilles d'évaluation (21 %). Bien que les critères d'utilisation de l'instrumentation ultrasonique étaient axés sur le client, certains aspects des critères ne s'appuyaient pas sur une théorie actuelle. Les objectifs de programme ou de cours étaient surtout liés à la connaissance théorique plutôt qu'aux

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WHY THIS ARTICLE IS IMPORTANT TO DENTAL HYGIENISTS

- Dental hygiene ultrasonic instrumentation education tends to be rooted in a traditional approach that underutilizes the full potential of new technology.
- Standardization of dental hygiene ultrasonic curricula based on current evidence would improve practice outcomes.
- Ongoing professional development for clinical dental hygiene educators in ultrasonic instrumentation, the articulation of clinical objectives, and the use of evaluation rubrics would enhance ultrasonic instrumentation instruction in dental hygiene programs and its clinical use by new graduates.

compétences cliniques. **Conclusions :** Bien que la technologie ultrasonique soit offerte aux étudiants en hygiène dentaire, il existe des lacunes dans le programme d'études d'hygiène dentaire canadien sur l'instrumentation ultrasonique, telles qu'un manque d'approches contemporaines et fondées sur les preuves en matière d'enseignement de l'instrumentation ultrasonique. Les auteurs recommandent des examens approfondis, des modifications et des évaluations futures des programmes d'études sur l'instrumentation ultrasonique dans tous les aspects des programmes canadiens d'hygiène dentaire.

Key words: curriculum, dental hygiene, dental prophylaxis, dental scaling, periodontal debridement, ultrasonic instrumentation

INTRODUCTION

Since the development of the first Cavitron in the 1950s, the use of ultrasonic technology for the treatment and prevention of periodontal disease has dramatically evolved. Early “traditional” use of ultrasonic instrumentation focused primarily on gross removal of heavy supragingival calculus using instrument tips with a thick diameter and a straight profile.^{1,2} More recent, contemporary applications include the use of ultrasonic instruments with thin and ultrathin diameters complemented by a selection of straight and curved profiles (Figure 1).³ These latter designs allow for broader and improved clinical utility, providing access subgingivally and for the removal of lighter calculus and biofilm.

Disruption and removal of subgingival biofilm, conservation of tooth structure, removal of calculus, resolution of inflammation, time efficiency, and reduced operator fatigue are all objectives of modern periodontal debridement.⁴ Consequently, contemporary ultrasonic methods can provide distinct enhancements to hand instrumentation, making ultrasonic instrumentation an essential component of periodontal debridement.⁵⁻¹⁰ While published evidence and state-of-the-art ultrasonic technology support this contemporary approach to periodontal debridement,¹¹⁻²⁰ which includes a broad use of modern ultrasonic instrument designs, it is unknown whether these techniques are well established in the dental hygiene educational environment in Canada.

A previously published study conducted by these

authors examined newly graduated dental hygienists' (n = 485; 26% response rate) perceptions of their educational preparation, confidence, and use of ultrasonic instrumentation once in practice using a “new graduate survey” instrument.³ The results demonstrated that dental hygiene graduates used ultrasonic instruments in a more traditional manner, predominantly with moderate to heavy deposits (81.5%) rather than with light deposits (19%).³ In addition, respondents reported primarily using straight, slim instruments, which suggested to the researchers an incorrect application of the technology.³

This previous research revealed that more than one third of the new graduates were less prepared in the use of ultrasonic technology than they were with hand instrumentation. Additionally, over 80% of the respondents felt “very” or “mostly prepared” to use straight ultrasonic instruments as compared to only 53%, who felt that way about curved instruments.³ Similar findings were found with the use of ultrasonics in supra versus subgingival environments, with at least 70% of study subjects compared to less than 50% feeling very confident in those respective clinical environments.³ In addition, some study subjects reported that the introduction of ultrasonics in the curriculum occurred too late in the program (22%), about half felt they lacked practice time, and almost 60% felt there was little to very little reinforcement of the value of using ultrasonics with their clients once it was introduced.³

Figure 1. Traditional and contemporary ultrasonic instrument tips



Traditional ultrasonics
Standard/thick diameter instruments

Contemporary ultrasonics
Thin/ultrathin diameter instruments
Straight and curved designs
Specialty instruments

At the outset of the present study, the researchers theorised that dental hygiene ultrasonic instrumentation curricula in Canadian schools may be entrenched in more traditional methods; findings from the new graduate study appeared to affirm this premise.³ The purpose of this study was to further explore dental hygiene ultrasonic instrumentation curricula from the faculty perspective with respect to specific curricular elements including access to equipment, timing, content, and evaluation.

METHODS

The survey instrument was designed specifically for this study and was conducted simultaneously with the new graduate survey reported on previously.³ Because the faculty survey instrument was designed to collect verifiable, objective data about program curricula, reporting bias was believed to be minimal relative to more socially charged research topics. The survey was created in steps, beginning with development of background knowledge and a conceptualization of the questionnaire, followed by format design and planning for analysis and establishing validity and reliability of the survey instrument. Establishing validity was an iterative process between the members of the research team and the statistician. A focus on content, construct, and face validity were all considered, with an emphasis on the comprehensiveness of the survey thus ensuring all relevant topic areas were explored.

Reliability of the survey was addressed by encouraging program directors to complete the survey with their faculty members while referencing program materials to ensure accuracy. Statistical reliability tests were not conducted on survey results, but program directors were permitted to provide comments with their answers to help clarify responses. In some cases, program directors contacted the study coordinator for clarification surrounding interpretation of survey items. The study received ethics approval from the University of Manitoba Health Research Ethics Board (HREB). Following pilot testing with a small convenience sample to assess content, comprehension, and timing, after which necessary modifications were made, the survey was sent to all Canadian dental hygiene program directors via electronic method. The survey instrument consisted primarily of closed-ended questions, and SurveyMonkey® was used for the implementation of the electronic questionnaire.

The survey was disseminated in English only by the study coordinator, and submission of a completed survey indicated consent to participate. The survey was open for 4 weeks and up to 2 electronic reminders were given to nonresponders prior to the closing of the survey. Participating directors/coordinators were entered into a draw for one gift of ultrasonic instruments for the dental hygiene program clinic, with a value of approximately \$750. The draw was made within 8 weeks of the close of the survey. Completed faculty surveys were collected through SurveyMonkey®. The data collected from the survey

instrument were downloaded into an electronic spreadsheet (Microsoft Excel® 2010 for Microsoft Windows), which included no identifying information and was accessible only to the research team. Participant email addresses were stored separately and at no time were individual responses linked to study subjects.

Anonymized data underwent quantitative analysis, using SAS/STAT®, by the research team and statistician. Two open-ended questionnaire items were included generating narrative data that were analysed using inductive qualitative thematic analysis. Descriptive and analytic statistical calculations included frequencies, proportions, means, and cross-tabulations examining potential relationships between various curricular characteristics and dental hygiene educational programs. Data were securely stored and will be destroyed according to requirements of the researchers' approved ethics submission.

RESULTS

Of the 40 invited dental hygiene program directors/coordinators, 25 participated in the study. Six surveys were excluded from the analysis because they were incomplete. Therefore, 19 questionnaires were analysed resulting in a 47.5% response rate. Of all submitted responses, including the ones that were later excluded from analysis, the largest percentage of respondents was from 2-year diploma programs ($n = 10$, 40%), followed by 3-year diploma programs ($n = 6$, 24%). A much smaller proportion represented the <2-year diploma programs ($n = 1$, 4%) and 3-year degree programs ($n = 1$, 4%). Several respondents self-identified as "other" ($n = 7$, 28%) (Figure 2). Although the questionnaire was only circulated in English, one survey was returned with comments written in French and was translated and included in the analyses.

Figure 2. Survey respondents by type of academic program

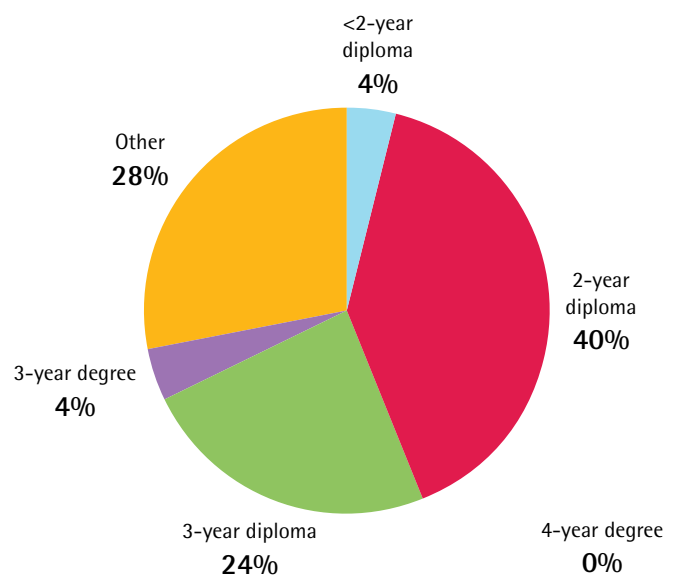
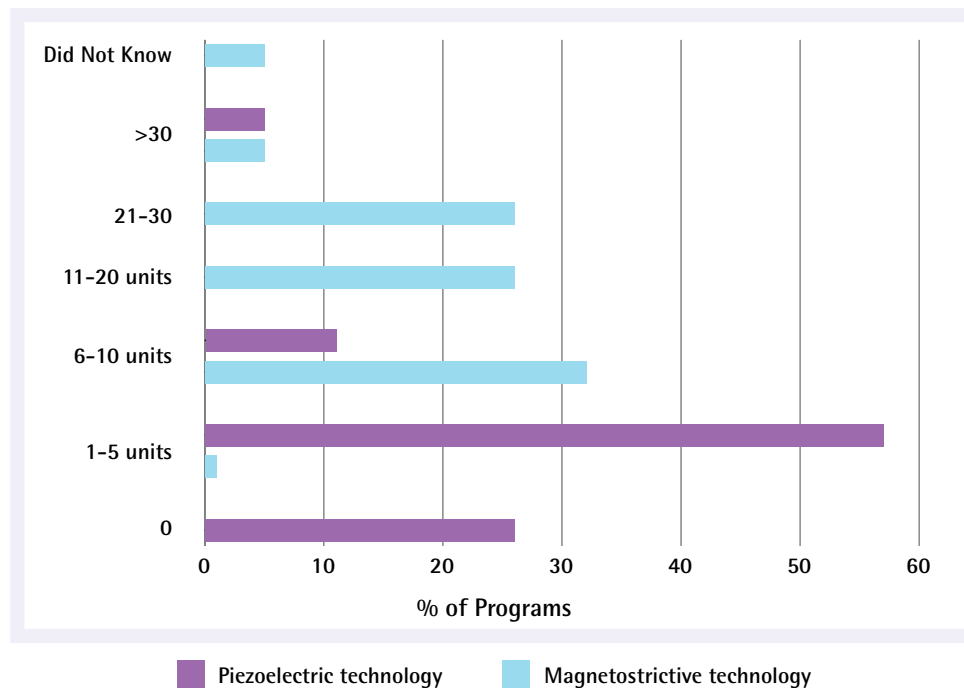
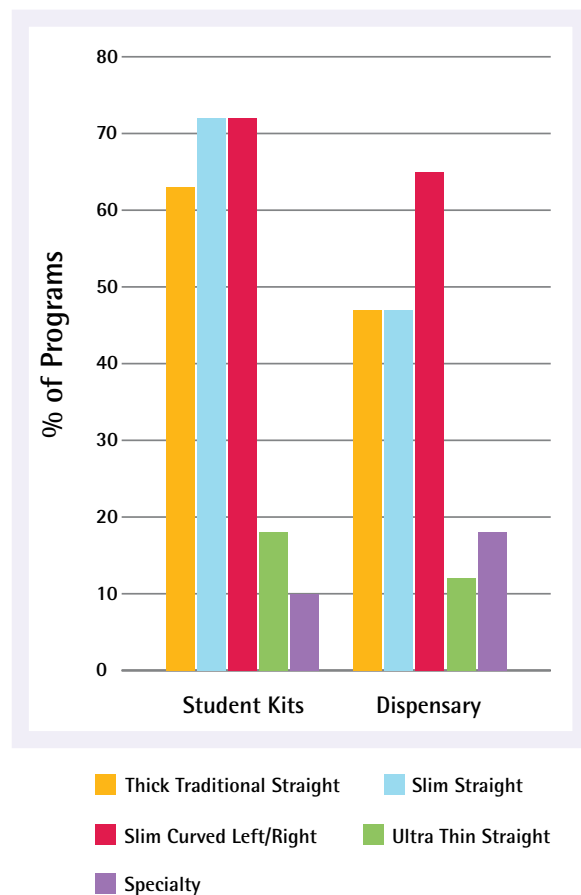


Figure 3. Student access to ultrasonic units



Study participants were questioned about the number of clinical units in their school and about the ultrasonic units and instruments (tips/inserts) available to students. A range of 1 to more than 50 treatment units/chairs were reported, with varying access to piezoelectric and magnetostrictive ultrasonic units. Most of the respondents (n = 11, 58%) reported that students had access to 1 to 5 piezoelectric ultrasonic units in the dental hygiene clinic with only one school reporting more piezoelectric compared to magnetostrictive units. While one program reported that students had access to more than 30 piezoelectric ultrasonic units, 5 others reported that students had no access to piezoelectric ultrasonic units (Figure 3). In

Figure 4. Student access to ultrasonic inserts



contrast, all respondents reported that students had access to magnetostrictive ultrasonic units within their programs. Most of the program directors (n = 16, 84%) reported having between 6 and 30 magnetostrictive units, which likely reflects the overall number of clinical chairs.

All program directors/coordinators reported offering dental hygiene students access to ultrasonic instruments (tips/inserts) through the clinic dispensary and/or student instrument kits. The vast majority (n = 18, 95%) of schools equip dispensaries with ultrasonic instruments for student use while a large proportion (n = 12, 63%) require students to purchase their own ultrasonic instrument kits, suggesting some schools have a combination of purchased and borrowed ultrasonic instruments. The number of ultrasonic instruments included in each student kit ranged from 2 to 5 inserts; the number of ultrasonic instruments available for student use from the clinic dispensary ranged from 1 to 10. The type of ultrasonic instruments, in either the student kits or the dispensary, varied and included traditional thick, straight inserts along with more contemporary designs such as slim straight, slim curved left/right, ultrathin, and specialty (implant, furcation) designs (Figure 4). None of the programs reported having diamond-coated ultrasonic instruments available.

Program directors/coordinators were asked about the timing and number of curriculum hours allocated to ultrasonic instrumentation theory, preclinic and clinic components in their programs. Respondents noted a wide range of both theory and preclinic instructional

hours, ranging from 2 to 20 hours and 0 to 12 hours, respectively. More than half of the respondents stated that the clinic component of their ultrasonic instrumentation curriculum comprised either more than 20 hours or was client specific, with the latter meaning it was based on what was made available by the client pool. However, 29% (n = 5) of program directors reported clinical instruction time of 8 hours or less. The introduction of ultrasonic instrumentation into classroom theory, preclinic and clinic settings was also wide-ranging occurring mostly throughout semesters 1 to 3 (Figure 5).

With regard to ultrasonic instrumentation evaluation, most (n = 16, 84%) of the respondents indicated evaluating preclinical knowledge and skills; 100% reported doing so in the clinical environment. In addition, program directors were asked about evaluation methods for assessing ultrasonic preclinical and clinical knowledge and skill development. Although the response rate to this question was low, within the preclinical setting, results showed there was a similar level of reliance on examinations only (n = 3, 21%) and observation only (n = 3, 21%), while 36% (n = 5) of programs reported using both examinations and observation. Evaluation rubrics were used only by 21% (n = 3) of programs. Within the clinical setting, ultrasonic knowledge and skill were predominantly evaluated through clinical observation (n = 14, 78%), while 22% (n = 4) reported evaluating clinical outcomes, 17% (n = 3) reported using a rubric, and an additional 17% reported using some other evaluation method (Figure 6).

Study participants were asked about the resources used to support student learning in ultrasonic instrumentation. The majority of programs used textbooks (n = 18, 95%) and guest speakers (n = 17, 90%), and in-house developed clinic manuals were used by 37% (n = 7) of programs (Figure 7). The following resources were mentioned specifically:

- Nield-Gehrig's *Fundamentals of Periodontal Instrumentation* (n = 12, 63%)
- Darby & Walsh's *Dental Hygiene Theory and Practice* (n = 10, 53%)
- DENTSPLY Canada's *Clinical Educator* (n = 10, 53%)
- Wilkins' *Clinical Practice of the Dental Hygienist* (n = 3, 16%)

Two open-ended survey items generated narrative data, which were analysed using inductive qualitative thematic analysis. Through these questionnaire items, the researchers were interested in gaining insight into what criteria existed, if any, on which students based treatment plans and subsequently implemented ultrasonic instrumentation; and what, if any, learning objectives for ultrasonic instrumentation were available in the program.

First, for the establishment of criteria for planning and using ultrasonic instrumentation, 2 main themes emerged from the analysis: contraindications and indications for use. In addition, 2 sub-themes under each main theme—student-related issues and client-centred issues—were

Table 1. Criteria for ultrasonic instrumentation: themes and subthemes

Subthemes	Themes	
	Contraindications	Indications
Student-related	<ul style="list-style-type: none"> • need to develop arm/wrist/hand strength 	<ul style="list-style-type: none"> • need to reduce arm/wrist/hand fatigue
Client-related	<ul style="list-style-type: none"> • client dental issues (e.g., crowns, bridges, veneers, implants) • client problems or concerns (e.g., gag reflex, sensitivity, root surfaces) • restorative issues • client falls within a specified population group (e.g., pedo; newly erupted teeth) • health concerns of client • client deposit/difficulty level 	<ul style="list-style-type: none"> • client dental issues (e.g., overhanging margins) • client falls within a specified population group (e.g., periodontitis) • health concerns of client • client deposit/difficulty level/stain removal, especially heavy deposits • client biofilm/material alba levels • dental treatment needs • appliances in need • client in need of lavage/flushing/irrigation

identified (Table 1). For the student issues subtheme, developing hand strength was the only contraindication for ultrasonic use identified, and, conversely, reducing hand fatigue was identified as an indication for use.

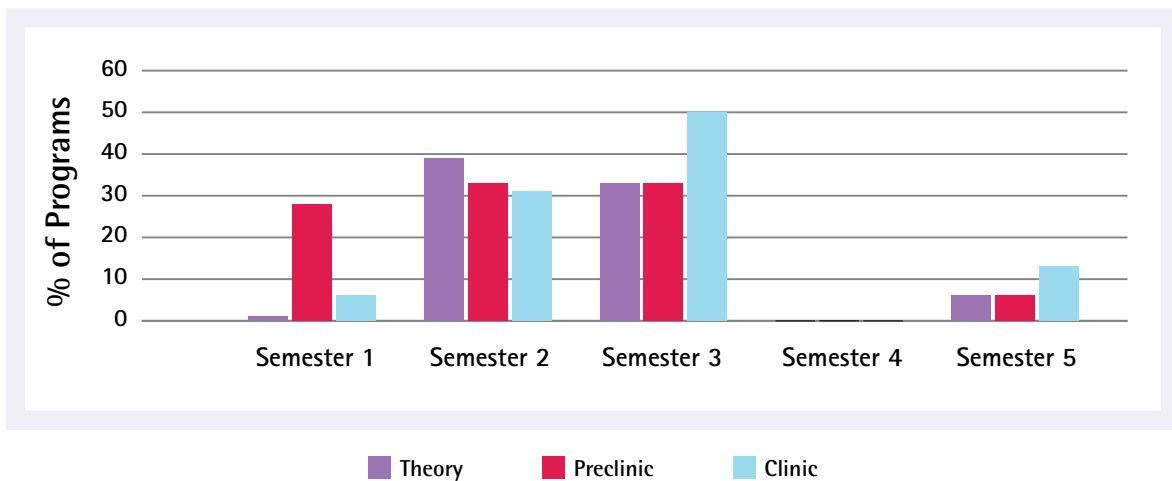
For the client-centred subtheme, a more diverse set of issues emerged and were distributed fairly evenly into both contraindications and indications for use. For example, respondents noted clients' dental or oral considerations, sub-population group, health concerns, deposit and difficulty level, dental treatment needs, appliances, and other factors.

Regarding the program or course objectives for ultrasonic instrumentation, several codes emerged from the data and were organized into 2 major themes: theoretical objectives and clinical/preclinical objectives. The majority of the objectives described fit within the more theoretical domain, whereas only a few of the described objectives pertained to preclinical or clinical domains (Table 2).

Table 2. Ultrasonic program or course objectives by learning domain

Learning domain	Codes
Theoretical	<ul style="list-style-type: none"> Utility Advantages Contraindications Technique Infection control Insert selection/types Mechanism of action
Preclinical or clinical	<ul style="list-style-type: none"> Utility Process of care

Figure 5. Timing of introduction to ultrasonic theory, preclinic and clinic



While the preclinical/clinical objectives primarily involved ultrasonic technique, a few concerned the process of care and implementation of client-centred care.

DISCUSSION

This paper reports the findings of a study designed to explore ultrasonic instrumentation curricula in Canadian dental hygiene programs from the perspective of program directors. The specific aim of this study was to examine theoretical, preclinical, and clinical elements of dental hygiene program curricula, with regard to their alignment with contemporary ultrasonic instrumentation approaches.

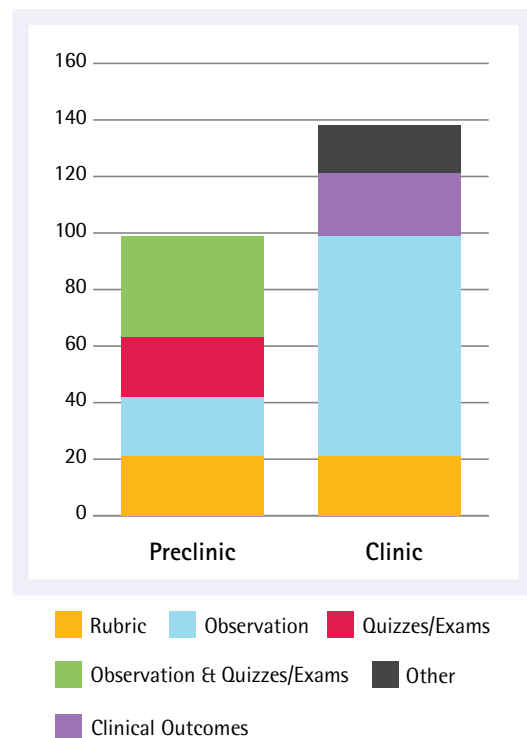
The findings indicate that there is a varied selection of ultrasonic instruments available to students during their education, including both instruments designed for more traditional applications (i.e., thick, straight) and those for more contemporary applications (i.e., thin, ultrathin, curved). This finding suggests that, although access to appropriate technology during training supports contemporary ultrasonic instrumentation practices, the teaching of more traditional approaches may be the norm.

The findings revealed a wide range in the timing of the introduction of ultrasonic instrumentation in the curriculum within all domains of instruction: theoretical, preclinical, and clinical. In some cases, very low numbers of hours of ultrasonic instruction were also evident. These findings may explain why, in previous research, some new graduates held unfavourable views of the timing of the introduction of ultrasonic instrumentation into the curriculum, the amount of practice time available, and the level of reinforcement of ultrasonic instrumentation use in the clinic.

In addition, data indicate a greater emphasis on ultrasonic instrumentation theoretical learning outcomes or objectives in comparison to those focused on clinically based knowledge and skills. This finding may reflect an overall program or even broader educational philosophy

of concentrating on ultrasonic instrumentation knowledge rather than its application to practice. The researchers also examined how ultrasonic instrumentation was evaluated, observing that both preclinical and clinical instruction were primarily assessed through written tests and observation or observation alone, while few study participants employed an evaluation rubric. Although in the new graduate survey, respondents reported that faculty were well calibrated with regard to linking ultrasonic theory to clinical practice,³ an underutilization of evaluation rubrics in ultrasonic instrumentation was evident in this study. When used, rubrics have the potential to ensure a more theoretical

Figure 6. Ultrasonic preclinic and clinic evaluation methods



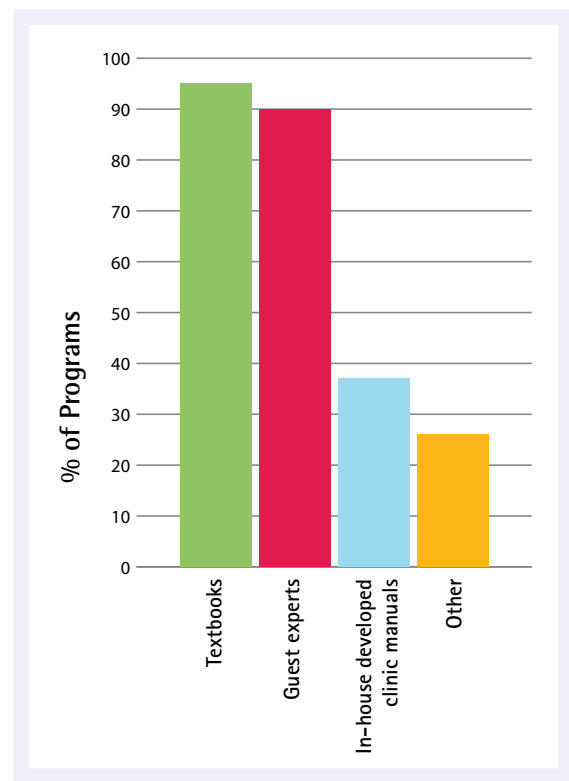
and evidence-based approach to evaluating and providing feedback to students.²¹

It is now considered best practice to base clinical curricula on specific client needs as opposed to student requirements.^{22,23} While it was evident from the directors' responses that specific criteria for ultrasonic use were based primarily on client conditions rather than student-related issues, some of these client conditions are no longer recognized as primary reasons for ultrasonic use in the literature. In a recently published study on American dental hygiene program ultrasonic curricula, it was reported that 77% of the 136 participating schools use "amount of calculus" as a criterion for ultrasonic use followed by 50% using "stain," while only 31% use "inflammation."²⁴ None reported biofilm reduction as a criterion. The study authors concluded that most programs continue to inappropriately use amounts of calculus as a criterion for ultrasonic instrumentation, and ultrasonic curriculum continues to focus on "...a traditional approach to instrumentation."²⁴ From both the present study and the US article, it is apparent that traditionally held beliefs surrounding client appropriateness for ultrasonic instrumentation may be ingrained in dental hygiene educators and may require more effort on the part of faculty to translate current evidence into educational practice.

It was interesting that dental hygiene programs rely considerably on guest experts in delivering ultrasonic instrumentation education, suggesting for this particular skill and knowledge set, a lack of in-house expertise, which may be driving programs towards the use of industry experts. Further, substantial use of textbooks in ultrasonic instrumentation teaching was also reported, and, although not unusual in dental hygiene and other educational settings, caution should be applied when relying on textbooks in health care education as this knowledge source can become rapidly outdated given frequent advances in research and technology.

Collectively, these findings indicate there are deficiencies in ultrasonic instrumentation education based on an overall lack of standardization for an evidence-based approach with contemporary ultrasonic instrumentation techniques. These findings may contribute to graduates' perceptions of their lack of preparedness and more traditional approach to the use of ultrasonic instruments, as reported previously.³ It appears that theory and clinical training in hand instrumentation are given more, and earlier, instructional emphasis. The authors speculate that this may result in "imprinting" where early experience has a lasting impact and manifests in a reliance on hand instrumentation in students. However, this assertion requires further investigation. Perhaps introducing ultrasonic instrumentation earlier in the curriculum, emphasizing current theory on the correct use of technology including units and inserts, enhancing the client selection processes including evaluation of client

Figure 7. Ultrasonic learning resources



needs for ultrasonic technology, and using appropriate evaluation mechanisms within the curricula, such as evaluation rubrics in both the didactic and clinical setting, would improve student outcomes. Canadian dental hygiene education accreditation requirements necessitate a continual curriculum review and the use of mechanisms to ensure that curricula remain evidence based and that clients receive quality care.²²

Limitations

There were several limitations to this study. First, because this study and analysis were conducted separately from the earlier new graduate study, the new graduates' reports of their ultrasonic instrumentation educational experience cannot be linked to specific curricular elements revealed in this study. Second, the study had a small sample size, although it did capture responses from across Canada within a range of dental hygiene educational program settings. Also, the sample may be more reflective of English-speaking program faculty given that the questionnaire was not circulated in French. However, data from one participant was received in French, which may have come from a French-speaking school.

Further, the study collected self-reported data, which can result in inaccuracies, but these typically relate to more socially sensitive research topics manifesting as social desirability response bias.^{25,26} While this research topic is relatively neutral, it is possible that program

directors have a desire to project their program favourably, which could result in imprecision. This potential bias was not controlled for in the study, however it was potentially mitigated through study participants' use of program materials and access to other faculty within their programs. While self-reporting can also exhibit recall bias, this was not an expected outcome because respondents were able to access faculty and curricular materials while completing the survey.

Ultrasonic instrumentation technology and technique have been evolving fairly rapidly over the last 15 years. As a result, it can be challenging for dental hygiene programs and their faculty to ensure that the most contemporary approaches are being taught and reinforced throughout all elements of educational programming. These results demonstrate that dental hygiene programs have done well in making both traditional and contemporary ultrasonic equipment available to students during their education. However, shortfalls in the amount of curricular hours, timing, content, technique, application, and calibration of ultrasonic instrumentation education in dental hygiene curriculum within all domains of learning are evident.

The authors postulate there may be a lack of faculty expertise in contemporary ultrasonic instrumentation approaches and technique, which may contribute to this deficiency. Certainly using external experts to teach some elements of the curriculum is pedagogically sound, but it does present challenges in ensuring that all faculty in contact, both theoretically and clinically, with students are competent in reinforcing evidence-based curricula throughout student educational experiences. It is anticipated the findings from this study will provide incentive for dental hygiene programs to re-examine ultrasonic instrumentation curriculum, develop evidence-based clinical course and program objectives, and create and use evaluation rubrics to better guide faculty in contemporary ultrasonic instrumentation instruction. Further, it may prove beneficial for faculty to seek professional development courses to elevate and calibrate their knowledge, skill, and confidence levels in ultrasonic instrumentation and better support students in evidence-based rationale and technique.

CONCLUSION

The preference of dental hygiene programs for magnetostrictive ultrasonic technology was evident from this study. The program directors reported that students have access to both traditional and more contemporary ultrasonic technology. However, there is a wide range of ultrasonic teaching hours, practice time, and variation in the timing of the introduction of ultrasonic training in Canadian dental hygiene curricula. In addition, there exists a heavy reliance on external, industry-sponsored educators for ultrasonic teaching, both didactic and clinically. The study revealed a lack of evaluation rubrics, clinical objectives, and ongoing encouragement for ultrasonic use in the clinic setting. Some elements of client selection for ultrasonic instrumentation are not based on current evidence, which is focussed on a resolution of inflammation through biofilm reduction. This study provides insight into dental hygiene ultrasonic instrumentation curricula, and may provide new understanding about graduates' perceived educational preparation and use of ultrasonic instrumentation. Given the demonstrated lack of alignment between aspects of contemporary ultrasonic instrumentation and dental hygiene program instruction, implementation of specific curriculum modifications and their evaluation would be beneficial.

CONFLICT OF INTEREST

This study was supported by an unrestricted educational grant from Dentsply Sirona Canada. Dani Botbyl is an educational specialist employed by the granting agency. During the latter stages of manuscript preparation, Marilyn J Goulding (a professor at Niagara College while the study was conducted) accepted a new clinical affairs position with Dentsply Sirona.

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Re-exposure rates of digital intraoral images taken by undergraduate dental hygiene students

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WHY THIS PAPER IS IMPORTANT TO DENTAL HYGIENISTS

- Recording the number of retake images (x-rays) is an essential component of running an effective digital dental radiography quality assurance program.
- By identifying the common errors made using digital systems, staff training can be specifically targeted to reduce errors, retakes, and thus client exposure.

ABSTRACT

Background: The objectives of this study were two-fold: 1) to investigate the prevalence of client re-exposure from images taken by dental hygiene students; and 2) to examine the causes of these errors. This information is essential for tailoring educational interventions to prevent specific errors from occurring, reduce repeat client exposure, and ensure an effective radiation dose. **Methods:** Two digital techniques for taking intraoral radiographs—bitewing and periapical—were investigated. Data were consecutively collected during the 8-month dental hygiene undergraduate academic year. Calibrated radiology instructors evaluated all primary images following a standardized template. Original images were taken using both direct and indirect technologies. The prevalence of and reasons for client re-exposure (retakes) were determined. **Results:** A total of 1886 reviewed images, consisting of 1296 bitewings and 590 periapicals revealed an overall retake prevalence of 6.5%. Periapical and bitewing radiographs, evaluated by projection, had similar retake rates: 5.6% and 6.9%, respectively. Image receptor misplacement was the cause of 52% of the retakes—42% from bitewing radiographs and 9.8% from periapical radiographs. Inadequate coverage of the apical areas caused 10.5% of direct sensor and 2.5% of photostimulable phosphor plate (PSP) retakes in periapical radiographs. **Conclusion:** The most common cause of retakes for periapical radiographs was the "cutting off" of apical areas. Image receptor misplacement was the most common cause of bitewing retakes and the most common cause of retakes overall. These issues should be addressed in schools and clinical practice to reduce re-exposure rates and thus client dose.

RÉSUMÉ

Objectifs : Les objectifs de la présente étude comprenaient 2 volets : 1) déterminer la prévalence de la réexposition des clients à la radiation en raison de la reprise d'images radiographiques par les étudiants en hygiène dentaire; et 2) examiner les causes des erreurs qui ont fait qu'une reprise d'images était nécessaire. Cette information est essentielle pour adapter les interventions éducatives dans le but de prévenir certaines erreurs particulières, pour réduire l'exposition répétitive du client à la radiation, et pour déterminer la dose de radiation qui est la plus efficace. **Méthodes :** Deux techniques de prise de radiographies intraorales; interproximale et périapicale, ont été étudiées. Les données ont été recueillies de manière consécutive pendant les 8 mois de l'année scolaire du programme d'hygiène dentaire de premier cycle. Des instructeurs de radiologie formés à l'étalonnage ont évalué toutes les images primaires en respectant un modèle normalisé. Les images radiographiques originales ont été prises à l'aide de technologies à la fois directe et indirecte. La prévalence de la réexposition des clients à la radiation en raison de la reprise d'images et les raisons pour lesquelles celle-ci était nécessaire ont été déterminées. **Résultats :** L'évaluation d'un total de 1 886 images, y compris 1 296 images interproximales et 590 images périapicales, a révélé une fréquence globale de reprises d'images de 6,5 %. Les radiographies périapicales et interproximales, évaluées par projection, ont dénoté des fréquences de reprises similaires, soit de 5,6 % et de 6,9 %, respectivement. L'erreur de placement du capteur d'images était la cause de 52 % de la reprise d'images, y compris 42 % des radiographies interproximales et 9,8 % des radiographies périapicales. En matière de radiographies périapicales, la couverture inadéquate des zones apicales était la cause de 10,5 % des reprises par capteur direct et 2,5 % des reprises par écran radioluminescent au phosphore. **Conclusions :** Les radiographies périapicales devaient être le plus souvent reprises en raison de zones apicales tronquées. L'erreur de placement du capteur d'images était la cause la plus commune non seulement de la reprise des radiographies interproximales, mais aussi de la reprise de radiographies en général. Ces problèmes devraient être traités dans les établissements scolaires et dans la pratique clinique pour réduire le taux de réexposition du client à la radiation et par conséquent, réduire la dose du client.

Key words: diagnostic imaging, hygiene, oral hygiene, prevalence, radiology

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INTRODUCTION

Intraoral radiographs play an important role in diagnosis and other aspects of client care. One of the main principles of radiography is the need to keep the radiation dose as low as reasonably achievable (ALARA). Direct digital sensors require less radiation exposure than film to produce a diagnostically acceptable radiograph.¹ However, this reduction can be nullified if radiographs are retaken, resulting in unnecessary radiation exposure for the client and additional use of clinical time and resources.

Intraoral radiography, specifically bitewing and periapical radiographs, represents the backbone of imaging in dentistry. Bitewing radiographs focus on the crowns of the maxillary and opposing mandibular teeth and are valuable in detecting early stage interproximal caries and alveolar bone level.² Periapical radiographs aim to show the entire tooth, providing an interpretable image of the root and surrounding structures.³

The adoption of digital dental radiography has increased over time, with more and more practitioners switching to indirect digital imaging (photostimulable phosphor plates [PSP]) or direct digital imaging (direct sensors). A comparison of these systems demonstrates that they are diagnostically similar, as both have high specificity and low sensitivity for the detection of caries.⁴ Much of the decision to select a particular system depends on user preference.

It is important that users, including students, receive effective training to optimise the benefits of these technologies and reduce client exposure to radiation. This is particularly pertinent in educational settings where higher retake rates are more common among student learners than experienced users.⁴ The prevalence of clinical retakes using direct digital sensors compared to film has been reported among undergraduate students⁵, but to the best of our knowledge, no studies have compared retake rates between different techniques—bitewing and periapical imaging—using digital technology (indirect PSP and direct sensors). Given that these are the 2 principal imaging techniques for taking intraoral radiographs, this information could be useful for tailoring educational interventions to prevent these specific errors from occurring and thus reduce repeat client exposure. Therefore, the objectives of this study are two-fold: 1) to investigate the prevalence of clinical re-exposures (retakes) of intraoral digital images taken by dental hygiene students; and 2) to examine the causes of these errors.

METHODS

The study was approved by the University of Alberta Health Research Ethics Board; project number Pro00065349. The data were consecutively collected over an 8-month period (September 2015 to April 2016) from clients attending the School of Dentistry, University of Alberta, undergraduate dental hygiene and dentistry clinics.

This study included only intraoral (bitewing and

periapical) images that had been taken by third-year dental hygiene students in the oral radiology department. Data collected included the total number and type of intraoral radiographs taken, the number of clinical retakes, and the technology (direct or indirect) used to make the primary image that required a retake.

All original images (those not considered retakes) were evaluated by calibrated radiology instructors according to the Department of Oral Radiology criteria for periapical and bitewing imaging.⁶ The evaluation criteria are listed in the Appendix.

To assess how individual students were progressing with their radiographic technique, a technique worksheet was used at each radiology visit. The worksheets were analysed and totalled to calculate an individual performance rate for each student. A “technical retake” is defined as an image that lacks significant diagnostic information according to the department’s intraoral imaging criteria, but since the area of concern is visible on another image, taken in the same series, no actual re-exposure of the client is required. In contrast, a “clinical retake” is defined as an image that lacks significant diagnostic information according to the department’s criteria, with the area of concern not being visible on any other image, taken in the same series, so re-exposure of the client is required. A “minor error” is defined as an error that is present but does not compromise the diagnostic capability of the image.

Only images with errors that required client re-exposure were included in the study. Following the ALARA and ALADA (as low as diagnostically acceptable) principles, any anatomical areas missed on a particular image but visible and diagnostically acceptable on a different image taken at the same time did not result in clinical re-exposure and, hence, were not included.

All radiographs were taken using rectangular collimation sizes 1 and 2 (Sirona Dental Systems, Bensheim, Germany) and receptor holders (Rinn Dentsply XCP-DS Fit, Dentsply-Rinn Corp). Sizes 1 and 2 PSP (Imaging Plates, Digora Optime UV, Soredex, Tuusula, Finland) and charge coupled device (CCD) sensors sizes 1 and 2 (Sirona Dental Systems, Bensheim, Germany) were used.

Statistical analysis

The R statistical software (Lucent Technologies, GNU General Public Project) was used for data analysis. For data description, mean and standard deviation (SD) were used for continuous variables, while frequencies were used for categorical variables. Data regarding the number of clients imaged and the number of bitewing or periapical radiographs taken by each student for their assigned clients over the course of the 8-month study were analysed.

In this study, only non-diagnostic images that necessitated actual clinical re-exposure of the client (i.e., clinical retakes) were referred to as “number of retakes.” Different factors were further analysed as determinants of the retake. Blinded data were analysed by a statistician.

RESULTS

The total number of intraoral digital images taken on clients over the 8-month period by 42 senior dental hygiene students was 1886, consisting of 1296 bitewing images and 590 periapical images. From these primary images, 123 re-exposures (retakes) occurred, resulting in a retake rate of 6.5%.

Table 1 illustrates the number of retakes that occurred for bitewing and periapical radiographs with both PSP and

Table 1. Re-exposure rates and number of retakes by technique and image type

Image type	Radiographic technique	Number of retakes	Retake rate by image type (%)
Bitewing	PSP (plates)	36	2.7
	Direct sensor	54	4.1
	Total	90	6.9
Periapical	PSP (plates)	5	0.8
	Direct sensor	28	4.7
	Total	33	5.6
Bitewing and periapical total		123	

direct sensors. Primary images taken with direct sensors resulted in 54 retakes; primary images taken with PSP resulted in 36 retakes during bitewing procedures. Use of direct sensors resulted in more retakes during periapical radiographs, with 28 retakes compared to 5 retakes when the PSP were used. Periapical and bitewing radiographs both had similar retake rates: 5.6% and 6.9%, respectively.

Table 2 presents the number of clients per student (mean of 14.6 [SD, 3.7]) and the total number and type of images taken per student, ranging from 16 to 80 with a mean of 41.2 (SD, 13.3), bitewing_{mean}= 31 (SD, 12.2) and periapical_{mean}= 14.1 (SD, 9.4). The mean performance rate was 75.7% (SD, 10.6), recorded before remediation.

Table 2. Number of clients seen, images taken, and dental hygiene student performance rate

	Minimum	Maximum	Mean	Standard deviation
Clients per student	6	24	14.6	3.7
Images taken per student	16	80	41.2	13.3
Periapicals taken per student	9	61	14.1	9.4
Bitewings taken per student	10	57	31	12.2
Student's technique performance rate ^a	37.7%	91.2%	75.7%	10.6

^aPerformance rate calculated from technical worksheet data and before student remediation (if required)

Table 3 shows the error that necessitated each retake for PSP plates and direct sensors when taking bitewing radiographs. The main cause of bitewing retakes, for both direct sensors (26.8%) and PSP (15.4%), was an error in image receptor placement. The next most common cause of bitewing retakes was missing bone level for direct sensors and collimator cutting for PSP.

Table 4 contains information on the errors that necessitated retakes for PSP and direct sensors when taking periapical radiographs. The main cause of periapical retakes for both direct sensors (10.5%) and PSP (2.5%) was “apical areas cut off.” The next most common cause of periapical retakes for both types of receptor was image receptor misplacement, making it the most prevalent intraoral image error made by students overall. Missing crowns and cone cutting occurred more often with direct sensors than PSP plates when taking periapical images.

DISCUSSION

One of the main principles of oral radiology is ALARA; a principle that includes client-specific prescription, the use of dose-reducing measures, and careful attention to image acquisition and technique. When a radiograph is determined to be non-interpretable and a retake is performed, the client is exposed to twice the amount of radiation than if the retake had not been required. An important component of ALARA, therefore, is reducing the number of retake exposures. The results of this study demonstrated an overall radiographic retake rate of 6.5%. This is a slightly higher retake rate compared to previous studies, which reported a retake rate of less than 5% in a dental school radiology department, and lower than the 9% to 13% retake rate reported in other studies.^{4,7}

One possible cause for the discrepancy between our results and previous studies^{4,7} could be that each study has its own parameters for what constitutes a useable or diagnostic image and what necessitates a retake. The “cut-off” for this decision may differ according to the strictness of the criteria and how stringently they are applied, to what extent personnel are calibrated and prepared to enforce the criteria, and of course client factors. With this in mind, an

Table 3. Reasons for bitewing imaging retakes for PSP and direct sensors^a

Cause	Bitewing retakes			
	Direct sensor (n = 54)		PSP (n = 36)	
	Number of retakes	% of total retakes	Number of retakes	% of total retakes
Image receptor placement	33	26.8	19	15.4
Bone level missing	11	8.9	4	3.3
Cone cut	4	3.3	6	4.9
Client not biting	3	2.5	3	2.5
Crowns missing	2	1.6	0	0
Foreign body on image	1	0.8	0	0
Patient movement	0	0	1	0.8
Image receptor backwards	0	0	1	0.8
Overlapping contacts	0	0	1	0.8
Other	0	0	1	0.8

^aTables 3 and 4 sum up 100% of retakes (n = 123)

important part of applying ALARA to retakes is to always strive to reduce the number of retakes in each workplace.

When comparing retake rates for periapical and bitewing radiographs, the rates were found to be similar, at 5.6% and 6.9%, respectively. Students appeared to have equal difficulty taking periapical and bitewing images, with more retakes required when using direct sensors rather than PSP (clinical observation). The temptation to lower the threshold for re-exposure when using direct sensors, due to the ease and speed of retaking direct images compared to PSP, may have contributed to this outcome.⁸ It could also be due to challenges in direct sensor placement when compared to PSP. This information suggests that further training, especially training that addresses direct digital sensor usage, may be necessary in order for students and practitioners to effectively utilize direct sensor technology. Videos that demonstrate tips and specific techniques for each modality can be utilized to improve basic radiography skills.⁶

The reasons for re-exposures are recorded in Tables 3 and 4. Image receptor misplacement was the most common mistake, accounting for 52% of the retakes. It was the main cause of retakes for both PSP and direct sensors in bitewings, accounting for 57.8% of bitewing retakes. Image receptor misplacement with direct sensors was also the second most common cause of retakes of periapical images, and it ranked third among the top 5 causes of retakes overall. Regarding bitewings, the term “image receptor placement error” was most often applied to premolar bitewing images

that failed to capture the canine to first premolar contact area, as the receptor was not placed far enough anteriorly. Similarly, it was also used when a molar bitewing image failed to capture the distal surface of the last erupted molar tooth, as the receptor had not been positioned posteriorly enough. As the high prevalence of these particular errors became apparent early in the academic year, additional training on how to avoid these errors was given to all students.

Image receptor misplacement was also the second most common cause for periapical retakes (9.7%), due to similar errors in anterior–posterior receptor placement. These results, like those of previous studies, confirm that incorrect receptor placement is a common, widespread, and persistent radiographic problem.^{9–11} Although an image receptor placement error was common for both direct and indirect receptors, the reasons why the error occurred varied. Direct sensors tend to be bulky, possibly making it more difficult to be placed in the ideal position.^{12,13} Another potential cause of error may be the fact that the sensor has an active receptor area smaller than the PSP active area. Additionally, the temptation to lower the threshold for re-exposure due to the ease and speed of retaking direct digital images may also contribute to the increased retake rate.⁸ In contrast, PSP may suffer from receptor holder displacement or plate bending.¹⁴ Positioning a plate too far anteriorly can also occur when students, familiar with using direct sensors and compensating for the sensor bulk, switch to using PSP.

Table 4. Reasons for periapical imaging retakes for PSP and direct sensors^a

Cause	Periapical retakes			
	Direct sensor (n = 28)		PSP (n = 5)	
	Number of retakes	% of total retakes	Number of retakes	% of total retakes
Apical areas "cut off"	13	10.5	3	2.5
Image receptor placement	10	8.1	2	1.6
Crowns missing	3	2.5	0	0
Cone cut	2	1.6	0	0

^aTables 3 and 4 sum up 100% of retakes (n = 123)

The most prevalent error for periapical images exposed with direct sensors and PSP was "apical areas being cut off" (13%). This error occurred more frequently with direct sensors than PSP, perhaps due to difficulties in placing the direct sensor parallel to the teeth and the smaller active surface area compared to film and PSP. Proper placement technique and vertical inclination of the tube head could reduce this error.

From a teaching and student assessment standpoint, each image taken by a student was graded to monitor individual student performance. For the purposes of this study, individual student identifiers were removed but this information was available to faculty to target students who required more client experience and remediation.

Limitations of this study

This study did not include radiographs taken by third-year dental hygiene students in community settings outside of the School of Dentistry main clinic. However, the prevalence and cause of errors identified within the radiology department did provide valuable information for student remediation and the development of additional educational materials (e.g., technique guides and videos).

Additionally, although the total number and type of images taken by students was recorded, the details of what type of digital receptor (either direct sensor or PSP) used to make the primary image was only recorded if a retake image was taken. In order to adequately compare the retake rates between indirect and direct sensors this information should have been recorded for all images taken, including the primary images that did not result in a retake. Future studies could compare retake rates between these image receptors to determine if one results in a higher retake rate so that educational resources can be directed to address challenges associated with specific devices.

CONCLUSION

A retake rate of 6.5% was recorded for intraoral images taken with digital receptors by the senior dental hygiene students in a dental school setting. The most common technique error that prompted a retake for both direct and PSP receptors was image receptor misplacement for bitewings and inadequate coverage of the apical area for periapical images. Future studies should explore if student education targeted specifically at these errors will result in a reduction in retake prevalence and, thus, a reduction in radiation re-exposure to clients.

Implications for education

1. Measures to decrease retake rates should be taken to reduce wasted time, resources and most importantly client radiation exposure. For example, image receptor misplacement is a common cause of retakes that should be addressed by radiology instructors.
2. An individual student error rate assessment could help target remediation and monitor student progress.
3. Calibration of instructors and a standardized worksheet with clear criteria for images could optimize the minimal requirements for each image.

Implications for clinical practice

1. Imaging quality assurance programs, including the monitoring of client re-exposure rates, should be implemented with an ongoing goal of reducing client re-exposure.
2. Once prevalence and the common errors are identified for each technique, training can then be specifically targeted to address the common problems.

APPENDIX: CRITERIA FOR A FULL MOUTH SERIES OF RADIOGRAPHIC IMAGES⁶

BITEWING EXAMINATIONS

General considerations

The occlusal plane should be straight or slightly curved upward towards the distal. There should be equal demonstration of the maxillary and mandibular crowns and crestal bone. All the interproximal contact points should be open and visible on the premolar and/or the molar bitewing.

Specific views

Horizontal and vertical premolar bitewings (BW)

- Demonstrate the distal surface of canine crowns and all of the first and second premolar crowns.
- The following interproximal contacts must be open: first/second pm, second pm/first molar (if not seen on the molar BW). Ideally the canine/first premolar contact should be visible. This is consistently achievable and expected with PSP plates or film. However, when a direct sensor is used, it can sometimes be difficult to obtain the distal surface of the canine.

Horizontal and vertical molar bitewings

- Demonstrate all of the first molar crown (if not seen on the premolar bitewing) and the second molar and third molar crowns (or the distal surface of the most distal fully erupted tooth).
- The following interproximal contacts must be open if not seen on the pm BW: second premolar/first molar & first molar/second molar/ third molar

Often, an additional molar bitewing view is required, on each side, when vertical molar bitewings are requested and third molars are present.

PERIAPICAL EXAMINATIONS

General considerations

At least 2 mm to 3 mm of bone around the apex of each root should be visible. The complete crown of the tooth (including the incisal edge/occlusal table) should be visible and ideally the contact points between the teeth should be open. This is particularly important if bitewings have not also been taken.

Specific views

Maxillary incisors (two size 1 receptors used)

- Each image demonstrates the entire central incisor and the majority of the lateral incisor on that side. Ideally the central incisor/central incisor and the central incisor/lateral incisor contacts are open. Incisal edges should be seen.

Mandibular incisors (one size 1 receptor used)

- Demonstrate both central incisors including the incisal edges. Often the majority of both lateral incisors is also seen. Ideally the central incisor/central incisor and the central incisor/lateral incisor contacts are open.

Maxillary/mandibular canine (one size 1 receptor used)

- Demonstrates the entire canine tooth and any portion of the lateral incisor not seen on the incisor view.
- Ideally the lateral incisor/canine contact is open.

Note—the canine/premolar contact will often appear overlapped on this image. This is a result of the curve of the arch and the transition to a double row of cusps.

Maxillary/mandibular premolar (size 2 receptors used)

- Demonstrates the first and second premolars (and often the first molar) and their apices.
- Ideally the canine/first premolar and the first premolar/second premolar contacts and the second premolar /first molar contacts are open.

Maxillary/mandibular molar (size 2 receptors used)

- Demonstrates the first molar (if not seen on the premolar view), the second molar and the third molars — or the most distal fully erupted tooth.
- Ideally the 2nd premolar/first molar (if not seen on a premolar periapical) and the first/second molar contacts are open.

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CONFLICT OF INTEREST

The authors have declared no conflicts of interest and no funding sources for this study.

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Effectiveness of early pediatric dental homes: A scoping review

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ABSTRACT

Objective: This scoping review examines literature on the effectiveness of early pediatric dental homes based on clinical, behavioural, and cost parameters. **Methods:** A search of MEDLINE-Ovid, PubMed, CINAHL, Embase, Cochrane Database of Systematic Reviews (CDSR), Scopus, and BioMed Central databases was undertaken using "dental home" and "dental homes" as key words. In total, 232 non-duplicate citations were identified. After reviewing the titles and abstracts of these citations, 14 full articles were reviewed. In the final data set, 7 articles met the inclusion criteria of preschool study population and a focus on effectiveness parameters. **Results:** The existing body of evidence generally supports the effectiveness of early pediatric dental homes for improving clinical outcomes (i.e., dmft scores) and behavioral outcomes (i.e., including utilization of future dental care services), and offering potential cost savings. However, exact quantifications of the impact on clinical and behavioral outcomes as well as cost savings vary due to heterogeneity of study design and methodological considerations related to level of evidence. **Conclusion:** Current research generally substantiates the establishment of a dental home model as an effective practice to improve early pediatric oral health.

RÉSUMÉ

Objectif : Le présent article examine la documentation sur l'efficacité des soins dentaires pédiatriques au cours de la petite enfance d'après des paramètres cliniques, comportementaux et de coûts. **Méthodes :** Une recherche sur les bases de données de *MEDLINE-Ovid*, *PubMed*, *CINAHL*, *Embase*, *Cochrane Database of Systematic Reviews* (CDSR), *Scopus*, et *BioMed Central* a été effectuée en anglais, en utilisant les mots clés « *dental home* » et « *dental homes* ». Au total, 232 citations non redondantes ont été cernées. Après avoir examiné les titres et les résumés de ces citations, les versions intégrales de 14 articles ont été évaluées. Dans le dernier ensemble de données, 7 articles remplissaient les critères d'inclusion de la population d'âge préscolaire étudiée et de l'accent sur les paramètres d'efficacité. **Résultats :** L'ensemble des preuves existantes appuie de façon générale l'efficacité des soins dentaires pédiatriques précoces dans l'amélioration des résultats cliniques (c.-à-d., des indices DCMO) et des résultats comportementaux (c.-à-d., de l'utilisation future de services de soins dentaires), et l'offre potentielle d'une économie des coûts. Cependant, l'évaluation quantitative exacte de l'effet sur les résultats cliniques et comportementaux, ainsi que sur l'économie des coûts, varie en raison de l'hétérogénéité du modèle d'étude et des facteurs méthodologiques liés au niveau de preuve. **Conclusion :** La recherche actuelle corrobore généralement la mise en place du modèle de soins dentaires en tant que pratique efficace pour l'amélioration de la santé buccale au cours de la petite enfance.

Key words: child, dental home, dental visit, early childhood caries, infants, pediatric, toddlers

INTRODUCTION

While recognizing that advances in the provision of oral health care have been significant and commendable, it is also acknowledged that the mandate of oral health care providers is to ensure continual evidence-based improvements to enhance client care. In this context, the Canadian Dental Association approved a position statement in 2005 endorsing the first dental visit by 12 months of age.¹ Similarly, the Canadian Dental Hygienists Association has endorsed the importance of infant oral

health care through several publications including an oral health care call to action presented to the House of Commons Standing Committee on Finance in 2010, which prioritized data collection related to infant oral health.² This call to action further noted that the Canadian Association of Paediatric Health Centres identifies early childhood caries as the most common chronic childhood disease, declaring it a "pandemic in North America"², p⁴ in 2007.

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WHY THIS ARTICLE IS IMPORTANT TO DENTAL HYGIENISTS

- The early pediatric dental home is a promising model to improve pediatric oral health based on clinical, behavioural, and cost effectiveness outcome measures.
- Dental hygienists and other dental practitioners should encourage families with infants and toddlers to start seeing a dental professional no later than age one for routine professional oral health care.

Though the first dental visit by age one has been endorsed in Canada for over a decade, implementation of the practice standard has been limited within the dental and medical community.³ A cross-sectional study of children in one Canadian city indicated that fewer than 1% had received oral health exams by age one and only 1.9% of children had preventive dental care by 2 years of age.⁴ Of further concern, the Canadian Institute for Health Information has reported that treatment of early childhood caries is the most common reason for pediatric day surgery in Canada.⁵ In particular, the report highlighted the significant prevalence of dental disease in Aboriginal populations and children from rural and lower socioeconomic status neighbourhoods.

Abating early childhood dental disease and improving uptake of first-year dental visits are inherently complex undertakings. However, the dental home model is one strategy that has been supported at an oral health policy level to improve access to early pediatric oral health care.^{6,7} Just as the American Academy of Pediatrics' policy on the medical home states that "medical care of children of all ages is best managed when there is an established relationship between a practitioner who is familiar with the child and the child's family,"^{8, p93} the American

family-centred model.

This article aims to advance oral health care practitioners' awareness of the dental home concept by summarizing and disseminating the results of research on the effectiveness of the early pediatric dental home. As purported by Nowak and Casamassimo, "a major obstacle in validating the dental home concept and early dental intervention and altering the antiquated view of when a child first needs to see a dentist is the lack of data, with few sources of nonemergent prevention available for study."^{11, p124} This article reviews current literature focused on effectiveness of early pediatric dental homes using a scoping review methodology, with the intent of informing future programming, policy, and initiatives that seek to improve uptake of dental homes by age one.

A scoping literature review seeks to "scope" and map the breadth of literature that underpins a research area or field of interest.^{12,13} Scoping reviews are undertaken for various purposes, which include creating a summation of research findings through which compiled data can be disseminated to policy makers, practitioners, and consumers, and identifying gaps in existing literature.¹² Though a scoping review is distinct from a systematic review in that the scoping review focuses on a broad examination of existing literature without presenting a robust analysis of the evidence, it "takes the process of dissemination one step further by drawing conclusions from existing literature regarding the overall state of research activity."^{12, p21}

Succinctly, by summarizing and disseminating a review of literature on early pediatric dental homes for infants and toddlers, the authors seek to inform future research, policy, and action to improve early pediatric dental care in Canada. To fulfill this purpose, this scoping review focuses on research that addresses the following question: "What is the effectiveness of early pediatric dental homes?"

METHODS

A literature search was undertaken using MEDLINE-Ovid, PubMed, CINAHL, Embase, Cochrane Database of Systematic Review (CDSR), Scopus, and BioMed Central databases. Databases were searched using the following algorithm (dental home* or dental homes).mp.), and truncations were adapted for the various databases as shown in Table 1. Database searches were conducted in consultation with a health sciences librarian who recommended not placing any limits on the preliminary search strategy because of the relatively limited number of articles matching the search criteria of dental home or dental homes. Searches were conducted up to and including April 2016. While no date limits were placed on the search strategy, the search yielded articles published between January 1977 and February 2016.

A summary of the search and citation retrieval process is presented in Figure 1. In total, 232 non-duplicate citations were identified. To facilitate identification of potentially relevant citations, inclusion and exclusion criteria based

Table 1. Search strategy and results

Database	Number of citations
MEDLINE-Ovid	146 (2 duplicates)
PubMed	138
CINAHL	80
Embase	120
Cochrane DSR	0
Scopus	165
BioMed Central	18
TOTAL	667

Academy of Pediatric Dentistry (AAPD) defines the dental home as "the ongoing relationship between the dentist and the patient, inclusive of all aspects of oral health care delivered in a comprehensive, continuously accessible, and family-centered way. The dental home should be established no later than 12 months of age."^{7, p12} The AAPD operational definition of the dental home has been adapted in contemporary literature to include both physical spaces where a child can access routine oral health care and a broader, more inclusive model of care in which dental and other health care professionals deliver preventive care through telehealth and community-based sites.⁷⁻¹⁰ However, despite these variations, the dental home concept is inextricably connected to commencement of oral health care by a child's first birthday and a philosophy of care that seeks to improve routine access through a client/

on the research question were developed prior to abstract review. Inclusion criteria were study population (preschool children or preschool programming such as Head Start or Early Head Start initiatives) and a focus on clinical, behavioural or cost effectiveness of early pediatric dental homes. Non-human studies were excluded from the review.

The authors assessed eligibility of titles and abstracts. When an abstract was not available, the full article was reviewed. After preliminary screening of titles and abstracts, 12 potentially eligible citations were considered for full article review. Two additional citations were obtained for full review by hand searching reference sections from 2 book chapters that were included in the preliminary database search. All 14 potentially eligible citations were retrieved and assessed based on inclusion and exclusion criteria. Seven of the fourteen citations were removed following full article review because they did not fit the inclusion criteria. Seven articles were included in the final scoping review. Literature synthesis was completed by the first author and was subsequently verified by the co-author prior to abstraction into 2 data tables corresponding to primary study or systematic review (Tables 2 and 3). Quality assessment based on level of evidence was not performed, in keeping with the nature of a scoping review.

RESULTS AND DISCUSSION

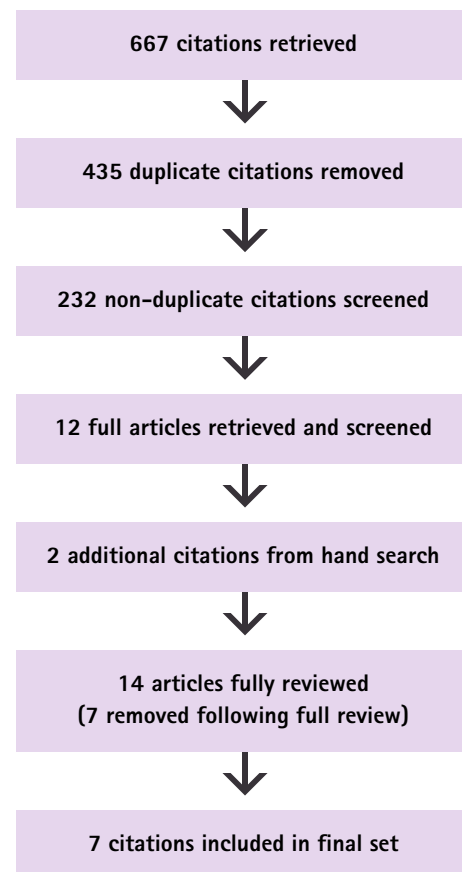
Six primary studies and one systematic review were included in the final data set and are presented in Tables 2 and 3. These data extraction tables identify author, study design, population and outcomes, as well as conclusions. Additionally, the second column in Tables 2 and 3 indicates which outcome measure or measures were considered in each study. Within these evaluation parameters, there is significant heterogeneity in study design, sampling strategy, methodological approach, and outcome variables used to assess effectiveness of early pediatric dental homes. The summary of evidence based on study outcomes reflects these incongruities.

Clinical parameters

Clinical effectiveness of the early pediatric dental home has most frequently been measured using decay, missing or filled teeth (dmft) or decay, missing or filled surfaces (dmfs) indices related to decay experience. Two cross-sectional survey studies of Head Start ($n = 115$) and Medicaid ($n = 132$) preschool-aged children independently reported that children who had an established dental home had statistically significant lower caries experience.^{14,15} This trend remained consistent in both univariate and multivariate models where Kierce et al. applied covariate adjustments for age, gender, daily servings of juice, age at first dental appointment, and presence of biofilm and gingivitis (OR = 0.10, 95% CI = 0.02, 0.40).¹⁵ Likewise, Wagner and Heinrich-Weltzin reported that an interdisciplinary oral health program in Germany, employing oral health care providers as well as allied health practitioners

(midwives, social workers, and nurses), was effective in reducing early childhood caries prevalence.¹⁶ The children who participated in the oral health program ($n = 174$) were recalled for continuous oral health care from birth to 5 years of age and had significantly lower caries prevalence and experience (10.9%, 0.2 ± 0.7 d_{3-4} mft) (d_{3-4} = dentinal caries) than children in a matched control group ($n = 115$; 57.4%, 2.9 ± 3.8 d_{3-4} mft) ($p < 0.05$). These findings diverge from those reported by Biel et al., (as presented in Bhaskar et al. [2014]), who employed a retrospective cohort design to match Medicaid claims files with kindergarten state dental surveillance data ($n = 11,394$).¹⁷ Using multivariate modelling, Biel et al. found that children who had their first dental visit before 24 months and children who had a first visit between 24 and 36 months had similar clinical caries status. These authors also found that children who had their first dental visit before 24 months had poorer clinical disease status (higher dmft) compared to children who had a first visit between 37 and 60 months of age (as reported in Bhaskar et al. [2014]). Bhaskar et al. suggest that these findings may reflect a problem-driven pattern of dental care seeking, in which early dental visits in the under-24-month cohort may be the result of early presentation of caries and consequently the preventive value of early pediatric care is somewhat masked.¹⁷

Figure 1. Search and retrieval process flow chart



Beyond caries experience, Kierce et al. also considered the presence of biofilm and gingivitis as clinical variables to code the child's dental status using adapted guidelines from the World Health Organization's (WHO) Basic Model of Oral Health Surveys. They found that a greater percentage of preschool-aged children with no dental home presented with biofilm (96.8%) and gingivitis (71%) compared to children with an established dental home (79.2% and 44.6%, respectively) ($p < 0.05$). Clinicians who collected the data were calibrated prior to the beginning of the study.¹⁵ However, a methodological limitation is that the study does not clearly state how the WHO model was adapted to measure gingivitis and biofilm, thus making it difficult to extrapolate and compare their findings to other related studies.

Behavioural factors

Current research has also assessed the effectiveness of early pediatric dental homes based on behavioural factors. Not only did Kierce et al. report that Medicaid-enrolled preschool children with a dental home had lower prevalence of caries, but the authors also found reduced cariogenic feeding practices in the dental home group.¹⁵ This included lower frequency of consumed juice and soda, fewer sticky snacks, decreased nocturnal sippy cup feeding with milk or juice, and earlier bottle-fed weaning ($p < 0.05$), which the authors speculated may have been related to early anticipatory guidance and nutritional counseling implemented through the early dental home.¹⁵ These results are encouraging, but the generalizability of these outcomes would be enhanced by future research employing larger samples to increase statistical power to corroborate the association between decreased cariogenic feeding and an established dental home as found in this cross-sectional study.

Establishment of an early pediatric dental home also appears to be effective in improving utilization of oral health care services over the long term. For example, Savage et al. found that children who had at least one preventive dental visit by age one were more likely to have future preventive dental visits compared to children whose first dental visit was in later preschool years.¹⁸ Improved preventive dental care utilization is congruent with the findings of Grembowski and Milgrom¹⁹ and Wagner and Heinrich-Weltzien¹⁶, in which early access to dental care was promoted through community-based programming that linked care to public health programs, such as Washington's ABCD program and a communal visiting newborn service (CVNS) in Germany. In the latter study, early establishment of continual dental care (i.e., through a dental home model) improved uptake of fluoride varnish as 100% of children in the program received fluoride varnish compared to 16.3% in the control group, and the number of applications was also significantly higher (5.8 ± 2.7 versus 1.2 ± 0.5).¹⁶ This outcome is of particular significance for children who are at a high risk of early childhood caries.

Cost effectiveness

Treatment costs are a third parameter that have been studied to evaluate the effectiveness of the early pediatric dental home. Cost effectiveness has been examined using both privately insured and publicly insured children. Through a retrospective cohort study, Kolstad et al. performed a cost-benefit analysis of the age one dental visit for privately insured children ($n = 94\,574$) by comparing the age of first dental visit and the average cost of care per year from ages 1 to 5.²⁰ While only 1% of the sample had received dental care by age one, the annual costs for children who had a first-year dental visit were significantly less than for children whose first dental exam was in later preschool years. The positive effect of early dental homes on dental expenditures was also evident among publicly funded Medicaid-enrolled children. Savage et al. found a significant positive correlation between age of first dental visit and dental expenditure ($n = 9204$ children between 0 and 5 years of age).¹⁸ Cost effectiveness of early dental homes was also validated by Nowak et al. who compared 2 groups: late starters, defined as first dental visit between the ages of 4 and 8 years ($n = 25\,492$), and early starters, defined as children whose had their first visit under 4 years of age ($n = 17\,040$). Results indicated that there were an average of 3.58 more dental procedures performed on the late starters at a cost of \$360 more per child over 8 years of follow-up.²¹ The cost effectiveness of public health programs that support establishment of early dental homes was studied by Sen et al. (see Bhaskar et al., 2014) based on claims from Alabama's Children's Health Insurance Program (CHIP) and preventive procedure codes of 36 805 enrollees.¹⁷ Their findings showed that preventive visits were associated with a reduction in non-preventive visits and thus lower non-preventive expenditures. However, the cost savings associated with reduced non-preventive visits appear to be offset by the cost of early intervention procedures since no reduction in overall dental expenditures was evident.¹⁷ This outcome appears to contradict previously mentioned studies, but it should be noted that this study only considered cost of care and did not evaluate the comparative oral health outcomes of the various cohorts.

Recommendations arising from the scoping review

Research on the effectiveness of early pediatric dental homes has produced mixed results because of methodological limitations and study heterogeneity. Nonetheless, the current body of evidence generally supports the clinical, behavioural, and cost effectiveness of the early pediatric dental home model.

One purpose of a scoping review is to highlight gaps in the literature. From this perspective, while research has begun to create an evidence base to support effectiveness of early pediatric oral health care, additional longitudinal research that specifically focuses on effectiveness of establishing a dental home by age one is merited.

Table 2. Effectiveness of early pediatric dental homes: Primary research studies

Author and country	Effectiveness parameter	Study design	Study population	Study outcomes	Conclusions
Chi et al. (2013) ¹⁴ United States (Washington)	Clinical	Cross-sectional study	3- to 5-year-old Head Start-enrolled children (n = 115)	Head Start children who had a dental home had lower dmfs scores. The dmfs prevalence ratio was 0.61 (CI 95%: 0.42, 0.89; $P < 0.01$).	Findings suggest an association between children having a dental home and lower caries rates. The data do not reflect clinical outcomes relative to the age at which the dental home was established.
Grembowski & Milgrom (2000) ¹⁹ United States (Washington)	Behavioural	Post-test-only comparison group design	13- to 36-month-old children enrolled in Washington's ABCD program study (n = 465); n = 228 ABCD participants n = 237 comparison group (Medicaid-enrolled, not in ABCD)	Children who were enrolled in the ABCD dental program had an increased use of services, particularly preventive services, compared to non-enrolled Medicaid children (OR = 5.50, CI 95%: 3.45,8.79).	ABCD program increased access to dental care among Medicaid preschool children.
Kierce et al. (2016) ¹⁵ United States (Manchester, NH)	Clinical Behavioural	Cross-sectional study	2- to 5-year-old Medicaid-enrolled children (n = 132)	Children with a dental home had lower rates of biofilm and gingivitis ($p < 0.05$) and lower dmft scores (1.8 vs 5.19, $p < 0.05$) compared to children with no dental home. Having a dental home had a strong protective effect on caries and dmft index (OR = 0.22; 57.4% vs 22.6% had no decay experience, $p < 0.05$). Children with no dental home consumed more juice and soda, ate more sticky snacks, were more likely to go to bed with a sippy cup containing milk or juice, and were bottle fed longer ($p < 0.05$).	Establishment of an early dental home may decrease ECC prevalence and reduce risk factors related to cariogenic feeding practices.
Kolstad et al. (2015) ²⁰ United States (California, New York, Pennsylvania, Texas)	Cost	Cohort study	≤5-year-old children with private dental insurance (n = 94 574)	The annual cost per child per year of coverage was significantly less for children who had their first exam by age one; however, the difference in total average cost per child was not statistically significant.	There appears to be an annual cost benefit in establishing a dental home by age one for privately insured children.
Nowak et al. (2014) ²¹ United States (Tennessee)	Clinical Cost	Cohort study	≤8-year-old children from lower SES (n = 42 532); cohort groups: early starters <4 years old, late starters >4 years old	There were 3.58 more dental procedures performed on late starters compared to early starters (CI 95%: 2.80, 4.46; $p < 0.001$). Children whose first dental visit was after age 4 had a total dental cost (restorative and extractions) of \$360.13 more than children who had their first visit before 4 years of age, $p < 0.001$.	Children seen for dental care earlier in life had fewer restorative procedures and lower treatment costs compared to children who did not have dental care in preschool years.

Table 2 continued. Effectiveness of early pediatric dental homes: Primary research studies

Author and country	Effectiveness parameter	Study design	Study population	Study outcomes	Conclusions
Wagner & Heinrich-Weltzien (2016) ¹⁶ Germany (Jena, Thuringia)	Clinical Behavioural	Cohort study	Birth cohort with assessment at mean age 5.2 years Prevention group (PG) n = 174* Control group (CG) n = 115 *PG participated in early oral health program	Children in PG had lower caries prevalence (10.9%, 0.2±0.07 d ₃₋₄ ,mft) compared to children in the CG (57.4%, 2.9±3.8 d ₃₋₄ ,mft) (p < 0.05), as well as lower caries experience (17.2%, 0.3±0.8 d ₁₋₄ ,mft vs 62.4%, 4.2±4.5 d ₁₋₄ ,mft (p < 0.001). All carious lesions were restored in the PG compared to 47.3% in the CG. The average number of dental visits in the PG was 10.5±3.4 compared to 3.3±1.4 in the CG and all children (100%) in PG received fluoride varnish (average number of applications = 5.8±2.7), compared to 16.3% of CG (1.2±0.5 applications).	Early oral health program, including early establishment of dental home during the first year of life, was effective in reducing ECC risk in preschool children. Establishment of an early dental home may be associated with improved preventive dental care utilization, including use of preventive therapeutics (e.g., fluoride varnish).

Table 3. Effectiveness of early pediatric dental homes: Systematic review

Citation	Effectiveness parameter	Study design	Study population	Study outcomes	Conclusions
Bhaskar et al. (2014) ¹⁷ United States	Clinical Behavioural Cost	Systematic review (4 retrospective cohort studies)	Review undertaken to analyse effectiveness of early preventive dental visits on oral health outcomes	Beil et al. (2013) found no benefit of early preventive dental visits in clinical dental caries levels in Medicaid-enrolled kindergarten children. The other 3 studies found mixed support for an association between early preventive dental visits and more preventive and fewer non-preventive visits, as well as lower non-preventive dental expenditures. Selection bias and seeking dental care when problems arise may have affected results.	Early preventive dental visits may be associated with reduced restorative dental care visits and related expenditures; however, evidence base is limited. The clinical benefits of early visits before age 3 are most evident in high-risk children and those with existing dental caries. Early visits may reduce restorative care and related expenditures.

Additionally, the scoping review did not identify any articles that were conducted within a Canadian context. As external validity and generalizability of the current literature may be influenced by factors such as policy and culture, research in a Canadian context needs to be undertaken. It would also be beneficial if studies in the Canadian context included research on cohorts most impacted by early childhood caries, including

children in Aboriginal, lower socioeconomic status, and rural communities.

A second purpose of a scoping review is to summarize research for dissemination to stakeholders. Accordingly, oral health care practitioners should be aware that current evidence, even with significant variation in study design and methodological limitations, predominantly substantiates effectiveness of early pediatric dental homes

for infants and toddlers. Support for greater implementation of Canadian practice guidelines and policies with respect to early pediatric oral health care appears to be warranted, but it is also evident that evidence-based research to further validate the efficacy of early access to infant and toddler dental homes should continue to be conducted.

CONCLUSION

Based on the findings of this review, the early pediatric dental home is a promising model to improve pediatric oral health based on clinical, behavioural, and cost effectiveness outcome measures. However, gaps in the literature and heterogeneity in study methodology limit the potential to conduct rigorous cross-comparison of results to fully establish the potential effectiveness of the age one dental home. Research in a Canadian context is important to improve support for and implementation of age one dental visit practice guidelines.

CONFLICT OF INTEREST

The authors have declared no conflicts of interest.

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Therapeutic oral rinsing with non-commercially available products: Position paper and statement from the Canadian Dental Hygienists Association, part 2

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ABSTRACT

Background: To control biofilm and prevent gingival inflammation and disease, mechanical methods of oral hygiene can be complemented with a therapeutic oral rinse. Much research has been conducted on commercially available oral rinse products, and there is also considerable research being conducted on formulations not yet available to the Canadian market, of which many are natural or herbal products. This comprehensive review focuses on non-commercially available therapeutic oral rinse products and is the second part of a 2-part position paper and statement that replaces the 2006 Canadian Dental Hygienists Association position paper on oral rinsing. **Methods:** Based on a PICO question, a literature search using MEDLINE-PubMed, Cochrane Central Register of Controlled Trials, and the Cumulative Index to Nursing and Allied Health Literature (CINAHL) databases was conducted in stages. The search was limited to English-language articles published between 2006 and 2016. Articles were selected if they focused on predetermined variables, and each article was reviewed utilizing an analysis table to identify the study parameters. **Results:** The search returned 452 studies, and initial screening of titles and abstracts identified 20 papers for full review. An additional 25 articles identified through hand searching resulted in 45 full-text articles retrieved. Of these, 26 studies were included in the final review. Studies were categorized and reviewed according to a research-stage taxonomy. **Discussion and Conclusions:** Because no long-term (≥ 6 months) clinical trials have been conducted on any non-commercial oral rinse formulations, statements about these rinse products' effectiveness or safety cannot be made at this time. Several products did show efficacy in lower level research, indicating that further study of these specific formulations may be warranted. There is a need for more well-conducted studies using standardized research designs to produce findings that dental hygienists and other oral health professionals can use to guide their client recommendations for appropriate oral biofilm control.

RÉSUMÉ:

Contexte : Les rince-bouche thérapeutiques peuvent être un complément aux méthodes mécaniques d'hygiène buccale pour contrôler la formation de biofilm et prévenir l'inflammation et l'affection des gencives. Plusieurs recherches ont été effectuées sur les rince-bouche offerts en vente libre et il existe aussi de nombreuses études qui sont menées sur des formulations qui ne sont pas encore offertes sur le marché canadien, dont plusieurs sont des produits naturels ou à base d'herbes. Cette analyse approfondie est axée sur les rince-bouche thérapeutiques qui ne sont pas offerts sur le marché et représente la deuxième partie d'un exposé de position et d'une déclaration à 2 volets qui remplace l'exposé de position de 2006 de l'Association canadienne des hygiénistes dentaires sur le rinçage buccal. **Méthodes :** D'après une question PICO, une recherche documentaire a été effectuée en étapes à l'aide des bases de données de MEDLINE-PubMed, Cochrane Central Register of Controlled Trials, et le Cumulative Index to Nursing and Allied Health Literature (CINAHL). La recherche était limitée aux articles de langue anglaise publiés entre 2006 et 2016. Les articles étaient sélectionnés s'ils étaient axés sur des variables prédéterminées et chaque article a été examiné au moyen d'un tableau d'analyse pour cerner les paramètres de l'étude. **Résultats :** La recherche a produit 452 études et la vérification initiale des titres et des résumés a répertorié 20 articles pour examen complet. Grâce à une recherche manuelle, 25 articles supplémentaires ont été trouvés, ce qui a permis de repérer le texte intégral de 45 articles. Parmi ces articles, 26 études ont été ajoutées à l'examen final. Les études ont été classées et révisées en fonction de la taxonomie par phase de recherche. **Discussion et conclusions :** Comme aucun essai clinique à long terme (≥ 6 mois) n'a été effectué sur des formulations de rince-bouche non commerciaux, des déclarations sur l'efficacité ou la sécurité de ces rince-bouche ne peuvent être faites en ce moment. Lors des recherches à bas niveau, plusieurs produits ont fait preuve d'efficacité, démontrant que des études complémentaires sur ces formulations particulières pourraient être justifiées. Il est nécessaire d'effectuer d'autres études bien menées en utilisant des modèles de recherche standardisés pour produire des résultats qui permettront d'orienter les hygiénistes dentaires et autres professionnels de la santé buccodentaire lorsqu'ils formulent des recommandations aux clients pour le contrôle approprié du biofilm buccal.

CANADIAN DENTAL HYGIENISTS ASSOCIATION POSITION STATEMENT

Dental hygienists are encouraged to recommend a demonstrated effective and safe therapeutic oral rinse to their adult clients to complement home care routines for the reduction of plaque and gingival inflammation. Based on the research reviewed, there is no evidence from rigorous, long-term (≥ 6 months) studies to show that non-commercially available oral rinse formulations are as effective as commercially available prescription or over-the-counter oral rinses in reducing plaque and gingivitis. Consequently, dental hygienists should continue to recommend the use of commercially available oral rinse products that have been proven effective and safe, taking into account specific client needs, to promote optimal oral health.

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Key words: dental plaque, mouth rinse, mouthwash, oral antiseptic, oral biofilm, oral chemotherapeutic, oral hygiene, oral rinse

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BACKGROUND

It is recognized that people have persistent challenges in achieving satisfactory oral hygiene and controlling gingival inflammation through mechanical methods alone.^{1,2} Oral biofilm is the primary etiology for gingivitis, periodontitis, and caries and also contributes to halitosis and systemic well-being.³ Therapeutic oral rinsing has been advanced, most recently in the updated Canadian Dental Hygienists Association's (CDHA) position statement on oral rinsing, as an important component of home care routines to optimize oral hygiene.⁴ While research conclusively demonstrates the therapeutic effectiveness of some commercially available oral rinses,⁴ there are numerous formulations not yet commercially available that are in development and undergoing study. Many of these non-commercial formulations are made with synthetic products; others contain what are commonly referred to as “natural” compounds, which are of interest not only to Canadian dental hygienists and their clients, but also to those concerned with improving the oral health of vulnerable populations globally, who may be better able to access natural, locally derived products.⁵

This position paper, endorsed by CDHA, represents a comprehensive review of the research on non-commercially available oral rinse products currently in development. Commercially available over-the-counter and prescription oral therapeutic rinsing agents were reviewed in part 1 of the position paper.⁴ The findings of both reviews have been used to update CDHA's position statement on the use of home oral rinses as a preventive oral health strategy particularly as it relates to periodontal disease initiation and progression. The author of the 2006 CDHA position paper was contracted by CDHA to research and write the present position paper.

INTRODUCTION

While studies testing the efficacy and effectiveness of oral rinse agents have been extensively conducted, readers will note a wide variety of study designs and protocols, particularly with non-commercially available products, making the research difficult to compare and interpret, which can subsequently complicate evidence-based decision making in clinical practice. Oral rinse studies can be placed on a continuum from early- to late-stage research (Table 1), which was discussed in detail in part 1 of this review.⁴ New product formulations, often testing active ingredients before commercial products are developed, are typically initially studied using short-term in vitro and in

vivo studies and, if found to be effective, may proceed to longer term studies ultimately including home use clinical trials, which are more expensive and involve ethical considerations.⁶ If a formulation is found to lack efficacy in the early stages of research, it is unlikely to be effective in later stage trials; these trials are therefore unwarranted.⁶ There has been a call from some investigators in the field to apply a more standardized and systematic approach to therapeutic oral rinse studies.⁶

Many not yet commercially available oral rinse products undergoing testing are natural or herbal products and fall within the scope of traditional medicine, which is a field of health that has expanded globally both in developing and developed countries.⁵ With this expansion comes the need to examine the safety and efficacy of such products. Quality control is increasingly important to health authorities, researchers, and the public.^{5,7} There may be an inherent belief that these products are safe, consistently formulated, and offer benefits to one's health.⁵ As regulated health care providers, dental hygienists must maintain a critical eye as part of competent and ethical practice, and make client recommendations based on the best available research. According to the World Health Organization (WHO), the safety and efficacy data on herbal medicines are generally insufficient to support worldwide use, thus substantiating the need for well-conducted clinical trials to confirm the efficacy demonstrated in some early-stage research.⁷

This second part of the position paper aims to summarize, interpret, and make recommendations based on non-commercially available oral rinse research published in the last decade. This review is framed according to research design stages in order to situate products on an evidence continuum and clarify for dental hygienists and other readers the practical relevance of non-commercially available oral rinse products.^{4,6}

MATERIALS AND METHODS

Along with the author and CDHA staff, a committee was convened to oversee the development of the position paper and assist in defining the scope of the review. Committee members were selected based on their content and/or research expertise. Committee members and CDHA staff communicated with the author via teleconference throughout the review process.

The first step in the investigation was to develop a PICO question to guide the literature search and the writing of this review. The initial PICO question was limited to commercially available products:

Do healthy adults who have plaque or biofilm or gingivitis or early periodontitis [Population] who use home mouth rinse or mouthwash or oral rinse according to manufacturers' directions with a commercially available, non-prescription or prescription formulation as an adjunct to mechanical cleansing including toothbrushing alone or toothbrushing and flossing or interdental cleansing [Intervention] compared to not using oral rinse [Comparison] have improved plaque or biofilm or inflammation or gingivitis scores [Outcome]?

Because of the substantial quantity of research on non-commercially available products that emerged through the search, it was determined that a separate review would be undertaken to examine these products specifically. The PICO question was adjusted by removing the term "commercially available" in order to broaden the scope of the review. The literature search for both parts of the review was conducted simultaneously in stages from

January 4, 2016, to April 30, 2016, using the following electronic databases: MEDLINE-PubMed, Cochrane Central Register of Controlled Trials, and the Cumulative Index to Nursing and Allied Health Literature (CINAHL).

The initial part of the search focused on primary research studies and excluded reviews. The search was limited to articles written in English and published between 2006 (when the first CDHA position paper was released) and April 30, 2016. For the second part of the review, papers were selected for retrieval if they focused on:

- *Independent variables:* non-commercially available home oral rinsing product
- *Outcome variables:* impact on bacteria/plaque/biofilm, inflammation/gingivitis

The second phase involved a manual search of references from papers retrieved in the first phase. Systematic reviews, meta-analyses, reports, and grey literature were also hand searched to ensure that no original research meeting the inclusion criteria was missed in the initial review.

To ensure consistency and minimize researcher bias, the author reviewed each paper utilizing an analysis table to identify the study parameters, including the study authors/researchers, date of study publication, stage of research, proposed active ingredients, outcome measures and results (effect sizes; *p* values), and any other notes regarding the study.

Table 1. Stages of therapeutic oral rinse research^a

Stage	Classic design	Measured outcomes	Comments
Stage 1	In vitro kill ability; 8-hour in vivo substantivity	Bacterial vitality (vital fluorescence technique), minimal inhibitory concentrations (MIC), colony forming units (CFU)	Measures bactericidal activity and plaque inhibitory effects in cleaned surfaces after single rinse over 8± hours; other oral hygiene suspended; MIC: the lowest concentration of a formulation that will inhibit bacterial growth after a period of incubation; crossover designs suitable
Stage 2	4-day plaque regrowth in vivo	Plaque indices, gravimetry, planimetry	Plaque inhibitory effects in cleaned surfaces while rinsing daily (1x to 3x/day); other oral hygiene suspended; crossover designs suitable
Stage 3	21-day experimental gingivitis study in vivo	Plaque and gingivitis indices, bleeding indices	Plaque and gingivitis inhibitory effects in cleaned surfaces while rinsing daily (1x to 3x/day); other oral hygiene suspended; shorter than 21 days insufficient time for gingivitis to occur in all study subjects; should use parallel groups to minimize number of times experiencing gingivitis
Stage 4	Home use studies; long term; in vivo; requirements for safety records	Plaque (i.e., plaque index [PI]) and gingivitis indices (i.e., modified gingival Index [MGI]); bleeding indices (i.e., bleeding index [BI]); side effects; favourability	Typically 6 months; plaque and gingivitis inhibitory effectiveness in real-life conditions while rinsing daily (1x to 3x) and while using other mechanical methods; parallel groups

^aSource: Asadoorian J. Therapeutic oral rinsing with commercially available products: Position paper and statement from the Canadian Dental Hygienists Association. *Can J Dent Hyg.* 2016;50(3):126–39.

RESULTS

The initial electronic search of the databases returned 452 research papers (relevant to either part of the review), of which 20 articles on non-commercially available products were selected for full review. An additional 25 studies were identified through the hand search, which resulted in 45 full-text articles retrieved. Of these, 26 studies were found to:

- focus on the research question
- be original research
- include a non-commercially available oral rinse formulation
- include a relevant outcome measure
- be available in English

and were, thus, included in the review. Studies were excluded if they focused on a commercially available product, lacked a suitable study population, comparison group or outcome measure. As with the first part of the position paper, the non-commercially available oral rinse studies were reviewed and presented within the study stages framework (Table 1) and were summarized according to this taxonomy.^{4,6} The 2006 CDHA position paper did not consider non-commercial formulations.

Non-commercially available products

Stage 1 summary

Stage 1 studies are primarily aimed at determining the efficacy of a formulation under controlled laboratory conditions and, if so, for how long and if the outcomes sufficiently warrant studying the formulation in higher stage research designs. In addition, some of these studies examine new methods of preventing biofilm formation at different stages of the disease process, such as adherence and co-aggregation, without having actual bactericidal activity.

Five stage 1 studies examining a variety of experimental, non-commercial rinse formulations were located and included minimum inhibitory concentrations (MIC), plaque vitality, adherence, bacterial counts, and colony forming units (CFU) as the outcome measures. These experimental products consisted of a wide variety of primarily natural compounds, and almost all of these studies included chlorhexidine gluconate (CHG) as a positive control rinse, although some used an established commercially available essential oil (EO) rinse or other comparison group. Several studies included negative controls along with or without a positive control group. The research design parameters, including the formulation and outcome measures, of these stage 1 studies varied widely.

An early-stage 2012 study was conducted on a 2% taurolidine rinse, which is a chemical antimicrobial pharmaceutical product with limited application and is not currently used as an oral rinse. This 24-hour study measured the effects of the test rinse compared to 0.2% CHG and a placebo on the vitality of the plaque flora under the fluorescence microscope (VF%). The VF was reduced with the CHG rinse, which demonstrated statistically significantly better outcomes than the placebo ($p < 0.001$)

and the taurolidine rinse ($p < 0.05$). However, the taurolidine also reduced the VF significantly when compared to the control rinse ($p < 0.0001$).⁸

A 2013 in situ study evaluated the effect of 3 edible oils (safflower, linseed, and olive oil) compared to CHG (0.2%). The study required participants to hold these oils intraorally for 10 minutes to simulate the practice of “oil pulling,” a controversial practice of current interest as an oral hygiene activity. The CHG had considerable effects on the adherent bacteria, whereas none of the oils had a significant effect ($p > 0.05$). Similarly, the CHG statistically significantly reduced quantities of CFU while the oil rinses had no effect. Overall, no reduction of the microbial colonization of the enamel was observed with the oil groups.⁹

Chitosan is a naturally occurring and abundant polysaccharide that has been used in diverse industries. In a 2014 laboratory study, a 0.4% chitosan-based rinse was compared to EO and CHG rinses (0% not reported) with regard to the MIC of 5 microorganisms. The MIC was determined by observation of the lowest concentration of rinse inhibiting visible bacterial growth. The MIC of the chitosan rinse was comparable to the EO rinse, whereas the chitosan rinse resulted in even lower MIC values than the CHG rinse. The chitosan rinse was also significantly superior ($p < 0.05$) in preventing adherence of microorganisms compared to the EO and the CHG. Further, the chitosan had significantly better ($p < 0.05$) anti-biofilm activity compared to the 2 positive controls. The researchers concluded that chitosan, although likely not compatible within other formulations, has potential as a therapeutic oral rinse.¹⁰

In the Middle East and Africa, the *Salvadora persica* plant, a small tree growing wild, is most commonly used as a wooden dental cleaner and has been used for centuries as an oral hygiene aid. A recent study compared a persica-based mouthwash to 0.2% CHG, a commercially available EO mouthwash, and a negative control. Plaque samples were incubated and the zone of bacterial inhibition (ZOI) was measured along with CFU. Bacterial counts were reduced in all test groups, but the CHG performed the best followed by the EO and then the persica-based rinse. The difference between CHG and EO was not significant ($p > 0.05$), but CHG was found to be significantly better ($p < 0.05$) when compared to the persica group. All 3 test groups were significantly superior ($p < 0.05$) to the negative control. For the ZOI test, there was no demonstrated inhibition of bacterial growth by the EO, persica, and placebo, whereas the CHG prevented the growth of bacteria. This discrepancy between the CFU and ZOI outcomes was explained by the researchers as follows: the ZOI was measured 24 hours after the last exposure to the rinses and the products were presumed to have lost their effectiveness.¹¹

Although only marginally applicable to this review, an earlier but unique study examined a MPC-polymer solution

in comparison with a negative control to determine its effect on streptococcal adherence in vitro (initial colonizers) and fusobacterial adherence to streptococcal biofilm in vitro (co-adhesion). Results showed that the MPC-polymer treatment significantly ($p < 0.05$) inhibited the adherence of *Streptococcus mutans* to saliva-coated hydroxyapatite, and the MPC-polymer treatment also significantly ($p < 0.05$) inhibited the co-adherence of *Fusobacterium nucleatum* to both saliva-treated streptococcal biofilms.¹²

Stage 2 summary

Five stage 2 plaque regrowth studies were reviewed and all, with one exception, were either a 4- or 5-day model, of which the former is considered the classic timeframe.⁶ Plaque regrowth study designs examine the degree to which a product suppresses plaque on cleaned surfaces in vivo in the absence of other oral hygiene methods.⁶ An additional 24-hour study was included in this section although it was of shorter duration, because it used a similar protocol. The studies compared various non-commercial formulations to CHG and in some cases used other commercial products for comparison. Test formulations in these studies included a polyherbal, two propolis (natural bee) products, pomegranate extract, and an aloe vera extract-based product.

Triphala, meaning “three fruits,” is a traditional herbal formulation composed of 3 native fruits to India: amalaki (*Emblica officinalis*), bibhitaki (*Terminalia bellerica*), and haritaki (*Terminalia chebula*). A crossover study was designed to compare de novo plaque formation 24 hours after the use of triphala in comparison to HiOra® (a commercially available herbal rinse), CHG (% not provided), and a CPC rinse (Colgate® Plax®; % not provided), but no negative control group. The study demonstrated no statistically significant difference in plaque suppression between the groups, with the exception of the CPC rinse, which was significantly outperformed by all of the other rinses ($p < 0.05$). The study was limited by the fact that concentrations of positive controls were not provided, there was no negative control group included for comparison, the dosages were not consistent across groups, and rinsing was carried out for an unconventionally long period (3 minutes).¹³

An alternative branch of health care referred to as “apitherapy” offers unconventional treatments for various health conditions and illnesses using honey and other bee products.¹⁴ A novel 2012 4-day plaque regrowth study was designed to examine a honey rinse compared to 0.2% CHG and a placebo with regard to MIC and inhibition of several strains of micro-organisms, but the study did not measure actual plaque scores, which is customary in this design.⁶ Although the MIC was lowest in the CHG group, the honey rinse did inhibit growth of all 6 bacterial test species, while the placebo rinse did not.¹⁴ A 2011 5-day plaque regrowth study compared a propolis-based rinse with 0.2% CHG and a placebo and demonstrated the CHG rinse to significantly

reduce plaque ($p < 0.05$) compared to both the propolis-based rinse and the placebo. Although the propolis rinse was better at suppressing plaque than the placebo, the results were not statistically significant.¹⁵

A 4-day plaque regrowth study compared a pomegranate extract-based rinse to 0.2% CHG and a placebo. Both the pomegranate and CHG rinses significantly reduced ($p < 0.05$) plaque and bacteria as compared to placebo; however, no significant difference was demonstrated between the 2 groups.¹⁶ More recently a large ($n = 300$) 4-day plaque regrowth study comparing an aloe vera extract rinse to 0.2% CHG and a placebo rinse showed both the test group and positive control to significantly ($p < 0.05$) reduce plaque compared to the placebo, while no statistically significant difference was demonstrated between them.¹⁷

Stage 3 summary

Stage 3 experimental gingivitis studies are designed to measure the ability of a test rinse to inhibit plaque and suppress gingival inflammation in vivo over a 3-week period with other oral hygiene suspended. Five non-commercial stage 3 experimental gingivitis studies of sodium hypochlorite, turmeric extract, propolis, green tea, and polyherbal rinse products were included in the review and, overall, the studies showed mixed results. Of these suspended oral hygiene in vivo studies, 3 were 21 days in duration and were therefore conducive to analysing gingival inflammation suppression.

A 21-day study evaluating the twice daily, 60-second use of 0.05% sodium hypochlorite (household bleach) in comparison to a negative control rinse with all other oral hygiene methods suspended demonstrated statistically significant ($p < 0.05$) suppression of plaque, gingival inflammation, and bleeding in the test group as compared to the control. However, significantly higher levels ($p < 0.05$) of extrinsic brown tooth stain appeared (100%) in the test subjects versus the control group (35%). In addition, a (mostly) tolerable bleach taste, red tongue, and burning sensation were reported side effects in the experimental group.¹⁸

A 21-day equivalence study of a 2% propolis-based rinse compared to a positive control rinse containing 0.05% NaF plus 0.05% CPC in 21 pairs of twins demonstrated no difference ($p > 0.05$) between the groups in suppressing gingival inflammatory values through papillary bleeding scores and standard digital imaging of the gingival tissue, referred to as a G parameter.¹⁹ No negative control group was included in the study for comparison, and plaque suppression was not evaluated.

A larger ($n = 100$) 21-day study that included adults ages 25 to 35 using a turmeric extract rinse in comparison to CHG (0.2%) demonstrated significant reductions ($p < 0.05$) in plaque, gingival inflammation, and microbial counts for both groups when compared to baseline measures. When comparing the CHG rinse to the turmeric extract group,

the CHG was found to be statistically significantly superior in reducing plaque scores compared to the turmeric rinse ($p < 0.05$). However, there was no significant difference between groups in inflammation scores or microbial counts. The study lacked a negative control group.²⁰

A small ($n = 30$), 1-week study investigating green tea catechin rinse (0.25%), the major component of green tea extract, compared to 0.12% CHG rinse was conducted with young adults (ages 18 to 25 years). Although the study was short and did not include an assessment of the gingiva, it was included in this section of the review because the protocol was similar to 21-day experimental gingivitis studies; participants rinsed 2 times daily while all other oral hygiene methods were suspended. The study demonstrated no statistically significant difference in plaque reductions between the 2 groups over the 1-week period ($p > 0.05$). It should also be noted that study subjects rinsed for a full minute and there was no negative control group included.²¹

Although only 2 weeks long, an experimental gingivitis study compared a polyherbal non-commercial rinse (HM-302) containing traditional herbal medicines *Centella asiatica*, *Echinacea purpurea*, and *Sambucus nigra* to a CPC rinse (% not reported), EO rinse, and a negative placebo control (15 mL each). This combination of herbal components was selected following pretesting that demonstrated this specific mixture to have the best anti-inflammatory profile. While all rinses resulted in increased plaque scores, only the placebo ($p < 0.008$) and EO ($p < 0.04$) rinses were found to be significantly increased from baseline measures, albeit only marginally in the case of the EO. While the study was not long enough to make definitive conclusions about inflammatory findings, the results showed only the placebo rinse had a statistically significant increase in inflammation ($p < 0.05$) compared to baseline. The herbal test rinse group had a very small improvement in inflammation scores from baseline, but this was not shown to be significant ($p = 0.66$).²²

Stage 4 summary

Positive outcomes in home use long-term (≥ 6 month) clinical trials are considered to be the hallmark for demonstrating effectiveness and safety in real-life conditions.^{4,23,24} In non-commercial home use clinical trials, the majority of studies were short term (1 week to 1 month), which in many cases precludes measurement of visible changes to gingiva, although gingival parameters were often included as outcome measures. These short-term home use studies are differentiated from stage 3 experimental gingivitis studies in that home use trials do not suspend other oral hygiene methods and are, therefore, aimed at measuring effectiveness under more realistic conditions. At the time of this review, no long-term (≥ 6 month) home use clinical trials of non-commercially available oral rinse products were found, although there was one 3-month home use study, which was reviewed.

Eleven home use studies testing non-commercial

formulations were located, many of which focused on derivatives of natural compounds such as essential oils from plants, teas, neem (*Azadirachta indica*), cinnamon, algae (*Enteromorpha linza*), witch-hazel (*Hammelis virginiana*), while others involved several products in combination referred to as polyherbals. In most cases, these short-term home use studies compared the experimental formulation to CHG, commercially available EO and/or placebo. Virtually all of these studies demonstrated plaque reductions in test groups compared to baseline.

A short-term early study was conducted with a rinse made from the essential oil of leaves from a shrub native to northeast Brazil called *Lippia sidoides*, which is more commonly known as pepper-rosmarin. Although the study was only 1 week long, it was included in this section of the review because participants continued to use their usual home care aids in addition to the test or positive control rinse. This study compared the test formulation to 0.12% CHG and measured both plaque and gingivitis, although measurements at 1 week is considerably early to detect a gingival response in many subjects. The study found a significant decrease ($p < 0.001$) in plaque and gingivitis from baseline for both groups and, while there was no difference found between groups, 44% of the test rinse group experienced a mild burning sensation, whereas only 14% of the CHG group reported such a side effect. The study did not include a negative control group.²⁵

A 6-week home use study examined a rinse derived from *Enteromorpha linza* extract, a green algae found on European, Mediterranean, South Korean, and Japanese coastlines, which attaches to solid bedrock, mobile boulders, mud banks or sandy shores where it rapidly colonizes. The test formulation was compared to a commercially available EO rinse and measured plaque, gingival inflammation, and bleeding. The study found statistically significant reductions from baseline in both groups ($p < 0.05$). No difference was reported between the groups, but the researchers did not include this data in the report. The study was limited in that it lacked a sufficient number of participants to include a negative control group and the dose of the positive control rinse was half (10 mL) of what is recommended by the manufacturer.²⁶ In addition, there was a disproportionate number of tobacco smokers in the positive control group (33%) as compared to the experimental group (17%), which was not controlled for. Despite the unlikelihood of a home oral rinse penetrating into the sulcus or pocket, the study also examined the reduction of specific periodontal pathogens (*Porphyromonas gingivalis* and *Prevotella intermedia*) within “the deepest pockets” in each quadrant of study subjects. The reductions found in both groups were statistically significant.²⁷

Another home use study examined a neem-based (*Azadirachta indica*) mouthrinse, which is derived from the leaves of a tree indigenous to India and considered to have

medicinal properties. The test rinse (0.19%) was compared to 0.2% CHG and a negative control, all using a 2 times daily regimen with 15 mL for 1 minute over 21 days. Both the test and positive control groups significantly reduced ($p < 0.05$) plaque and gingivitis measures. The study demonstrated no difference with the negative control group as compared to baseline or between the groups.²⁸

A small study conducted with young adults also examined a rinse derived from neem stick powder (2%) (*A indica*) to tea leaves (0.5%) (*Camellia sinensis*) and a positive control, CHG (0.2%). Over both a 2- (all groups) and 3-week period (neem and tea only), anti-plaque effectiveness was observed from baseline in all groups ($p < 0.05$), with the highest reductions observed in the tea group. The CHG group was only tested over 2 weeks as planned a priori because of anticipated side effects, which precludes comparisons regarding inflammation given that it can take a full 3 weeks to observe such effects.⁶ While all 3 groups reduced inflammation over 2 weeks, there was no significant difference between the groups ($p > 0.05$). The study also lacked a negative control group.²⁹

A small study conducted in 2015 also included a rinse made from green tea leaves (*C sinensis*) (0.5%) compared to CHG (% not reported), and demonstrated significant improvements ($p < 0.05$) in both plaque and gingival outcome measures in both the test and positive control groups compared to baseline over 1 month. No significant difference between groups was observed. The green tea rinse resulted in a statistically significant decrease in bleeding index compared to the chlorhexidine group. The study did not include a negative control, and the rinsing time, rinsing amount, and concentration (positive control only) were not reported.³⁰

Cinnamon is derived from the inner bark of several species of trees largely grown and cultivated in South Asia. Research supporting cinnamon as a medicinal ingredient is limited. A recent 30-day study was conducted with young adults comparing a cinnamon extract rinse to 0.2% CHG and a negative control rinse. Both the test and positive control groups showed significant reductions ($p < 0.05$) in plaque and gingival inflammation compared to baseline and to the placebo. However, in this study, the CHG rinse had a significantly better ($p < 0.05$) effect than the test product.³¹

Witch-hazel (*Hamamelis virginiana*) is a shrub grown in North America, China, and Japan, and its bark and leaves have a history of use as a medicinal ingredient. Another recent 21-day 5-block study compared a witch-hazel-based rinse to several well-established commercially available oral rinses: CHG 0.12%, EO, CPC, and triclosan, but no placebo group was included. Results demonstrated the non-commercial product to significantly reduce mean plaque scores over the 3-week period ($p < 0.01$), but it was shown to be statistically significantly the least effective of all of the products compared.³²

Another 21-day study ($n = 40$) examined a polyherbal

rinse consisting of tea tree oil (0.2% to 0.3%) (*Melaleuca alternifolia*) plus oils of clove (0.2% to 0.3%) (*Syzygium aromaticum*) and basil (0.2% to 0.3%) (*Ocimum sanctum*) compared to an established, commercially available EO rinse measuring plaque and gingival inflammation. Both the test and commercial EO groups significantly reduced both outcome parameters from baseline ($p < 0.0001$), while there was no significant difference demonstrated between groups. Of note, the study did not include a negative control group and used only 10 mL of the positive control rinse, which is half the recommended dosage.³³

A 2016 study also investigated a polyherbal rinse, in this case derived from coarsely powdered ginger (*Zingiber officinale*), rosemary extract (*Rosmarinus officinalis*), and marigold (*Calendula officinalis*) (5% v/w), in comparison to 0.2% CHG and a negative control. The study demonstrated significant improvements ($p < 0.05$) in both plaque and gingival outcome measures in both the test and positive control group compared to baseline, but no significant difference between them. The negative control group demonstrated no significant effects. The study was only 2 weeks in length, which, therefore, precludes definitive conclusions about the anti-inflammatory benefits of the tested products.³⁴

A recent study conducted with young adults (20 to 30 years of age) compared 0.2% CHG to a commercially available probiotic-derived rinse (Sporlac Plus[®]) and a negative control, but the study is included in this part of the review because the product is commercially indicated for diarrhoea of varied etiology and was used experimentally in the study for oral application. Probiotics are ingested live microorganisms believed to offer human health benefits, although research demonstrating such benefits is limited. The test product, Sporlac Plus[®], contains *Lactobacillus acidophilus*, *Lactobacillus rhamnosus*, *Lactobacillus sporogenes*, *Bifidobacterium longum*, and *Saccharomyces boulardii*.

The participants rinsed for 15 days with their assigned rinse, but the study did not indicate what other oral hygiene aids were permitted during the rinse period. Outcome measures were taken at 14 days and 28 days, but it is unclear from the report what oral hygiene regimen was followed after the test period (day 15) until the final measure (day 28). The study demonstrated significant effectiveness for both the CHG and the probiotic rinse in reducing both plaque and gingivitis scores compared to baseline and the placebo ($p < 0.05$), while there was no difference between them. The study did not indicate the dosage of the CHG. It was also not clear from the report what outcome measure time period (day 14 or day 28) was used in the statistical analysis and results, as only 1 set of data was presented.³⁵

The longest of the home use studies was conducted over 3 months and compared a rinse containing African basil (*Ocimum gratissimum*) to CHG (0.12%) and a negative

control rinse. *O. gratissimum* is a tropical aromatic plant whose essential oil has shown some antibacterial effect. This study had a small sample size—only 10 subjects in each group—but demonstrated significant ($p < 0.05$) plaque and gingivitis reductions in the test and CHG groups, but no significant difference between them. The participants used their assigned rinse (10 mL) for a full minute along with toothbrushing 3 times per day.³⁶ While there was good compliance among test rinse users, there was evidence of staining and taste alterations in the CHG group.

Systematic reviews

While only primary research studies were included in this review, it is helpful to survey previously conducted systematic reviews in order to ensure that no primary studies have been overlooked and to compare findings. The search strategy for this position paper failed to locate any systematic reviews specifically conducted on non-commercially available products. However, 1 systematic review targeting natural compound-containing rinses has been conducted.³⁷ Less than half of the test formulations included in that systematic review were commercially available.³⁷ Although the reviewers considered commercially available EO rinse LISTERINE® to be a natural compound-containing rinse, it was not included in the review because it had been included in several previously conducted systematic reviews and meta-analyses.³⁷⁻⁴⁰

The systematic review of natural compound-containing products yielded 2236 titles and abstracts; 11 clinical trials were included in the final review.³⁷ Substantial heterogeneity of the study parameters prevented the researchers from conducting a meta-analysis.³⁷ Of the 11 studies that met inclusion criteria, 5 were considered to be of low quality. All of the studies included had small sample sizes and low-level study design. All but 3 of the included studies were published prior to 2006 and were, therefore, not considered for the present review. The systematic review categorized natural compounds into 3 groups: those containing a single natural product, those containing compounds from several natural products, and those containing both natural and synthetic products. This categorization highlights the challenge inherent in examining the specific benefits of individual products included in polyherbals. Of course, some therapeutic products like commercially available EO rinses have demonstrated effectiveness within a combination formulation.⁴ The researchers of the systematic review concluded that the evidence demonstrating effectiveness of natural compound-containing rinses was insufficient and that further study is required.³⁷

DISCUSSION

The American Dental Association (ADA) has stringent guidelines for awarding its seal of acceptance for oral rinses, including a study period of at least 6 months to evaluate both efficacy and safety of chemical agents as well

as client compliance along with an intermediate evaluation at 3 months.^{23,24} Because no long-term (≥ 6 -month) home use studies of non-commercial products were located at the time of this review, it is not possible to confirm the effectiveness of any non-commercial oral rinse products reviewed. Therefore, with just over half of the studies reviewed here being in stages 1 to 3 and the remaining being short-term home use studies, this position paper can only identify products that are most promising and may warrant further research, ideally at the appropriate stage and with the use of standardized parameters.

Of the studies included in this review, most demonstrated positive effects compared to baseline and/or placebo controls of a wide variety of compounds. However, there were some important weaknesses in study designs and methods, which may mitigate the merits of conducting additional, especially higher level, research that involves ethical considerations for human study subjects.

Of the 5 products studied in stage 1 research designs, 2 formulations showed positive effects. The chitosan rinse was shown to be superior to both CHG and EO rinses with regard to MIC and adherence qualities. The study of MPC-polymer also produced interesting findings with regard to preventing adherence and colonization of pathogenic microbes. While persica and taurolidine rinses performed better than placebo, the effect was significantly less than positive controls. Edible oil-based rinses simulating the practice of “oil pulling” were found to have no effect. In the stage 2 plaque regrowth studies, both the pomegranate and aloe vera extract-based rinses demonstrated positive outcomes as compared to placebo rinse, while no significant differences were demonstrated compared to the positive control (CHG). Two studies showed bee products (propolis) to inhibit plaque compared to the negative control, though only one had statistically significant results, but neither was as effective as CHG, the positive control rinse. A further study was conducted with a traditional herbal rinse, but had major limitations in methodology making its interpretations erroneous.

In the stage 3 experimental gingivitis studies, none of the test formulations demonstrated significantly favourable effects over both positive and placebo controls. One study with sodium hypochlorite suppressed inflammation significantly better than the placebo although it did result in statistically significant increases in brown dental stain. The turmeric extract rinse showed similar inflammatory reductions to CHG, but there was no placebo control in that study. The remaining studies did not demonstrate significant results with regard to positive controls and had other design flaws including a lack of placebo groups, short duration (< 21 days), and unconventional rinse times.

All of the home use studies were less than 6 months in duration, and only 1 was greater than 1 month long. None of the test formulations was shown to have statistically significant superior effects when compared to positive

controls, but many demonstrated no difference between the test and positive controls (CHG, EO). Of these, several studies did not include a placebo control rinse, were very short in duration thus precluding inflammatory measures, lacked reporting of treatment regimens, used less than recommended dosages in positive control groups, or had other poor design features. However, one 3-week neem rinse (0.19%) study and the 3-month African basil study both showed no statistically significant differences between test formulation outcomes, including plaque and inflammatory measures, and the positive control rinse (CHG), although they were shown to have significantly superior effects compared to placebo.

Limitations

Inadequacies in research designs or methods and voids in reporting limit the conclusions that can be drawn about many of these non-commercial products. An important consideration for these studies is the inclusion or exclusion of active or positive controls and placebo or negative control rinses. The lack of a negative control was the norm for all 4 of the stages of research reviewed. The problem with not including a placebo group is that the study is unable to demonstrate internal evidence of efficacy or effectiveness.⁴¹ The inclusion of a placebo rinse allows for absolute measures of efficacy and safety versus relative measures taken when using active controls.⁴¹ Furthermore, if proper blinding and randomization occur, a negative control group controls for a placebo effect and all other potential influences on study outcomes.⁴¹

Active or positive controls can reveal differences between a test and a known product that has established effectiveness or efficacy. These differences are important in oral rinse research because identifying products that are more accessible or of lower cost may benefit populations in developing countries and other vulnerable population groups. The use of control groups helps to determine the superiority, equivalency or non-inferiority of a new formulation in comparison to established products. Depending on the focus of the study, how the research hypothesis is stated and measured and how samples are calculated are affected.

In addition, where the aim is to study a test product in relation to its equivalence to a known active control, the acceptable equivalence margin must be determined prior to the start of a study. The equivalence margin is the range of values that is described as being “close enough” to be deemed equivalent.⁴¹ Furthermore, studies including an active control are affected by compliance and placebo response and may require larger sample sizes.⁴¹ In studies including a positive control, a key point is ensuring that the study is “fair” in that the dose and regimen of the active rinse are consistent with the demonstrated effectiveness in previous research.⁴¹

Only 1 of the studies reviewed here was referred to as an equivalence study.¹⁹ While no equivalence margin was

stated in the study, there was no significant difference demonstrated between the test rinse and what was deemed the positive control.¹⁹ Interestingly, however, the positive control used in the study—a NaF/CPC rinse—has not been demonstrated to be equivalent to the gold standard, CHG, or to other well-established oral rinse products like commercially available EO in plaque and inflammation studies. While many studies did include a positive control group, these were often not used according to manufacturer instructions. In commercially available rinse studies,⁴ many studies include both an active control group, sometimes multiple groups, and a negative control group to determine both absolute and relative effectiveness. Likely reflecting the relative infancy of non-commercial oral rinse research, the failure to include negative placebo groups and/or appropriate active control treatment regimens makes it difficult to draw conclusions and identify products warranting further research.

In addition, other methodological weaknesses in these studies limit the ability to make comparisons. For example, many of the stage 1 and 2 studies conducted with non-commercial products measured gingival changes, which is inappropriate given the short duration of these studies and their design.⁶ In addition, in some studies, the confounding effect of smokers was not taken into account. For example, in 1 study 50% of the positive control group smoked versus 25% of the experimental group, which may affect gingival outcome measures particularly in shorter studies.²⁷ In short-term home use clinical trials there was substantial heterogeneity across study designs making it difficult to compare and interpret results. Inconsistencies among active ingredients, the concentration of active ingredient, inclusion and exclusion criteria for study participants, study duration, outcomes measures, rinse amounts (dosages) and rinse times, control groups, blinding, ambiguity in reporting, and the lack of repeated studies all make it difficult to compare findings and draw conclusions. Such inferences have been made by other review authors.³⁷ Interestingly, there has been a lack of replication research conducted where earlier studies, which show significance, are repeated in some way to explore or verify earlier findings.⁴² Much of the research conducted in the field of non-commercial formulations appears to be unique rather than conceived as part of a larger, systematic research agenda.⁴² Such an approach will limit or slow the expansion of the body of knowledge on this topic.

Rationale for natural compound-containing products and research

Many of the active ingredients in non-commercial oral rinse products are natural compounds and are of particular interest to researchers and others attempting to find low-cost alternatives to established commercially available rinses, particularly for populations in developing countries where formulations with demonstrated effectiveness cannot be as readily accessed.^{5,7,22,41} In addition, it has been

suggested that some natural compounds may not require the inclusion of alcohol in their preparations, which may present advantages to some population groups.⁴³ Other factors stimulating research on natural compounds include the negative side effects attributed to some commercial products, such as staining, poor or burning taste, potential systemic effects, antibiotic resistance, and other concerns.^{4,41}

In addition, there is great interest among the general public for natural products because of the perception that they are healthier and safer than synthetic compounds.^{5,44} However, there is a need for increased public awareness of what a “natural” product actually is. There is considerable ambiguity surrounding the nomenclature of natural products and herbal remedies. The *WHO Guidelines for Research on Traditional Medicine* provide definitions for terminology associated with herbal products⁷; some of these are provided in Table 2 and, for consistency, should be more widely utilized in discussions. In addition, it should be recognized that holism is an important element of traditional medicine. Herbal remedies may be used as part of a holistic approach to health rather than as a singular intervention outside of their intended context, which has been suggested as likely to occur in western health care approaches.⁷

Natural compounds are generally derived from plant extracts. Plants are rich in a wide variety of secondary metabolites which have been found in vitro to have antimicrobial properties.³⁷ Polyphenolic plant derivatives are a part of plants’ natural defence mechanisms, which are effective against both viral and bacterial pathogens, and these have been the main focus of research on natural compounds so far.⁴³ India, among other less developed countries, is a rich source of natural herbal products, which have been used both topically and systemically for disease treatment. Often, research emanating from these regions is aimed at substantiating locally available natural products that can be developed and made consistently into rinses for these populations. While the utility of these natural products is limited due to scant research testing product effectiveness,²⁹ WHO has developed guidelines and strategies for enhancing natural and herbal product research and development.^{5,7}

There has been extensive research conducted on commercially available products and, while research continues, a concomitant focus should also be on new products showing similar or enhanced outcomes to established products. Beyond their therapeutic benefits, these products have potential because they may prove to have fewer side effects, be more accessible, cost less, and have easier and more pleasant applications.⁴¹

Recommendations

Well-established randomized controlled clinical trials provide the highest level of evidence for efficacy and effectiveness and would lend credibility to natural

Table 2: Selected terminology for natural products and herbal remedies^{7,45}

Term	Definition
Herbal medicine	<p>“Plant-derived material or preparation with therapeutic or other health benefits which contains either raw or processed ingredients from one or more plants.”^{7, Annex II, p27}</p> <p>Note: Plant materials include juices, gums, fatty oils, essential oils, and other similar substances. Herbal medicines may contain some type of binding ingredient in addition to the active ingredients. Formulations containing additional “chemically defined active substances” are not considered to be herbal medicines. In some countries, traditional herbal medicines may also contain non-plant natural organic or inorganic active ingredients.⁷</p>
Processed plant materials	<p>“Plant materials treated according to their traditional procedures to improve their safety and/or efficacy, to facilitate their clinical use, or to make medicinal preparations”^{7, Annex II, p27}</p>
Natural products	<p>“A small molecule produced naturally by any organism including primary and secondary metabolites...include very small molecules...and complex structures; they may only be isolable in small quantities”⁴⁵</p>

products and herbal medicines in different regions and among people with different cultural traditions.⁷ The *ADA Acceptance Program Product Guidelines* require that products follow good and consistent manufacturing procedures,³⁷ and, therefore, virtually all of these products are not yet suitable for mass production. While making recommendations for the home use of these products by Canadian populations is premature, given the research reviewed here and elsewhere,³⁷ replication with more high-quality studies (i.e., those with standardized parameters including design, samples, outcome measures, safety) and in some cases at higher stages appears to be warranted.

CONCLUSION

At this time, while several non-commercial oral rinse formulations have shown possible benefits, their effectiveness and safety have not been proven consistently under the methodological demands of experimental procedure, particularly in long-term clinical trials. The research conducted on these products would benefit from a standardized protocol and systematic research agenda, which together have the potential to advance the field over the next several years. Based on both parts of this comprehensive review, dental hygienists should continue to recommend a commercially available therapeutic oral rinse that has been consistently shown to be effective and safe in numerous rigorous clinical trials.

CONFLICT OF INTEREST

Joanna Asadoorian was paid as a consultant by the Canadian Dental Hygienists Association for the design, research, and writing of this position paper. She has also done short-term contractual work with Johnson & Johnson in the past.

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Interprofessional education and collaborative practice

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ABSTRACT

The need for interprofessional education (IPE) has been well documented and communicated by many prominent governmental bodies and health organizations. A growing body of research demonstrates the benefits of IPE. This short communication defines IPE and collaborative practice, discusses related research, assesses the dental hygiene practice landscape pertaining to collaborative practice, introduces a national interprofessional competency framework, and offers insight into future research needs. The article also highlights how IPE is operationalized in the University of British Columbia's Dental Hygiene Degree Program and identifies available resources for IPE facilitation. The purpose of this article is to inform educators and practitioners of the importance of IPE and the impact it may have on collaborative practice.

RÉSUMÉ

L'importance de l'éducation interprofessionnelle (ÉIP) est bien documentée et signalée par plusieurs importants organismes gouvernementaux et de la santé. Un corpus de recherche croissant illustre les avantages de l'ÉIP. Ce bref article définit la pratique de l'ÉIP et la pratique collaborative, traite des recherches connexes, évalue le paysage de la pratique collaborative de l'hygiène dentaire, présente un cadre national interprofessionnel axé sur les compétences et offre un aperçu des recherches futures qui sont nécessaires. Cet article met aussi l'accent sur la façon dont l'ÉIP est mise en œuvre dans le Programme d'hygiène dentaire de l'Université de la Colombie-Britannique et cerne les ressources offertes permettant de faciliter l'ÉIP. Le but de cet article est d'informer les formateurs et les praticiens sur l'importance de l'ÉIP et de l'effet qu'elle peut avoir sur la pratique collaborative.

Key words: collaborative practice, degree education, dental hygiene, interprofessional education

INTRODUCTION

The need for interprofessional education (IPE) has been well documented and communicated by many prominent governmental bodies and health agencies including the World Health Organization (WHO). The WHO's commonly accepted definition of IPE states that IPE “occurs when students from two or more professions learn about, from, and with each other to enable effective collaboration and improve health outcomes.”^{1, p7} A growing body of evidence, particularly over the past decade, demonstrates the benefits of IPE within entry-to-practice health professional educational programs. Universities are committed to graduating health and human service professionals who have the ability to work as effective members of a health care team.^{2,3} However, numerous university-based health programs deliver curricula within discipline-specific silos.^{2,3} This approach is limited in its capacity to foster competence (knowledge, skills, and attitudes) in interprofessional collaboration.⁴ Interprofessional collaboration occurs when 2 or more professions work together to solve complex

issues through a jointly developed structure, shared responsibility and authority, and sharing of resources and rewards.⁵ The fundamental premise behind the integration of IPE is that if health professionals learn together then they will be better prepared to work together, ultimately improving client care and health outcomes.^{1,6,7} The purpose of this article is to provide educators and practitioners with an overview of IPE and collaborative practice as well as to highlight a model of its implementation at the University of British Columbia (UBC).

Background

IPE has been proposed by multiple organizations as an appropriate and innovative pedagogical approach to address global health care challenges in the 21st century.^{1,6,7} One of the more significant calls for IPE is found in the WHO's 2010 *Framework for Action on Interprofessional Education and Collaborative Practice*.¹ The World Federation of Medical Education has also advocated for IPE,⁶ and the Health Council of Canada has included a recommendation

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Figure 1. WHO vision for improved health services



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that each university health program offer IPE to reflect the vision of collaborative practice in multidisciplinary teams.⁷ Understanding and respecting the knowledge and unique contribution of each health professional, adopting a common language for communication, and applying theory about shared competencies are several outcomes of IPE that may improve client safety and health outcomes. Within an IPE framework, joint decision making is valued, and health science students are empowered to assume leadership roles on client issues that are appropriate to their growing expertise.^{2,3}

The WHO proclaims a worldwide shortage of approximately 4 million health care professionals.¹ The 59th World Health Assembly responded to the human resources for health crisis by adopting a resolution that called for a rapid expansion of the health workforce through various strategies, including the use of innovative approaches to teaching in developed countries.¹ The WHO acknowledges the need to strengthen health care systems by encouraging new educational approaches involving interprofessional collaboration. The organization also recognizes interprofessional collaboration as one of the most promising solutions to build a more flexible health workforce that is able to maximize limited resources. IPE is essential to foster a collaborative, practice-ready health care workforce and to improve health outcomes by enabling health care professionals to provide a wide range of comprehensive services together in a variety of practice settings (Figure 1).¹ It is within these interprofessional settings where the greatest strides towards strengthened health systems can be made.

A small, emerging body of research has started to demonstrate the benefits of collaborative practice for health care organizations, health professionals, and

clients.^{2,8,9} For example, collaborative practice behaviours have reduced rates and costs of hospitalization, improved communication among professionals resulting in a reduction in medical errors, and improved job satisfaction levels through sharing of challenges and increased collegial support.^{2,8,9} Clients have reported higher levels of satisfaction, better acceptance of care, fewer clinic visits, and improved health outcomes when cared for by a team.^{2,8,9} Since no one profession has the expertise to meet all health care needs, there is a clear benefit to collaboration among health and human service professionals from different disciplines.

In 2008, the WHO conducted an environmental scan to determine the status and best practices for IPE globally.¹ The environmental scan encompassed 396 institutions across 42 countries. Results indicated that IPE occurred in many countries and involved various health science and human service professions (Figure 2).¹ For health programs with an IPE component, IPE was a mandatory curricular activity. Notably absent from the environmental scan results were the oral health professions. Given the link between oral and systemic health and the increasingly complex oral and systemic health care needs of the public in the 21st century,¹ integrating oral health professionals into interprofessional teams is critically important.

DENTAL HYGIENE AND COLLABORATIVE PRACTICE

The Canadian Dental Hygienists Association also queried its members about interprofessional collaborative practice in its *2015 Job Market and Employment Survey*.¹⁰ This survey included a question asking with whom respondents practice collaboratively, to which 1063 respondents (17%) indicated they did not know or deemed this question to be not applicable to their practice. Another 639 survey respondents (10%) left no response. The remaining 73% of respondents reported that they did collaborate with others; 93% of those stated they did so with dentists followed distantly by denturists (28%), physicians (25%), and other health professionals with whom collaboration scores were 9% and lower (Table 1).

The fact that oral health professionals can be meaningful interprofessional collaborators in the delivery of public health services was acknowledged in the Public Health Agency of Canada's 2005 *Pan-Canadian Framework for Public Health Human Resources Planning* in which dental hygiene was included as 1 of 12 regulated professions, alongside public health nurses, dietitians, and speech-language pathologists, among others, who are viewed as having uniquely valuable expertise to contribute to an

Table 1. Workplace collaboration between dental hygienists and other health professionals

2015 RESULTS			
Health professionals	Count	Rela %	Rank
1. Dentists	4277	93%	1
2. Denturists	1292	28%	2
3. Physicians	1152	25%	3
4. Massage therapists	404	9%	4
5. Nurses and registered nurses	358	8%	5
6. Physiotherapists	332	7%	6
7. Chiropractors	235	5%	7
8. Dietitians	203	4%	8
9. Speech-language pathologists	168	4%	10
10. Occupational therapists	104	2%	11
11. Homeopathic doctors	95	2%	12
12. Other	184	4%	9
13. I do not know / Not applicable	1063		
No Response	639		
TOTAL	6283		

Source: Canadian Dental Hygienists Association. *2015 Job market & employment survey: Full report*. "Health profession collaboration." Ottawa: CDHA; 2015. p. 41.

interprofessional team.¹¹ The purpose of this framework was to facilitate partnerships between government and community stakeholders. It highlighted that, through collaborative planning, all jurisdictions in Canada can have access to a knowledgeable public health workforce to meet public health needs and to reduce health and social disparities. Dental hygiene was identified as one of the professions that can make a sizable contribution to achieving this vision, particularly given the link between oral and systemic health.¹¹

NATIONAL INTERPROFESSIONAL COMPETENCY FRAMEWORK

In 2010, the Canadian Interprofessional Health Collaborative (CIHC) published a *National Interprofessional Competency Framework*, which outlines 6 competencies required for effective interprofessional collaboration.¹² The result is a dynamic and flexible foundation for IPE. The framework comprises 2 competency domains that support the others—interprofessional communication and patient/client/family/community-centred care—and 4 domains within the integrated whole—role clarification, team functioning, collaborative leadership, and interprofessional conflict resolution. Competency statements for each of these domains

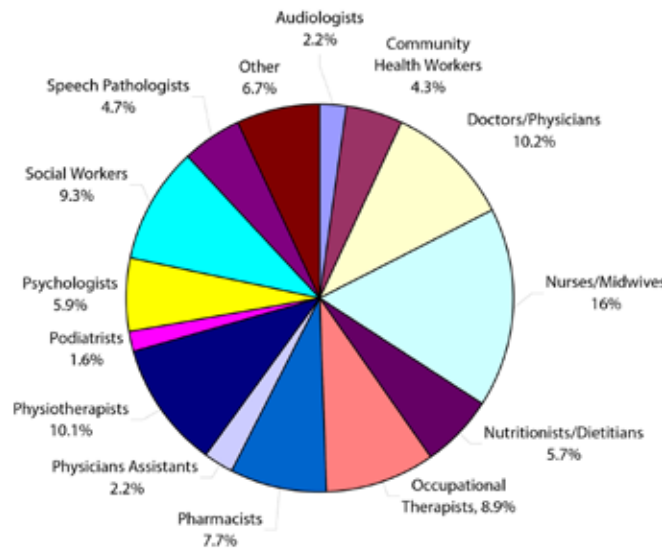
are found in Table 2. Figure 3 presents the configuration of the competency domains and highlights 3 background considerations that influence how the competency framework may be applied in different situations.

In an educational context, the *National Interprofessional Competency Framework* provides a starting point for developing curriculum content, learning strategies, learning objectives, and methods of assessment to determine if collaborative practice competencies are an outcome. If the end-point of learning is to foster a collaborative health care practitioner, then developing a curriculum that socializes future health providers to collaborate interprofessionally using standardized competencies is essential.

IPE AT THE UNIVERSITY OF BRITISH COLUMBIA

In its updated 2015 accreditation requirements, the Commission on Dental Accreditation of Canada states that dental hygiene programs must provide interprofessional collaboration experiences for students.¹³ Yet, even though competency frameworks such as the *National Interprofessional Competency Framework* provide a description of a collaborative practice model, an effective model of IPE delivery has yet to be clearly standardized and articulated.

Figure 2. WHO IPE environmental scan: Professional backgrounds of learners who received IPE at the respondents' institutions



Reprinted with permission from World Health Organization. *Framework for action on interprofessional education and collaborative practice*. "Figure 4. Types of learners who received interprofessional education at the respondents' institutions." Geneva: WHO; 2010. p. 16.

The 4-year entry-to-practice option of the Dental Hygiene Degree Program (DHDP) in the Faculty of Dentistry at UBC adopted mandatory IPE into its curriculum in 2013. IPE does not require large classroom-based activities to be successful but rather can be more meaningful in smaller teams addressing cases or scenarios in clinical and community practice settings.¹⁴ IPE involves students learning about, from, and with each other as articulated in the WHO definition. Merely listening to a lecture with no interaction among students from various health backgrounds would not constitute IPE.² As a result, UBC's DHDP opted to integrate IPE learning activities that are interactive, cumulative, and embedded throughout the curriculum.

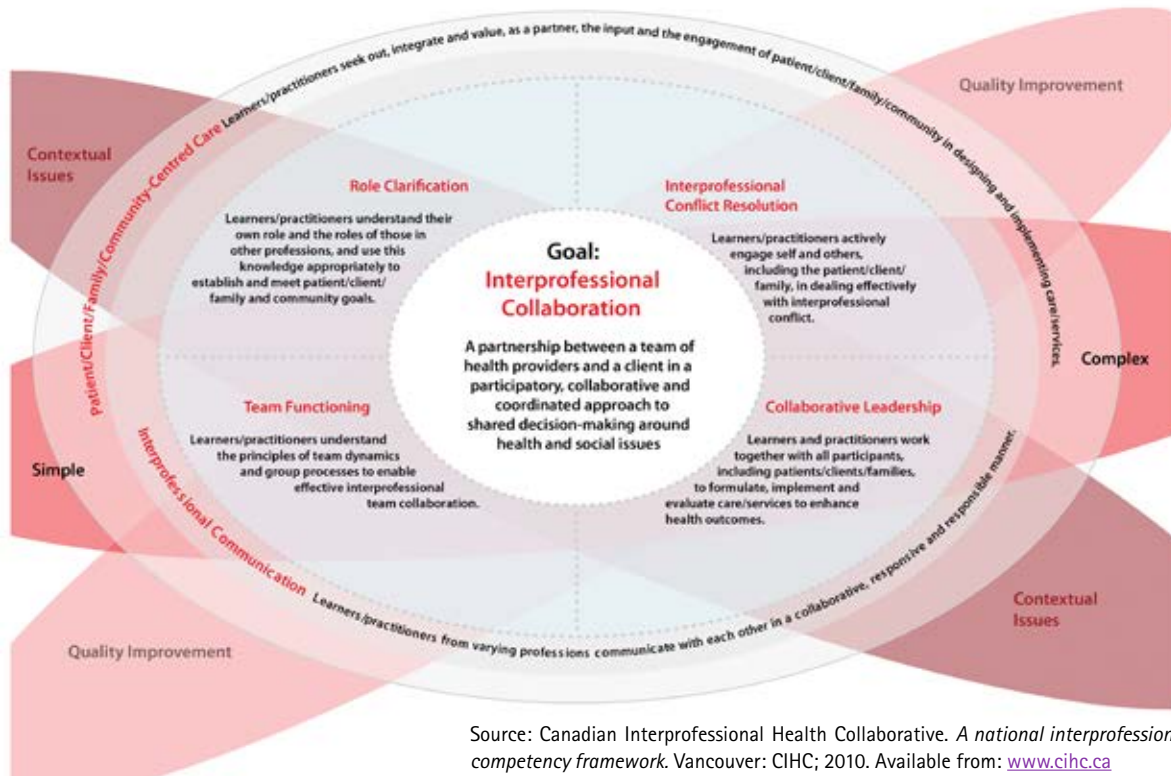
The Office of UBC Health serves as a resource for the health programs on campus particularly related to issues that are relevant across disciplines and require support for collaboration to achieve common goals. UBC Health is a partnership of all 12 academic health science and human service programs at the university (Table 3), and was established to enhance collaborative research and educational programming. Through the support provided by UBC Health, the DHDP has operationalized IPE through 2 primary mechanisms: 1) the IPE Passport program and 2) Integrated common curriculum within the Faculty of Dentistry and across health programs at UBC (Figure 4).

Table 2. CIHC National Interprofessional Competency Framework definitions

Interprofessional competency domain	Competency statement
Interprofessional communication	Learners/practitioners from different professions communicate with each other in a collaborative, responsive, and responsible manner.
Patient/client/family/community-centred care	Learners/practitioners seek out, integrate, and value, as a partner, the input, and the engagement of the patient/client/family/community in designing and implementing care/services.
Role clarification	Learners/practitioners understand their own role and the roles of those in other professions and use this knowledge appropriately to establish goals.
Team functioning	Learners/practitioners understand the principles of team work dynamics and team processes to enable effective interprofessional collaboration.
Collaborative leadership	Learners/practitioners apply leadership principles that support a collaborative practice model (including shared decision making with individual accountability defined by one's own scope of practice).
Interprofessional conflict resolution	Learners/practitioners engage in positively and constructively addressing disagreements as they arise.

Source: Canadian Interprofessional Health Collaborative. *A national interprofessional competency framework*. Vancouver: CIHC; 2010. Available from: www.cihc.ca

Figure 3. CIHC National Interprofessional Competency Framework



Source: Canadian Interprofessional Health Collaborative. *A national interprofessional competency framework*. Vancouver: CIHC; 2010. Available from: www.cihc.ca

IPE Passport program

The IPE Passport is an online tool that enables students to register for and track interprofessional learning. The passport tool provides a comprehensive list of the IPE activities offered to UBC students by various faculties. The passport is used as a vehicle to demonstrate that students have participated in IPE and completed the IPE requirements of their programs. Through the online tool, students are able to view upcoming events and important dates, register for IPE activities, earn passport points for their participation in IPE activities, download any required readings or forms, and complete evaluation forms or reflections.

Examples of IPE Passport activities include mental health awareness clubs, pain management modules, client and community voice workshops, motivational interviewing sessions, meal preparation and dietary counseling workshops, and aphasia camps, to name only a few. Each activity provides a specific number of points depending on activity length and depth of IPE exposure and immersion.¹⁵ In UBC’s DHDP, students participate in at least one IPE Passport activity above and beyond the prescribed curriculum in each of their second, third, and fourth years of study to earn a pre-determined number of passport points to meet program requirements for graduation. Students have the autonomy to select IPE Passport activities that speak to their own interests. In working towards these requirements, dental hygiene students learn about, from, and with students in

audiology and speech sciences, dentistry, dietetics, genetic counselling, medicine, midwifery, nursing, pharmacy, physical therapy, occupational therapy, and social work. Students in these other health professions reciprocally benefit from learning about the role of dental hygiene in health care teams.

Integrated common curriculum in the Faculty of Dentistry

Within the Faculty of Dentistry at UBC, the doctor of dental medicine (DMD) and dental hygiene undergraduate programs have identified common areas of learning in which both cohorts have been integrated within their prescribed curricula. Integrated curricular topics include clinical ergonomics, local anesthesia, head and neck anatomy (lectures and cadaver lab sessions), social determinants of health, addiction medicine, gender diversity, and

Table 3. Health and human service programs at UBC

UBC Health	
Audiology and speech sciences	Dental hygiene
Dentistry	Dietetics
Genetic counselling	Medicine
Midwifery	Nursing
Occupational therapy	Pharmacy
Physical therapy	Social work

Indigenous health cultural competency. In addition to these interactive classroom and laboratory sessions, students from both programs have been paired in the clinical practice setting to build their roles as co-therapists during assessment, diagnosis, planning, implementation, and evaluation procedures. Such integration has allowed students to recognize the commonalities between both oral health professions, to become familiar with each other's scope of practice, and to foster collaborative practice behaviours post-graduation. These integrative learning experiences have also reduced repeated teaching of the same content to different cohorts.

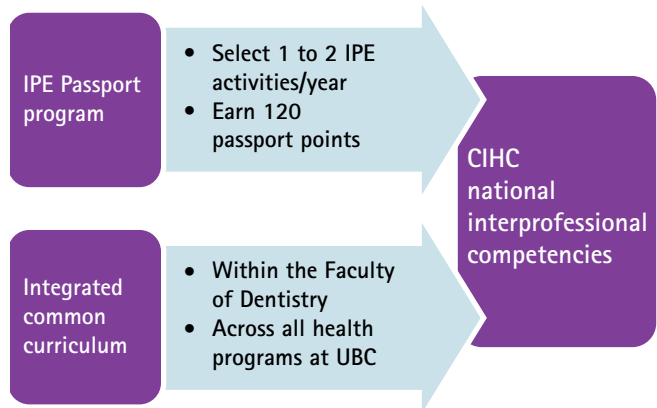
Integrated common curriculum across UBC health programs

Beyond the Faculty of Dentistry's internal efforts to integrate areas of common learning for DMD and dental hygiene students, UBC Health has explored the adoption of a layered, integrated approach to health professional education in which identified common areas of learning could be embedded into all health science and human service program curricula on campus. The Integrated Ethics (iEthics) curriculum was chosen as the exemplar for an integrated curriculum since ethics and ethical issues span the health professions.

The iEthics curriculum commenced in 2015 in all health programs at UBC and has been designed to complement profession-specific ethics learning. The iEthics curriculum is a series of flexible (online and in-person) learning activities that are offered over the course of any health program at UBC regardless of length and comprises 12 hours of IPE over 4 quartiles. The curriculum begins with an online introductory module and an interactive interprofessional workshop during which students define ethical practice, discuss the need for professional ethics in health care, and compare codes of ethics from different professions. The layered curriculum continues with more senior students working collaboratively through cases in the classroom-to-practice setting continuum. The iEthics curriculum aims to prepare students to be ethically competent and collaborative practitioners who recognize and value the role of each member of the health care team. Dental hygiene students partake in the iEthics curriculum in their second, third, and fourth years of study and must complete all quartiles to graduate.

Through the IPE Passport Program and Integrated Common Curriculum, UBC students work towards demonstrating the learning objectives captured within the interprofessional competencies outlined by CIHC (Table 2). Other identified common areas of learning are e-health and Indigenous health; they have been prioritized for curriculum development and implementation across all health programs at UBC. Further information about UBC Health initiatives and resources for educators including IPE frameworks, competencies, online modules, and facilitator guides can be found on UBC's affiliated websites: <http://www.health.ubc.ca> and <http://www.ipcontherun.ca>.

Figure 4. A model of interprofessional education in UBC's Dental Hygiene Degree Program



OTHER CONSIDERATIONS AND RESEARCH NEEDS

Even though the need for IPE has been well articulated and the benefits of collaborative practice models are clear, the literature has identified some barriers to the implementation of IPE, such as the coordination of schedules between health programs, the rigidity of curricula, the need to secure common learning spaces, the recruitment and training of qualified, committed faculty, and the perceptions of IPE as lacking in value.^{14,16} To manage the challenges involved in the coordination of program schedules, all health programs at UBC committed to reserving common protected times throughout the academic year to reserve for IPE learning experiences.

Research has also yielded mixed results about attitudinal differences or readiness for IPE among health science students. While some studies have concluded that IPE has increased students' understanding of professional roles and the importance of interprofessional communication and shared decision making,¹⁶⁻¹⁸ other studies have demonstrated a decline in students' positivity towards IPE over time.^{14,19,20} Authors of these latter studies attribute the decline in student attitudes after experiencing IPE to the format and duration of the initiatives. Since attitudes tend to predict behaviours, more research assessing students' attitudes preceding and following IPE with various interdisciplinary mixes and settings is needed. Although evaluation is a critical component of IPE, finding the appropriate tools to measure and assess outcomes can be challenging.

Despite international support for IPE, there remains a scarcity of evidence of its effectiveness in improving health outcomes. As the development and implementation of curricula involving IPE require significant time and resources, its adoption should be based on evidence of effectiveness.³ IPE can improve students' knowledge, skills, and understanding of collaborative practice. However, establishing a firm empirical relationship between IPE and client outcomes has been challenging.^{21,22} A 2015 report from the Institute of Medicine contained recommendations

for further study on IPE. These recommendations included: 1) the need to commit resources to a series of well-designed studies to demonstrate the association between IPE and collaborative behaviour; and 2) the need for both quantitative and qualitative studies to evaluate the effect of IPE on individual and population health system outcomes including economic analyses.^{21,23}

CONCLUSION

IPE represents an exciting field of study. National and international organizations such as the WHO, the World Federation of Medical Education, and the Health Council of Canada are influential proponents of IPE and collaborative practice. A *National Interprofessional Competency Framework* has been developed to assist educational institutions in the development and implementation of IPE, enabling health science and human service students to learn about, from, and with each other. A model from UBC offers insight into how IPE can be incorporated. While there exists a growing body of evidence that demonstrates the benefits of IPE within entry-to-practice health programs, more research is needed to evaluate the relationship between IPE and collaborative practice behaviours. Additional program participation and future research will contribute to a better understanding of this innovative pedagogical approach to health education.

CONFLICT OF INTEREST

The authors have declared no conflicts of interest.

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CREST® PRO-HEALTH™ WITH STABILIZED STANNOUS FLUORIDE

- THE ONLY FLUORIDE RECOGNIZED TO SLOW THE PROGRESSION OF EROSION TOOTH WEAR IN A PUBLISHED DENTAL CONSENSUS REPORT¹

When coming into contact with tooth enamel, stannous fluoride and sodium hexametaphosphate form a complex protective barrier, which is resistant to acid attack.

- Mielczarek AB et al. Dental and Medical Problems²

STANNOUS FLUORIDE PROTECTS AGAINST EROSION - EUROPEAN CONSENSUS DENTISTRY REPORT

A new Consensus Report of the European Federation of Conservative Dentistry recognizes the protective benefits of stannous against erosive tooth wear. Products [toothpastes] containing stannous fluoride have the potential for slowing the progression of erosive tooth wear.¹

HOW CREST® PRO-HEALTH™ CONTAINING STABILIZED STANNOUS FLUORIDE PROVIDES DUAL-ACTION EROSION PROTECTION

1. STANNOUS MECHANISM OF ACTION: ACID-RESISTANCE³

- Stannous adsorbs onto the tooth surface and forms a micro-thin shield that helps prevent enamel erosion caused by dietary acids
- The shield is made of a stannous precipitate mineral which binds to the tooth's surface where acid typically attacks and helps slow enamel surface dissolution
- In acidic conditions where hydroxyapatite (surface enamel) dissolves, the stannous bonds are more resistant to erosion which increases the tooth's ability to resist dietary acid attacks

2. FLUORIDE MECHANISM OF ACTION: REMINERALIZATION³

- All fluorides help to repair acid damage through a remineralization process that occurs most efficiently when the pH of the oral cavity is higher than ~4.5
- Stannous fluoride helps to repair weakened enamel inside and out
- Common fluorides will help to protect teeth from plaque acids. In the lower pH range, however, teeth are left vulnerable to dietary acid damage

Once enamel erosion has begun, lost enamel cannot be re-grown. Fluoride remineralization can only repair weakened spots caused by plaque acid. Recommending the use of stannous fluoride daily, to form an acid-resistant micro-thin stannous shield while the fluoride component rebuilds weakened enamel, will provide additional protection to help prevent enamel loss.³

STANNOUS FLUORIDE HELPS PROTECT AGAINST DIETARY ACIDS IN THE ENAMEL DANGER ZONE (~pH <4.5)

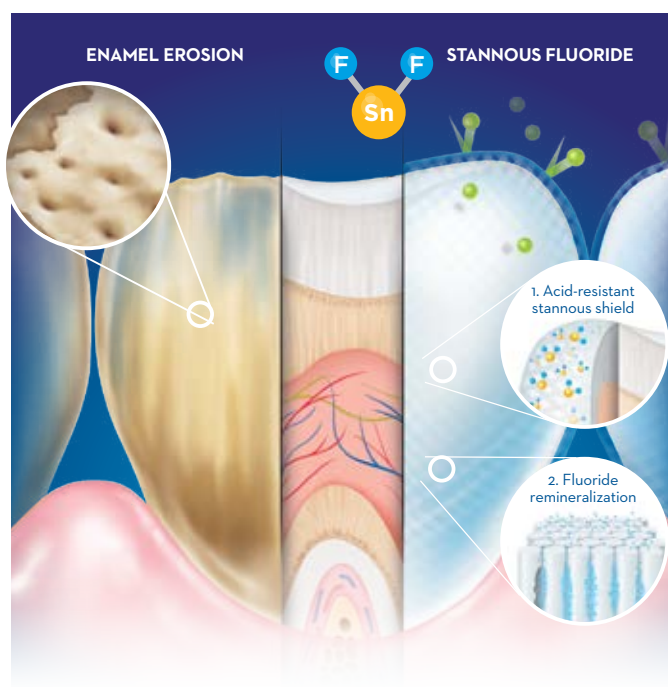


Illustration is an artist representation only



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ORAL-B® GENIUS™ TAKES BRUSHING TO THE NEXT LEVEL OF INTELLIGENCE

COCHRANE COLLABORATION SHOWS CONSISTENT SUPERIORITY OVER 3 REVIEWS¹⁻³

Cochrane Collaboration reported superiority vs. manual brushing with Oscillating/Rotating Technology – in 2003, 2005, 2014 independent analyses

ORAL-B® VS. SONICARE CLINICAL RESEARCH

Oral-B® GENIUS™ delivered superior results vs. Sonicare DiamondClean (p < 0.001)⁴



INCREASE IN WHOLE MOUTH PLAQUE REMOVAL



INCREASE IN BLEEDING SITE REDUCTION



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ORAL-B® VS. SONICARE – CONSISTENT SUPERIORITY IN CLINICAL EVIDENCE AND NUMBER OF STUDY DAYS

MORE THAN **45X** CLINICAL STUDY DAYS VS. SONICARE⁵

	ORAL-B® N =	SONICARE N =
PLAQUE	61,166	1,323
GUM HEALTH	61,166	0

2017 BEST PRODUCT RECOMMENDATION

Oral-B® Powerbrushes with O/R Technology awarded Clinicians Report BEST Product (toothbrushes) for 2017 in independent dental testing⁶

FEATURES OVERVIEW – ORAL-B® VS. SONICARE

ORAL-B® GENIUS™	SONICARE DIAMONDCLEAN ⁷	SONICARE FLEXCARE PLATINUM CONNECTED ⁸
Oral-B® App ✓ Award winning* – Best eHealth Product 2016	No	Philips Sonicare App
Position Detection Technology ✓ First and only powerbrush to combine motion sensor technology and video facial recognition to confirm brush position with accuracy ✓ Gives patients real-time guidance to brush all zones equally and evenly	No	3D Mouth-Map ✓ Sends your brushing data to the Sonicare app in real time via Bluetooth, providing you personalized coaching and feedback – This feature does not use smartphone camera pairing to accurately detect when or if the brush is inside the mouth
Triple Pressure Control System ✓ 360° SmartRing flashes as a visual pressure alert and patient is alerted on their Oral-B® App ✓ Brush automatically slows down, and stops pulsations when alert is triggered to avoid harm	No	Smart Sensor Technology
360° SmartRing ✓ Appears red when too much pressure is applied ✓ Signals when the toothbrush has paired with the smartphone, and prompts when it's time to move to a new brushing zone ✓ Colours customize to encourage compliance	No	No
Cleaning - oscillating/rotating pulsating action	Cleaning - side-to-side action	Cleaning - side-to-side action
Average cost per Oral-B® refill: \$8.99 [†]	Average cost per DiamondClean Standard refill: \$18.99 [†]	Average cost per AdaptiveClean Standard refill: \$18.99 [†]

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* Mobile World Congress, GENIUS and the Oral-B App won two awards – Best eHealth Product and Editor's Choice 2016.
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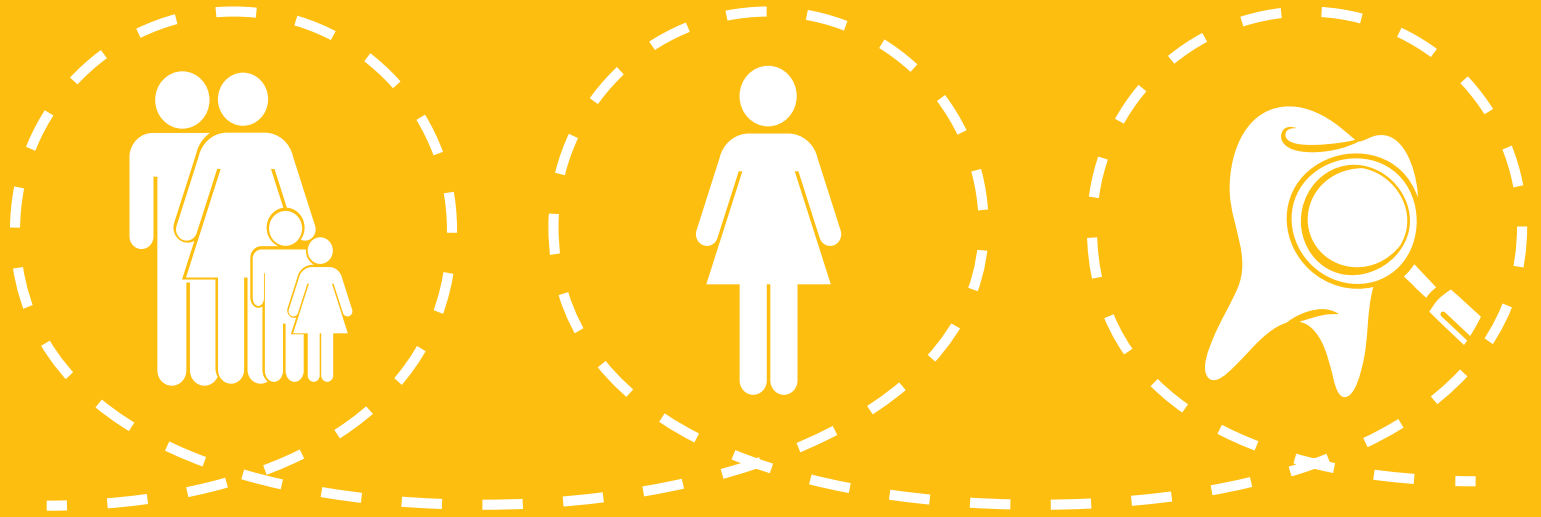
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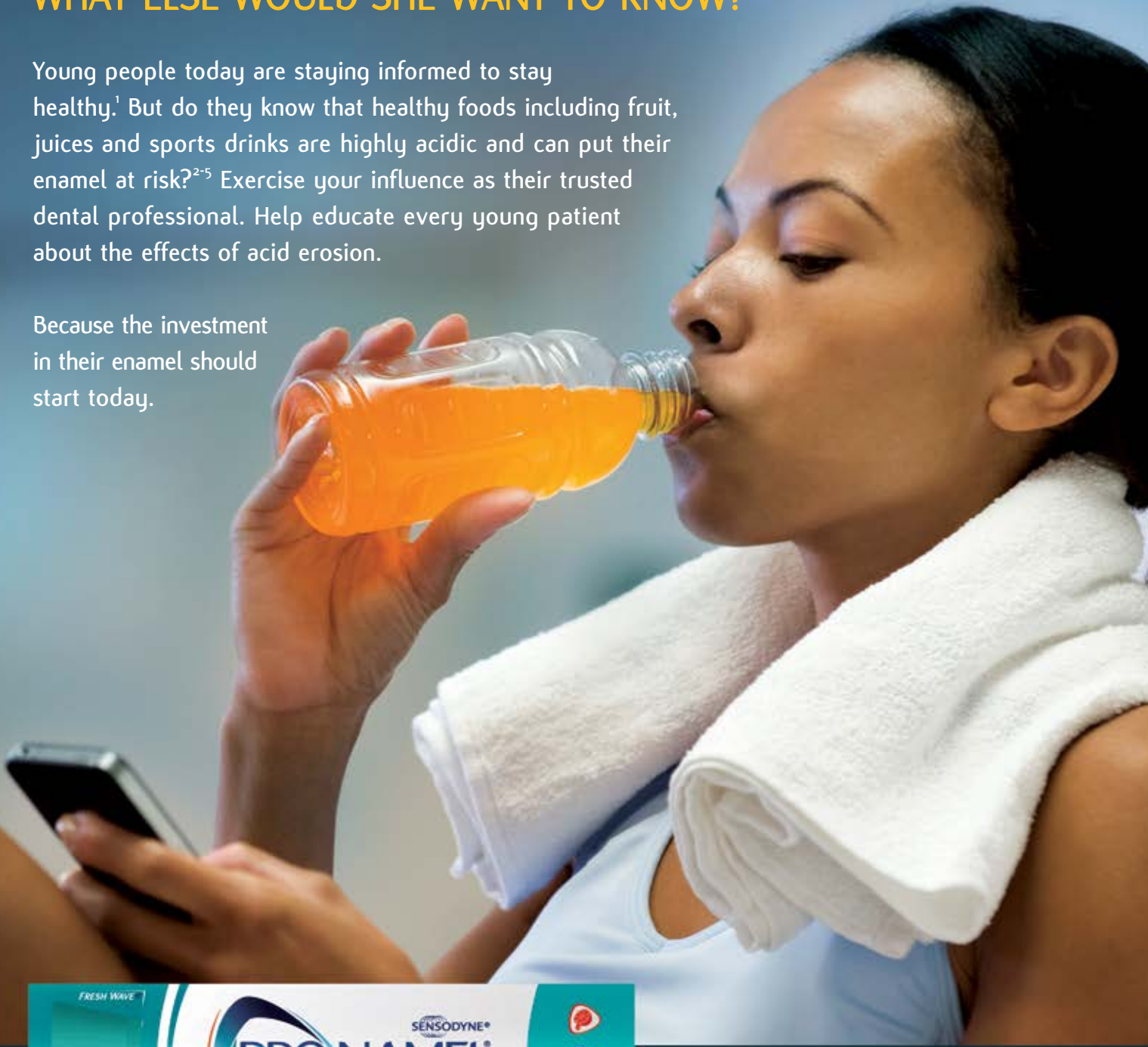


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1. GSK data on file, 2013. 2. Lussi A. Erosive tooth wear – a multifactorial condition. In: Lussi A, editor. Dental Erosion – from Diagnosis to Therapy. Karger, Basel, 2006. 3. Lussi A. *Eur J Oral Sci.* 1996;104:191–198. 4. Hara AT, et al. *Caries Research.* 2009;43:57–63. 5. Lussi A, et al. *Caries Research.* 2004;38(suppl 1):34–44.

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The *Canadian Journal of Dental Hygiene* (CJDH) invites manuscript submissions in English or French that make a significant contribution to the dental hygiene body of knowledge and advance the scientific basis of practice. Manuscripts must address one of the following *Canadian Dental Hygienists Association 2015-2018 Research Agenda* (www.cdha.ca/researchagenda) themes:

- Risk assessment and management
- Access to care and unmet needs
- Capacity building of the profession

and must be of the following types:

- Original research articles
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- Short communications/case reports
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CJDH Looks Forward to Hearing from You!

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Le *Journal canadien de l'hygiène dentaire* (JCHD) invite les auteurs à soumettre des manuscrits en anglais ou en français pour apporter une contribution importante à l'ensemble des connaissances de l'hygiène dentaire et pour faire progresser la base scientifique de la pratique. Les manuscrits doivent traiter d'un des thèmes du *Programme de recherche en hygiène dentaire 2015-2018 de l'Association canadienne des hygiénistes dentaires* (http://files.cdha.ca/profession/research/DHResearchAgenda_FR.pdf) qui suit :

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