

CANADIAN JOURNAL OF DENTAL HYGIENE · JOURNAL CANADIEN DE L'HYGIÈNE DENTAIRE
THE OFFICIAL JOURNAL OF THE CANADIAN DENTAL HYGIENISTS ASSOCIATION

CJDH



JCHD

OCTOBER 2016 · VOL. 50, NO 3

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Therapeutic oral rinsing

**Dental clients' perceptions of dental hygienists
with visible tattoos**

**Efficacy of sodium chlorite plus zinc gluconate on
volatile sulfur compound halitosis**

**Current status of the classification
of periodontal diseases**

EDITORIAL

Considering the value of volunteerism





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The *Canadian Journal of Dental Hygiene* is the official peer-reviewed publication of the Canadian Dental Hygienists Association (CDHA). Now 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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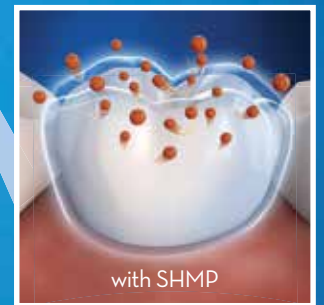
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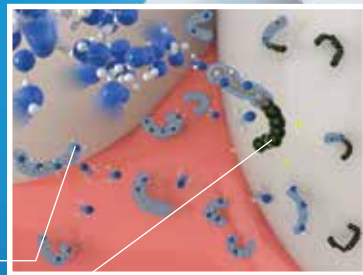
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Considering the value of volunteerism: A time for celebration!

Salme Lavigne, PhD, RDH

This year has truly been a formidable one for the *Canadian Journal of Dental Hygiene*, with so much to reminisce about and celebrate! With this final issue of 2016, our 50th anniversary celebrations reach a crescendo. We have compiled a timeline, highlighting the journal's milestones over the past 50 years, as well as a list of all those individuals who have contributed to the progress of the journal since 1966, and we are delighted to share them with you on the pages that follow.

Dental hygiene as a profession in Canada is still young when compared to other health professions. However, a 50-year history of publishing a professional journal certainly has contributed to the growth and advancement of our profession. The caliber of articles that we now publish, ranging from original research studies (randomized clinical trials, survey research, and well-designed qualitative studies, etc.) to comprehensive position papers, highlights how far we have come! Until 1973, 7 years after the inception of the journal, there were no formal guidelines for contributors. Now, we adhere to strict publication guidelines and peer-review procedures. We now have a comprehensive list of peer reviewers from around the world who volunteer their expertise to strengthen our publication. Additionally, we are indexed in 5 databases and are now respected internationally.

As I read through the historical milestones on pages 104–105, I couldn't help but feel a sense of pride in how much the journal has evolved since its humble beginnings. None of this progress would have been possible without the *volunteerism* and dedication of so many people. It is time to recognize and thank all of those hard-working people, the volunteer editors in the earlier years, the members of past editorial boards, some of whom served numerous terms, and CDHA staff and leaders of the profession, both past and present. I hope you enjoy the trip down memory lane as you read through the milestones and look at the pictorial history!

As dental hygienists, we have a strong track record of volunteerism within the profession, which has contributed to the growth and evolution of both the journal and



Salme Lavigne

the profession as a whole. Some people, however, may be reluctant to volunteer for positions within their professional association or for various professional undertakings, such as National Dental Hygienists Week™, community health events or health fairs. They may feel that they have nothing to contribute or that they don't have the time to get involved. Yet they may be overlooking an opportunity not only to grow their profession but also to experience personal growth.

Many studies have documented the powerful rewards of volunteerism.

Recent research has demonstrated that volunteering can actually lead to better health, and suggests that “those who volunteer have lower mortality rates, greater functional ability and lower rates of depression later in life than those who do not volunteer.”¹ An expert in volunteer management reported that the more people volunteered, the happier they were, and indicated that volunteering builds empathy, strengthens social bonds, and makes you smile.²

Most dental hygienists that I know entered the profession because they wanted to “help people.” That certainly was the case for me. We see our clients on a daily basis and reap the rewards of knowing that we are making a difference in their lives by helping them to improve their oral health. Think about how satisfied that makes you feel. Volunteering can give you that same sense of satisfaction!

Life these days tends to be on the “fast track” so it's no wonder that we all feel overwhelmed at times. As dental hygienists, we not only treat our clients, but we also re-evaluate the outcome of this care by re-measuring pocket depths, bleeding indices, and assessing overall tissue response. Perhaps we should also take a look at our own lives and re-evaluate just where our professional priorities lie. Volunteering could provide an escape from everyday routine, renew our purpose, and create a balance in our lives. Volunteering could also provide newfound energy and a sense of fulfilment capable of relieving tensions, fostering new perspectives, and expanding our horizons. In addition, volunteering offers incredible networking

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opportunities, both professionally and personally, by bringing together a diverse range of people in pursuit of a common objective.³ This networking could have a profound impact on your life.

We all “own” this profession, and it will take effort on all our parts to continue to nurture and grow the profession even further. In the business world, they call it continuous improvement. It is up to all dental hygienists to contribute to the advancement and improvement of our profession; no matter how small the contribution...it all counts! Be proud to be a dental hygienist and consider volunteering your time in some small way to help us to continue our professional evolution.

One of the great ironies of life is this: He or she who serves almost always benefits more than he or she who is served.

—Gordon Hinckle

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2. Merrill MV. *Ten professional development benefits of volunteering (Everything I learned in life I learned through volunteering)*. Columbus, OH: Merrill Associates; 2001. Available from: https://charityvillage.com/Content.aspx?topic=ten_professional_development_benefits_of_volunteering#.V-qcbU2rY2w
3. World Volunteer Web. Benefits of volunteering [Internet]. Available from: www.worldvolunteerweb.org/resources/how-to-guides/volunteer/doc/benefits-of-volunteering.html

IN THIS ISSUE

We are pleased to feature two original research articles in this issue. Amanda Verissimo, Susan Lynn Tolle, Gayle McCombs, and Aaron Arndt examine dental clients’ perceptions of dental hygienists with visible tattoos (p. 109), concluding that dental hygienists with large visible tattoos may be perceived as less professional by their clientele. Susan M Badanjak, Linda D Boyd, Kristeen R Perry, Lisa M LaSpina, Andrew T Rothman, and Lisa Byrne study the efficacy of sodium chlorite plus zinc gluconate mouthrinse in reducing volatile sulfur compound halitosis (p. 116). The results of their research suggest that a larger clinical trial is warranted. In addition, Joanna Asadoorian analyses the literature on commercially available oral rinses published since 2006 in order to update the Canadian Dental Hygienists Association’s position paper on therapeutic oral rinsing (p. 126). Bonnie Hoath, Colin Wiebe, Maria Isabel Garcia Fulle De Owen, Georgios Giannelis, and Hannu Larjava review the current status of the classification of periodontal diseases and updates that have been proposed by the American Academy of Periodontology in their short communication (p. 140). Finally, this issue pays tribute to the 50-year history of the journal with a historical timeline (p. 104) and a photo collage of past journal covers (p. 158), and recognizes the editors and editorial board members who have shaped the journal since 1966 (p. 103). As always, you will find a complete subject and author index at the end of this final issue of the volume year (p. 149).

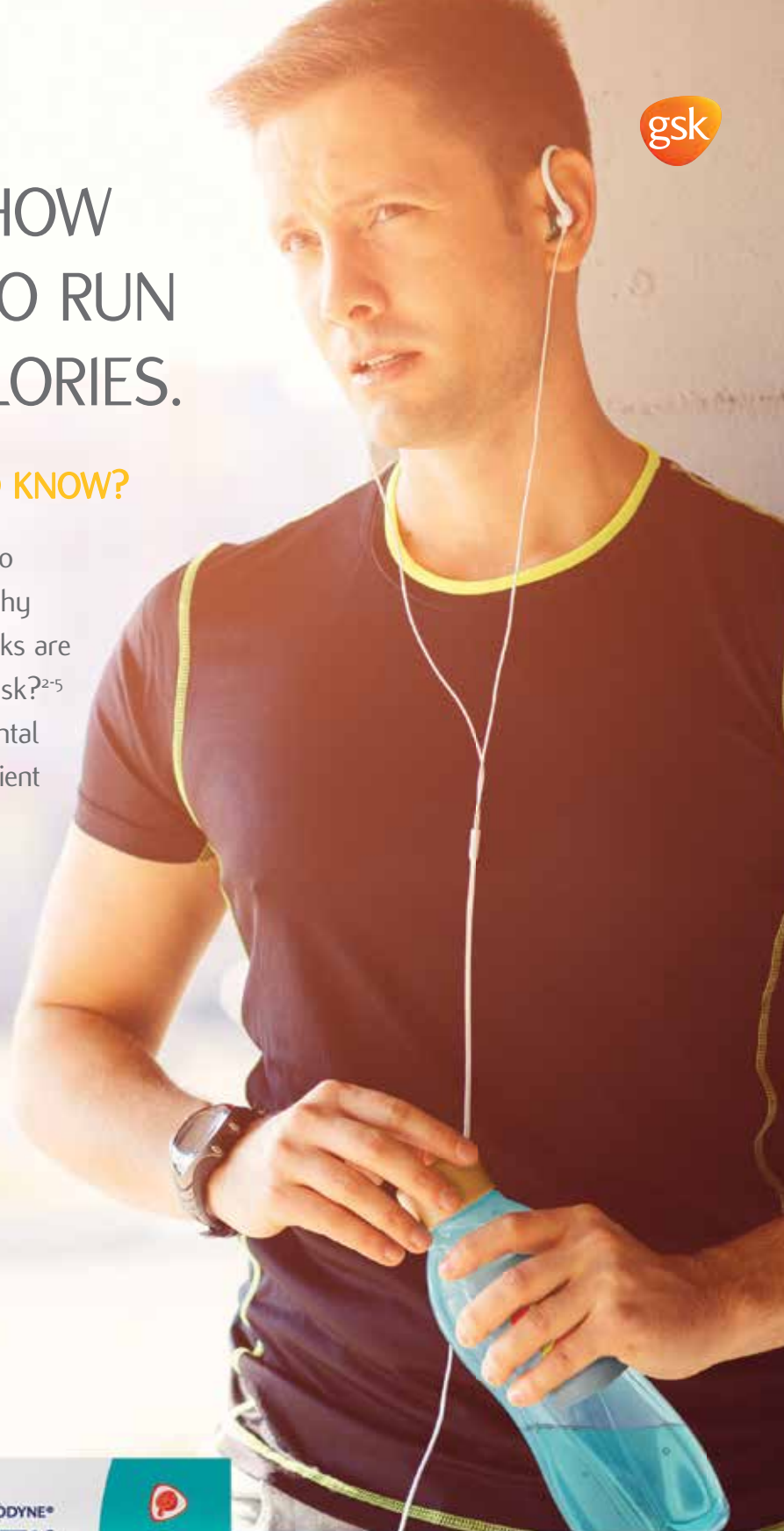


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1. GSK data on file, 2013. 2. Lussi A. Erosive tooth wear – a multifactorial condition. In: Lussi A, editor. Dental Erosion – from Diagnosis to Therapy. Karger, Basel, 2006. 3. Lussi A. *Eur J Oral Sci.* 1996;104:191-198. 4. Hara AT, et al. *Caries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

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CJDH Celebrates 50 Years

OUR EDITORS: 1966–2016

The *Canadian Journal of Dental Hygiene* thanks all past editors of the journal for their passion, vision, and dedication, which have contributed to the journal's growth and success over the past 50 years. Whether they held the title of chairman, editor, editorial director or scientific editor, these individuals shared their expertise and shaped a publication that continues to inform and educate its readers and contribute to the scientific body of knowledge of the dental hygiene profession. We stand upon the shoulders of giants.

1966	Dixie C Scoles	1989-1994	Marilyn Goulding
1967-1970	Patricia Kerr	1994-1996	Dianne Landry
1970-1972	Jackie Samson	1996-1998	Kristina Edwards
1973-1974	Hans E Franzgrote	1998-2004	Marilyn Goulding
1974-1979	Marjorie Dimitri	2004-2010	Susanne Sunell
1979-1985	Stephanie Nagle	2010-2015	Katherine Zmetana
1985	Arlee Malkewich	2015-present	Salme Lavigne
1986-1989	Fran Cotton		

OUR EDITORIAL BOARD MEMBERS: 1966–2016

The *Canadian Journal of Dental Hygiene* thanks those who served on its editorial board over the past 50 years, providing the expert advice and leadership required to sustain a high-quality, internationally recognized publication.

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Indu Dhir	Patricia Johnson	Janice FL Pimlott	

1960s



1966

- The Canadian Dental Hygienists Association launches a national journal under the provisional title, *Canadian Dental Hygienists Association Journal*

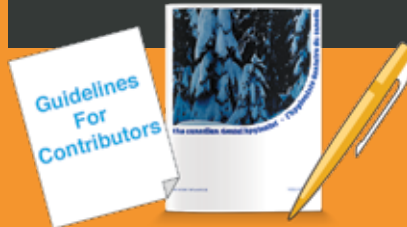
1967

- First issue using the official title, *The Canadian Dental Hygienist/L'hygiéniste dentaire du Canada*, is sent to all dental hygienists in Canada

1968

- First appearance of commercial advertising in the journal

1970s



1973

- First substantive *Guidelines for contributors* published

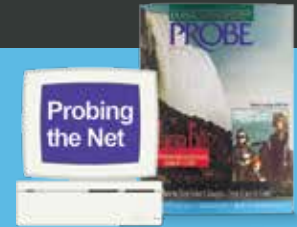
1974

- Journal moves from 2 issues to 4 issues per year (March, June, September, December)

1977

- *The Canadian Dental Hygienist* accorded an honorable mention in the Golden Pen Category of the 1977 International College of Dentists Journalism Competition
- Self-assessment tests published for the first time in the journal in recognition of the importance of continuing education

1990s



1990

- Journal publishes the proceedings of the 11th International Symposium on Dental Hygiene, which took place in Ottawa (June 29-July 1, 1989)
- First in-house managing editor hired

1993

- Journal begins publishing 6 issues per year
- Volunteer editorial director appointed to assist the scientific editor and managing editor in coordinating journal content

1996

- Launch of "Probing the Net" column to support self-directed online learning by dental hygienists

1998

- Self-assessment tests now published in both English and French

1999

- Two issues of *Probe* per year now devoted to the publication of original dental hygiene research
- First advisory group established to oversee the content of *Probe Scientific* issues

1980s



1982

- First journal readership survey conducted

1983

- First student journalism competition launched

1985

- Journal production moves to CDHA's national office in Ottawa

1986 (20th Anniversary of the Journal)

- Journal publishes the seminal *Summary and Recommendations of the Working Group on the Practice of Dental Hygiene in Canada*. Issue is distributed to all dental hygienists in Canada.
- Position of journal editor retitled from "editor" to "scientific editor" in recognition of the need to focus on strengthening the scientific sections of the journal
- **Journal undergoes a redesign and controversial name change to *Probe***
- Abstracts to scientific articles published in English and French for the first time

2000s



2000

- International Association of Dental Research (IADR) Abstracts published for the first time in *Probe Scientific*

2004

- **Journal renamed *Canadian Journal of Dental Hygiene/ Journal canadien de l'hygiène dentaire*.**
- CDHA research advisory committee formed to assist the journal in its new focus on research and evidence-based practice, and to advise CDHA on research matters

2005

- First issue of the journal published in print and online

2006

- Position of acquisitions editor established to assist the managing editor and scientific editor
- Journal now indexed by Thomson Gale (Cengage)

2007

- Formal criteria established for manuscript reviewers (minimum of a master's degree in a field related to dental hygiene, at least one publication in a peer-reviewed journal)
- CJDH now indexed by EBSCO and CINAHL

2008

- Journal now indexed by ProQuest

2009

- Journal begins publishing select bilingual Cochrane Review abstracts and summaries related to dental hygiene
- Journal publishes the proceedings of the first North American Dental Hygiene Research Conference jointly with the *Journal of Dental Hygiene*
- Launch of the "Research Corner" to highlight presentations given, awards and grants received, and other achievements of dental hygiene researchers in Canada

2010s



2010

- Journal publishes the inaugural winner of its Outstanding Research Award, sponsored by P&G

2011

- Journal reduces publication frequency to 4 issues per year (February, May, August, November)
- Launch of a "Student Corner" for manuscript submissions by senior students in an undergraduate degree or diploma program

2013

- **Journal adopts an open access model, making its contents available to the world, free of charge, 30 days after publication**

2014

- Journal approves and publishes its ethics policy, in English and French

2015

- Journal reduces publication frequency to 3 issues per year (February, June, October)
- Journal now indexed in Scopus
- CJDH Research Award now celebrates the best original research article and best literature review published in the previous volume year

2016

- **Scientific Editor presents a webinar, "The Mysteries of the Peer-Review Process," for dental hygienists with an interest in publishing in the journal**
- Student essay award competition launched to encourage budding authors and researchers
- The journal celebrates 50 years!



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Best Original Research Article

Competencies for Canadian baccalaureate dental hygiene education: A Delphi study, Part 2. *Can J Dent Hyg.* 2015;49(3):101–114.

Authors: S Sunell, J Asadoorian, CC Gadbury-Amyot, HC Biggar


Best Literature Review

Culturally safe oral health care for Aboriginal peoples in Canada. *Can J Dent Hyg.* 2015;49(1):21–28.

Author: EL Cavin

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Assessing dental clients' perceptions of dental hygienists with visible tattoos

Amanda Verissimo*, MS, RDH; Susan Lynn Tolle[§], BSDH, MS; Gayle McCombs[§], MS, RDH; Aaron Arndt[†], PhD

ABSTRACT

Purpose: The purpose of this study was to determine if visible tattoos affected dental clients' perceptions of dental hygienists. **Methods:** A survey was administered online to 203 subjects via a commercial web source. Participants viewed 1 of 3 photographs of a dental hygiene model wearing short-sleeved scrubs without a tattoo, with a small tattoo on the wrist or with a large sleeve tattoo on the arm. Respondents rated the professionalism of the dental hygiene model based on appearance and also indicated their willingness to use the dental hygienist's practice regularly. Finally, participants indicated whether or not they had tattoos. **Results:** The large tattoo negatively influenced perceptions of the dental hygienist's professionalism compared to no tattoo or a small tattoo. However, the dental hygienist with the small tattoo was not rated lower on professionalism. Furthermore, respondents with and without tattoos had a lower willingness to use the dental practice when the dental hygienist had a large tattoo. Although respondents with tattoos did not feel the dental hygienist with the small tattoo appeared to be more professional, they did have a greater intention to use the dental practice itself compared to respondents without tattoos. **Conclusions:** Large visible tattoos are perceived negatively by dental clients, with and without tattoos. Therefore, having a large visible tattoo may hinder clients' positive perceptions of the dental hygienist and puts the dental hygienist at risk of being negatively perceived by clients in the dental practice setting. While dental clients have a lower intention to use dental practices that employ dental hygienists with large tattoos, they are far more tolerant of small visible tattoos, particularly if they have tattoos themselves. Hence, it may be unnecessary for dental practices to adopt a "no visible tattoo" policy and instead to consider tattoos on a case-by-case basis.

RÉSUMÉ

Objectif : Cette étude visait à déterminer si les tatouages visibles influencent la perception des clients face aux hygiénistes dentaires. **Méthodes :** Un sondage a été mené en ligne auprès de 203 sujets par l'entremise d'une source Web commerciale. Les participants ont regardé une des 3 photographies où un hygiéniste dentaire modèle portait un uniforme à manches courtes sans tatouage, avec un petit tatouage sur le poignet, ou un plein tatouage sur le bras. Les répondants ont évalué le professionnalisme de l'hygiéniste dentaire selon son apparence et ont indiqué leur intention de visiter le cabinet de cet hygiéniste dentaire de façon régulière. Enfin, les participants ont indiqué s'ils avaient eux-mêmes des tatouages. **Résultats :** Le gros tatouage a influencé négativement la perception de professionnalisme de l'hygiéniste dentaire comparativement à la perception du professionnalisme de l'hygiéniste dentaire ayant un petit tatouage ou aucun tatouage. Cependant, l'hygiéniste dentaire ayant un petit tatouage n'a pas obtenu de cote plus faible en matière de professionnalisme. De plus, les répondants avec ou sans tatouage étaient moins désireux de fréquenter un cabinet dentaire lorsque l'hygiéniste dentaire avait un gros tatouage. Même si les répondants avec des tatouages ne trouvaient pas l'hygiéniste dentaire ayant un petit tatouage plus professionnels, ils avaient en effet une plus grande intention de visiter le cabinet dentaire comparativement aux répondants sans tatouage. **Conclusions :** Les gros tatouages visibles sont perçus négativement par les clients dentaires qu'ils aient des tatouages ou non. Par conséquent, le fait d'avoir un très gros tatouage visible peut compromettre la perception positive d'un client face à l'hygiéniste dentaire et met l'hygiéniste dentaire à risque d'être perçu négativement par les clients dans un cabinet dentaire. Alors que les clients dentaires ont moins l'intention de fréquenter un cabinet dentaire qui emploie des hygiénistes dentaires ayant un gros tatouage, ils sont beaucoup plus tolérants à l'égard des petits tatouages visibles, surtout s'ils ont eux-mêmes un tatouage. Ainsi, il n'est peut-être pas nécessaire que les cabinets dentaires adoptent une politique anti-tatouages visibles mais plutôt qu'ils envisagent les tatouages au cas par cas.

Key words: body art, dental hygienists, dental patients, dress codes in health care, professionalism, tattoos

INTRODUCTION

Perceptions of professionalism in health care are important in promoting positive relationships with clients and may be influenced by the health care provider's appearance.¹⁻⁵ Professional image and dress codes, therefore, are important considerations for every health care practice setting. A

new aspect of professional appearance in today's health care workforce is the presence of visible tattoos.⁶⁻⁹ Body art, including tattoos, have become popular among all ages, occupations, and social classes.¹⁰⁻¹⁵ For many, tattoos are becoming mainstream as cultural norms change,

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especially among the younger generation.¹¹⁻¹⁵ Twenty-five percent of the general population and between 20% and 60% of college-age students are estimated to have at least one tattoo.¹³⁻¹⁵ Not only are tattoos on the rise, but their visibility on persons in the workforce is increasing as well. This increase is likely related to more Generation Y persons entering the workforce and the high prevalence of tattoos in this population.^{7,13-15}

Despite the increasing popularity of tattoos, negative stereotyping of individuals displaying tattoos is a well-documented cultural norm. Research suggests that individuals with tattoos are viewed as non-conforming, risk-taking, rebellious, and as exhibiting unusual behaviours.¹⁴⁻¹⁸ Research also suggests that most people believe a person with tattoos is more likely to abuse alcohol and drugs than someone without a tattoo.¹⁴ Moreover people with tattoos are considered to be less credible, attractive, intelligent, and honest.¹⁶⁻²⁰ These negative attributes may impact the employee/employer relationship, the consumer/employee relationship, as well as the client/health care provider relationship.

Research indicates that tattoos in the workplace may suggest a lack of professionalism.⁶⁻⁹ Studies on consumers suggest that visible tattoos may hinder impressions of credibility and image, and many managers report that they prefer not to hire a person with a visible tattoo.¹⁶⁻²² In health care, a provider's first encounter with a client is the beginning of a relationship, and the professional attire and image of the health care provider may prompt an unintended and negative judgment.^{2,15} The image congruence theory suggests a link between employee appearance and consumer prediction of performance and satisfaction.²² If clients are not used to seeing their health care provider with a tattoo, they may expect their work performance to be less satisfactory as they associate tattoos with negative or risky behaviours. These perceptions have the potential to diminish the professional image of the provider in particular and the oral health care profession in general.²³ Moreover, health care client satisfaction is a goal of all dental practices. Dental clients who are dissatisfied, either because of perceived care issues or the appearance of a clinician, could detrimentally impact business, reputation, and performance. Their adherence to treatment recommendations and return appointment schedules could be compromised as well.

Few studies addressing visible tattoos in health care are available. Studies in nursing suggest that clients often hold negative perceptions of health care providers with visible tattoos, and positive relationships between health care providers and clients may be adversely affected by clients' negative perceptions and stereotyping of health care providers with body art.⁷ Westerfield et al. conducted a cross-sectional study evaluating 150 clients' perceptions of nurses with visible tattoos.⁷ Results revealed that hospitalized clients perceived the nurses without visible

tattoos as more caring, confident, reliable, attentive, cooperative, professional or approachable compared to nurse providers with visible tattoos. Female models with visible tattoos were perceived as less professional than male models, indicating possible gender bias in clients' perceptions of tattoos on female health care providers.

A study by Thomas et al. found that clients, nurses, nursing students, and nursing faculty considered the nurse with the most body art to be less caring, skilled, and knowledgeable than nurses with lesser amounts of body art.²³ Student nurses rated the nurse displaying the most tattoos more favourably than other participants, however, which suggests that younger workers may not view tattoos as negatively as their older colleagues. A study by Merrill revealed that clients and nurses did not consider visible tattoos to be professional for health care providers. These findings suggest that older participants and those without tattoos are more likely to rate the tattooed nurse as less professional.⁶

Marketing research has found that perceptions of competence, honesty, expertise, trustworthiness, and intellectual capabilities may be affected by an individual's personal appearance.¹⁸⁻²⁴ Consumers and clients may create a mental image of what "normal" service providers should look like depending on the type of service.¹⁹ If there is an incongruence between the expected physical appearance of the service provider and the service, it may distract the client from continuing the service or returning for future services. Research suggests that professional appearance provides clues to consumers about the level and quality of service to be expected.¹⁹⁻²² Consumer expectations may be lower when confronted with inappropriate dress and appearance.²¹ These same types of consumer perceptions can easily be transferable to business in health care and dentistry.

Dean investigated consumers' perceptions of visible tattoos on white collar workers.¹⁹ Results revealed that consumers had less confidence in the tattooed employee, were less likely to recommend the tattooed service provider to others, and were less satisfied with the service.¹⁹ Dean also surveyed people in public places about visible tattoos and found that participants viewed white collar workers (financial) with visible tattoos more negatively than blue collar workers (mechanics).²² Additionally, nurses and dentists with visible tattoos were both viewed as "dirty" or "unsanitary," even by those respondents who had tattoos, suggesting that health care occupations may be judged on the "appropriateness" of visible tattoos depending on what service they provide and how people think they should appear.

Research in this area is important, as biases about tattoos held by dental clients may influence their perception of the credibility and competence of their care providers and affect their decision to return for dental visits. Currently, there is a void in the literature regarding clients' opinions

Table 1. Demographic characteristics of respondents

		Frequency	Percent of respondents
Gender	Female	86	42.4
	Male	117	56.8
Highest degree earned	Graduate (master's or doctorate)	17	8.4
	Bachelor's	86	42.6
	Associate	40	19.8
Do you have a tattoo?	High school or equivalent	59	29.2
	Yes	47	23.2
	No	155	76.4
	1-3	34	70.8
How many tattoos do you have?	4-6	9	18.8
	7-10	3	6.3
	More than 10	1	2

of dental hygienists with visible tattoos and whether the tattoos affect these perceptions. The purpose of this study was to examine whether visible tattoos on a dental hygienist influenced clients' perceptions of the dental hygienist's professionalism and their intention to use the dental practice.

METHODS

After Institutional Review Board approval, an 11-item investigator-designed survey was administered online via a commercial web based software company (www.surveymonkey.com) to adult members of Amazon's Mechanical Turk (MTurk), a large crowdsourcing online marketplace, who demonstrated satisfactory work quality on previous MTurk assignments.²⁵⁻²⁶ The survey was made available to MTurk members in the United States who met 3 criteria: they had to be English speaking, at least 18 years of age, and had to have been a dental office client in the past 60 months. Consistent with other studies using MTurk, respondents received a nominal fee to complete the survey (US\$0.50).²⁷⁻²⁸ The MTurk website automatically collects respondent MTurk IDs so investigators know that participants completed the survey, but ID information is stored in a separate database (and computer) with connecting identifiers. Thus, respondent answers were not linked to the MTurk IDs and kept confidential.

The *Dental Hygiene Tattoo Survey* introduction letter provided participants with information about the study as well as obtained participant informed consent. A between-subjects research design was used in which survey participants were asked to select their birth month, which was used to determine which one of the 3 digitally modified photographs they viewed. The photographs were of the same dental hygienist dressed in scrubs with one of the following conditions: a) non-tattooed arm; b) large sleeve tattoo on the arm; c) small butterfly tattoo on the wrist.

After viewing the photograph of the dental hygienist, respondents were asked their opinions about the professionalism of the dental hygienist. Professionalism was measured using a 5-item scale created for this research and selected by a panel of dental hygiene faculty. The 5 attributes were ethical, responsible, competent, hygienic, and professional. Each was measured by asking respondents if they agreed with the statement, "This clinician gives the impression of being [attribute inserted]" using a 5-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Intention to use the practice was measured using a single item, "I would use this dental office on a regular basis," with a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). According to Bergkvist and Rossiter,²⁹ multiple items are unnecessary if additional items run the risk of tapping into another predictive attribute (which is likely in this experiment) and/or if there is a single concrete object (e.g., the dental office) and the attributes are concrete (e.g., intention to use). Demographic characteristics of the respondents were also obtained, providing the researchers with information on gender, education, age, approximate date of last dental visit, and if the respondent had a tattoo (Table 1).

Sample

The sample included 203 completed responses (no tattoo [n = 66], small tattoo [n = 70], large tattoo [n = 67]). The respondents were 57% male and 42% female, and had a mean age of 34.70 years. Twenty-three percent of respondents reported having at least one tattoo. Of respondents with tattoos, 54% were female, 33% reported that their tattoos were visible, 71% had 1 to 3 tattoos, and only 2% had more than 10 tattoos.

Scale validation

The validity of the professionalism scale was assessed by using a split sample procedure in which one half of the

sample was used in an exploratory factor analysis (EFA) and the other half was used in a confirmatory factor analysis (CFA). Respondents with even-numbered IDs were assigned to the EFA group; respondents with odd-numbered IDs were assigned to the CFA group. The EFA included the 5 items for professionalism and used principal component extraction. The items sorted onto a single factor (factor 1 eigenvalue = 4.20, percent variance explained = 84%). The component loadings are shown in Table 2.

Table 2. Professionalism scale

Item	EFA ^a	CFA ^a	CR ^a	AVE ^a	Cronbach's Alpha ^b
Ethical	0.902	0.844	0.939	0.755	0.944
Responsible	0.947	0.928			
Competent	0.936	0.897			
Hygienic	0.872	0.873			
Professional	0.926	0.797			

^aAnalysed using split sample

^bAnalysed using entire sample

A CFA was used on the other half of the sample. The chi-square was 3.96 (df = 3, model is not significant), the NFI was 0.99, the RFI was 0.97, the CFI was 1.0, and the RMSEA was 0.06. Given that the model was not significant, the NFI, RFI, and CFI were above 0.90, and the RMSEA was below 0.08, the model fit should be considered acceptable. Convergent validity is demonstrated by the high factor loadings (Table 2). Hence, the dental hygienist professionalism scale has acceptable psychometric properties. The scale was made by averaging the component items.

RESULTS

The full data set was used for the hypothesis testing. Analysis of variance (ANOVA) was used to compare dental hygienist tattoo (none, small, large) by respondent tattoo (no, yes) for professionalism. There was no significant interaction between dental hygienist and respondent tattoo ($F = 2.04$, ns). However, dental hygienist tattoo did have a significant direct effect ($F = 12.26$, $p < 0.001$). A Tukey's post hoc test was used to identify the specific effects. As shown in Figure 1, the large tattoo condition was rated lower than the no tattoo condition (mean diff = -0.73, $p < 0.001$). The large tattoo was also rated lower than the

small tattoo (mean diff = -0.52, $p < 0.001$). However, the small tattoo condition was not rated significantly lower than the no tattoo condition (mean diff = 0.21, ns). Thus, the large tattoo negatively influenced perceptions of the dental hygienist's professional attributes while the small tattoo did not. The direct effect of dental hygienist tattoo on professionalism is shown in Table 3.

An ANOVA was then used to compare dental hygienist tattoo (none, small, large) by respondent tattoo (no, yes) for intention to use the dental hygiene practice. There was a significant interaction between dental hygienist and respondent tattoo ($F = 4.35$, $p < 0.05$). Table 4 and Figure 2 show the interaction between tattoo condition and respondent tattoo on intention. Independent sample t-tests were used to identify specific differences between tattooed and non-tattooed respondents. There were no significant differences between respondents with and without tattoos for the dental hygienist without a tattoo (mean diff = 0.32, ns). There was also no significant difference for the dental

Table 3. Dental hygienist professionalism by tattoo status

Tattoo status	Professionalism	
	μ	σ^2
None	4.28	0.61
Small	4.07	0.73
Large	3.55	0.97

hygienist with a large tattoo (mean diff = 0.44, ns). However, when the dental hygienist had a small tattoo, respondents with tattoos were significantly more likely to become regular clients than respondents without tattoos (mean diff = 0.73, $p < 0.05$). Consequently, although respondents with tattoos did not feel that the dental hygienist with the small tattoo exhibited greater professionalism, they were more likely to use the dental practice itself.

DISCUSSION

Results from this study suggest that dental clients have less favourable perceptions of dental hygienists with large visible tattoos. The model with either no tattoo or a small tattoo was rated higher than the model with the large tattoo on every professional attribute tested in the study: ethical, responsible, competent, hygienic, and professional. Hence, our study partially confirms the findings by Westerfield et al. that clients view health care providers with visible tattoos

Table 4. Intention to use practice by dental hygienist tattoo and respondent tattoo

		Dental hygienist tattoo					
		None		Small		Large	
		μ	σ^2	μ	σ^2	μ	σ^2
Respondent tattoo	Yes	4.11	0.74	4.60	0.70	3.79	0.98
	No	4.43	0.62	3.87	0.87	3.35	1.14

as less caring, confident, and professional than providers without visible tattoos.⁸ Similar results were also found by Thomas et al. and by Merrill whose studies revealed that nurses with visible tattoos were considered by clients to be less professional, caring, competent, and knowledgeable than nurses without visible tattoos.^{6,23} These negative stereotypes have the potential to interfere with building trust and relationships, which could result in a negative relationship between the health care provider and client. Nevertheless, it was also found that dental hygienists with small visible tattoos were not rated significantly lower than those without tattoos. The implication of this finding is that dental clients assess tattoos on a case-by-case basis, and tattoos are not equally acceptable. Large tattoos are less acceptable than small ones.

In health care and dental hygiene in particular, clients may create an image of what a typical dental hygienist should look like. As noted in the image congruence theory, if the normalized expectation of physical appearance of the dental hygienist is not met, the incongruence may distract the client and promote negativity, which could also explain the low scores in this study of the large tattooed model. While large tattoos on dental hygiene professionals were viewed as inappropriate, the same tattoos on blue collar workers may be viewed as more acceptable.¹⁹ The nature of the work itself, with the dental hygienist mainly working within the personal space of the client, might have influenced the negative perceptions. The model in this study had a full “sleeve” tattoo on the arm

Figure 1. Rating of professionalism based on tattoo status

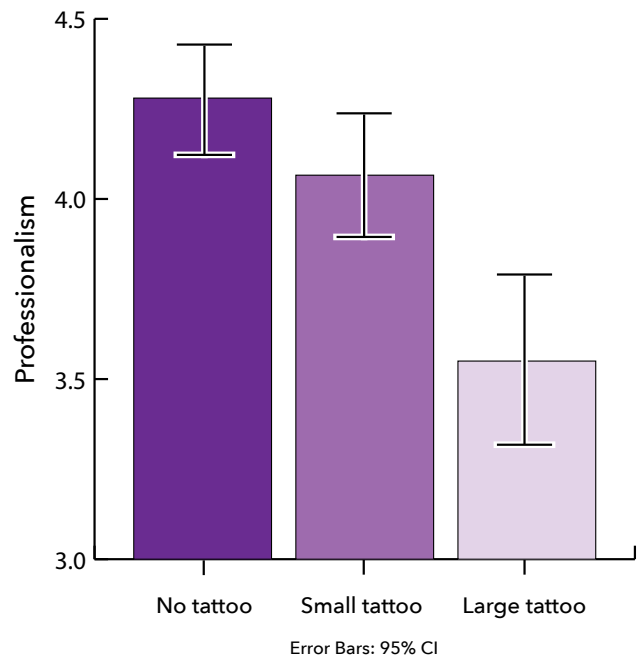
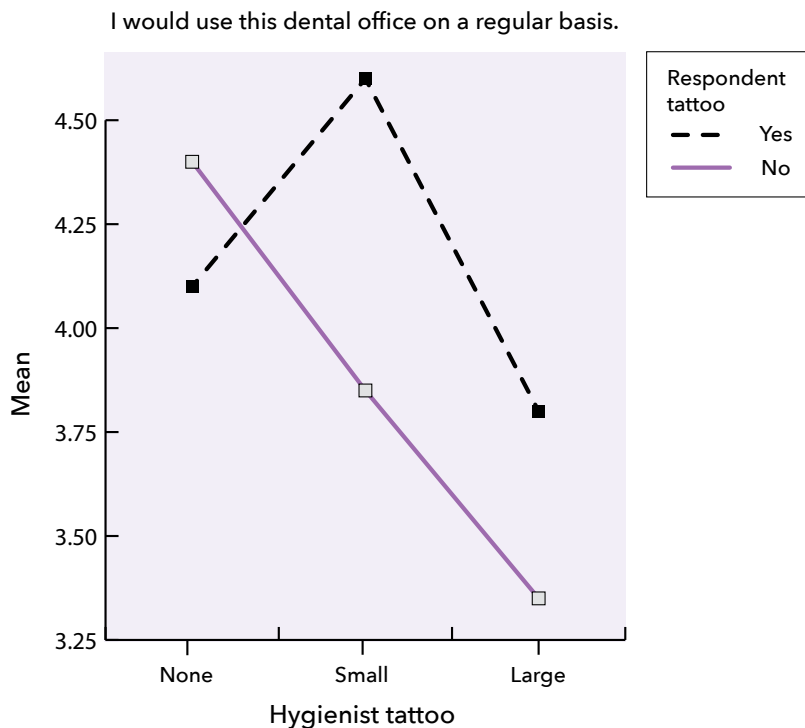


Figure 2. Interaction between tattoo status and respondent tattoo on dental visits



which would, theoretically, come in close proximity to the client's personal space and face when the dental hygienist instrumented. The same tattoo displayed elsewhere on the body may have yielded different results. Likewise, a different tattoo image (skull versus butterfly) might have influenced the findings as varying tattoos evoke different responses. Although not tested, it is likely that certain tattoo images (skull versus butterfly) might influence acceptability.

Furthermore, dental clients with tattoos have mixed attitudes towards dental hygienists with tattoos. Dental clients with tattoos rate dental hygienist professionalism and their own intention to use the dental practice lower for the dental hygienist with a large tattoo; hence, they are just as averse to large visible tattoos as dental clients without tattoos. Yet, even though clients with tattoos did not feel that the dental hygienist with the small tattoo exhibited greater professionalism, they still had a greater intention to use the dental practice as their regular dental home and to refer other clients. Dental clients with tattoos probably believe that a dental practice which hires dental hygienists with small visible tattoos will also be more tolerant of clients with tattoos.

This apparent contradiction between large and small tattoos can be explained by several factors. The literature has shown that tattoo wearers are not a homogeneous group.²⁹ Consequently, tattooed dental clients would not necessarily form a bond with a dental hygienist based solely on the presence of a tattoo; the form of the tattoo is more important. Another factor explaining the difference between large and small tattoos is the influence on professionalism. If dental hygienists with large visible tattoos are perceived to be less professional, then clients may question the wisdom of any dentist who hired them. It appears from the findings that the negative influence of large visible tattoos on perceptions of professional attributes is more salient than the potential benefit derived from a sense of acceptance felt by dental clients with tattoos.

The appearance of a health care provider should communicate to clients that the provider involved in their treatment is ethical, professional, competent, and trustworthy.^{30,31} For many clients, large visible tattoos may not be consistent with these types of characteristics. While some segments of the population are more accepting of an individual's freedom of self-expression, results from this study suggest that the professional image and credibility of a dental hygienist is negatively impacted by the presence of large visible tattoos. Perceived lack of credibility in a dental hygienist with large visible tattoos could have a detrimental effect on a dental office's overall practice image and level of client care. Thomas recommends that nurses who want to be perceived as skilled and knowledgeable limit the amount of visible body art.²³ Dental hygienists might consider adopting the same approach to project a more professional appearance while fostering positive relationships with clients. However, not all visible tattoos

have a negative effect on perceptions of professionalism or intention to use a dental practice, and some may actually be beneficial in attracting and retaining tattooed clients. However, the findings of this study suggest that tattoos should be assessed for their effect on perceived professionalism on a case-by-case basis.

Limitations

Several limitations could have influenced this study's findings. First, the experimental manipulation was based on a single person (a young Caucasian woman). Compounding stereotypical factors, such as gender, race or age, could influence how dental clients judge the appropriateness of tattoos on a dental hygienist. Future studies should assess other stereotypical information, such as manipulating the model gender. The tattoo images on the model also could have had an impact on the study findings. Varying types of tattoos may evoke a wide variety of responses in subjects, and different tattoo images may produce different results. No attempt was made to elucidate cultural differences, and future studies should also include a more diverse population as differing cultures may view tattoos differently. This study did not consider previous participant exposure to or experiences with dental hygienists. It only asked if participants were dental clients. Depending on the nature of their past dental hygiene experiences, either positive or negative, participants' perception of the model could be biased unintentionally regardless of the tattoo status. Likewise, if the participant had never received care from a dental hygienist, he or she may not view them as professionals and therefore questions on seeking care or referrals might have introduced bias.

CONCLUSIONS

The professional image of the health care provider is shaped by appearance. With the increasing number of persons entering the workforce with visible tattoos, it is important to obtain the client's perspective in health care and in particular dental hygiene. While individuals cannot be mandated as to whether or not they self-express with a tattoo, they should be aware of how these visual symbols are perceived. Results from this study suggest that dental clients perceive dental hygienists with small or no visible tattoos as more professional than dental hygienists with large visible tattoos. Limiting large visible tattoos may minimize negative client perceptions of the clinician and foster more positive interpersonal relationships between the client and dental hygienists.

These findings provide insight for dental hygiene clinicians as they contemplate decisions about obtaining visible tattoos. These findings also provide evidence-based information for dental hygienists, clinical supervisors, and hiring managers in a variety of practice settings as they formulate appearance and dress code policies relating to body art.

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Efficacy of sodium chlorite plus zinc gluconate on volatile sulfur compound halitosis: A randomized, double-blind, placebo-controlled pilot study

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ABSTRACT

Objective: The aim of this study was to assess the efficacy of sodium chlorite plus zinc gluconate (SC+ZG) mouthrinse in adults with halitosis from volatile sulfur compound (VSC) sources, using a randomized, double-blind, placebo-controlled clinical model. Investigators used the Yaegaki et al. standardized oral malodour clinical research protocol.¹ **Methods:** Seventeen (n = 17) subjects followed pre-testing preparation. On test day, baseline measurements of hydrogen sulfide (H₂S), methylmercaptan (MM), and dimethyl sulfide (DMS), were obtained using an OralChroma[®] CHM-2 gas chromatograph. Subjects were randomized to SC+ZG or placebo rinses. Supervised subjects rinsed with 15 mL of SC+ZG or placebo for 60 seconds and subsequently gargled with a second dose of the assigned mouthrinse for 30 seconds. Subjects were not permitted to eat or drink for 3 hours after the rinsing and gargling regimen, at which time measurements were repeated. **Results:** The study revealed some sizable differences in effect estimates between treatment arms when comparing changes in mean gas concentrations baseline to post-rinse. However, the results were not inferentially statistically significant, likely due to the study being underpowered. **Conclusion:** The study did not provide statistical evidence of efficacy of SC+ZG on all VSC halitosis, but demonstrated a slight trend in reducing H₂S and MM gas concentrations. Larger trials to establish efficacy and investigate a possible cumulative effect of SC+ZG mouthrinse are required. This is the first independent and disseminated study on SC+ZG mouthrinse.

RÉSUMÉ

Objectif : Cette étude visait à évaluer l'efficacité des bains de bouche au chlorite de sodium et au gluconate de zinc (CS + GZ) sur les adultes souffrant d'halitose provenant de composés de soufre volatils (CSV), au moyen d'un modèle clinique aléatoire, en double aveugle et contrôlé par placebo. Les chercheurs ont utilisé le protocole d'essai clinique standardisé de mauvaise odeur de Yaegaki et autres.¹ **Méthodes :** Dix-sept (n = 17) sujets ont suivi une préparation prétest. Le jour du test, des mesures de base du sulfure d'hydrogène (H₂S), méthylmercaptan (MM) et sulfure de diméthyle (DMS) ont été obtenues en utilisant l'OralChroma[®]CHM-2, un chromatographe en phase gazeuse. Les sujets ont été répartis de façon aléatoire entre le bain de bouche CS + GZ et le bain de bouche placebo. Les sujets ont rincé leur bouche sous supervision avec 15 mL de CS + GZ ou avec le placebo pendant 60 secondes et se sont par la suite gargarisé pendant 30 secondes avec une deuxième dose du bain de bouche qui leur avait été assigné. Les sujets n'étaient pas autorisés à manger ou à boire durant 3 heures après avoir rincé leur bouche et s'être gargarisé selon le protocole, moment auquel les mesures ont été prises de nouveau. **Résultats :** L'étude a révélé des différences considérables dans l'estimation des effets sur les 2 groupes de traitement, lorsque les mesures de base des changements moyens entre les concentrations de gaz ont été comparées aux mesures prises après le rinçage. Cependant, les résultats n'étaient pas implicitement significatifs sur le plan statistique, ce qui était probablement attribuable au fait que l'étude portait sur un petit nombre de cas. **Conclusion :** L'étude n'a pas offert de preuves statistiques de l'efficacité du CS + GZ dans tous les cas d'halitose au CSV, mais elle a démontré une légère tendance de réduction des concentrations de gaz H₂S et de la concentration de gaz MM. Des essais à plus grande échelle sont nécessaires dans le but d'établir et d'étudier l'effet cumulatif possible du bain de bouche CS + GZ. C'est la première étude indépendante et disséminée sur le bain de bouche au CS + GZ.

Key words: dimethyl sulfide, halitosis, hydrogen sulfide, methylmercaptan, mouthrinse, mouthwash, sodium chlorite, zinc gluconate

INTRODUCTION

Oral malodour is not a modern-age phenomenon and is frequently disclosed by clients to their oral care providers.¹⁻⁹ It is, in fact, one of the chief complaints reported to oral health care professionals.^{2,3,9,10} There is minimal scientific evidence on how to assess and manage the condition

effectively.^{1,2,9,11-13} Some shortcomings may stem from limited education on halitosis at the dental school level, including dental hygiene schools, and a lack of high-quality evidence regarding treatment.¹⁴⁻¹⁶ A thorough review of the literature did not produce any information

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on the ability of sodium chlorite plus zinc gluconate (SC+ZG) mouthrinse to reduce volatile sulfur compound-caused halitosis, hence the need for a study.

Without daily oral hygiene, the oral cavity becomes a hostile environment.^{2,3,5,17} Alterations in the normal flora or integrity of the oral cavity and its structures are potential precursors to or causes of oral malodour development.^{2,3,5,17} The exceptions include pseudohalutosis and halitophobia, which are not genuine causes of halitosis, but rather psychological disorders.^{2,3,18,19} Pseudohalutosis is characterized by a persistent complaint of halitosis by the client, even though no malodour is perceived by others or clinically detectable.^{2,3,18,19} Halitophobia is a recurrent and sometimes debilitating fear of halitosis, with the client insisting that oral malodour continues to be present, despite successful treatment of genuine or pseudohalutosis.^{2,3,18,19}

Hydrogen sulfide (H₂S) breath odour is said to be associated with poor oral hygiene, including intraoral appliances, and especially with tongue coating, while methylmercaptan (MM) oral malodour correlates strongly with periodontal disease.^{1-3,20} Both H₂S and MM are considered intraoral sources of halitosis.^{1-3,20} Hydrogen sulfide and MM are produced by almost all bacterial pathogens and are surrogate markers for bacteria-induced infection.²¹ It is important to note that it is the bacteria that produce the odour and not the host.²¹ Dimethyl sulfide (DMS), an extraoral source of halitosis, is usually a metabolic or organic disease/disorder olfactive biomarker.^{1-3,20} All three volatile sulfur compounds (VSCs) are highly toxic and have been implicated in oral and systemic host inflammation initiation in mammalian *in vitro* and *in vivo* models.²¹⁻²⁷

Traditional mechanical methods of halitosis treatment and management include tooth brushing,^{3,28,29} flossing,³⁰ tongue cleaning,^{3,28,29,31,32} and regular professional oral health care.⁵ The oral cavity, particularly the dorsum of the tongue, is believed to be largely responsible for acute intraoral halitosis.^{1-3,26,29,33-36} There has been much discussion about whether tongue brushing or scraping actually reduces oral malodour. Based on a review of high-evidence literature, it would seem that tongue brushing or scraping alone is not a satisfactory long-term solution for reducing intraoral malodour caused by tongue coating.^{3,28,29,31,32,37}

Masking or reducing halitosis can be achieved by using dentifrices,^{15,38-41} chewing gums,⁴²⁻⁴⁷ candies,^{31,48} tablets,⁴⁹ including mucoadhesive types,⁵⁰ or lozenges^{51,52} as vehicles for delivering therapeutic or cosmetic agents. Mouthrinses, however, have been the predominant mainstays for bad breath issues. Some of these agents have been shown to be more effective than others. However, like tongue cleaning, the effects are temporary. The ideal agent is one that provides a significant reduction in VSCs, has a long-lasting effect, and is used the fewest number of times in a 24-hour period. It should also be well tolerated, with no adverse

effects, especially with long-term use, and economical.

To date, there are only 4 mouthrinse ingredients that, when used regularly, seem to reduce or control halitosis effectively.^{14-16,53} These agents are chlorhexidine (CHX), cetyl pyridinium chloride (CPC), zinc, and sodium chlorite.^{14-16,53} There is some evidence that a combination of a zinc plus amine and stannous fluoride may also decrease VSC concentrations.^{15,16} However, the overall quality of evidence on the efficacy of therapeutic mouthrinses for halitosis is not robust.^{15,16}

In particular, there are no published clinical research data on the efficacy of SC+ZG, whether in the form of a rinse or in any other composition, on halitosis. The goal of this pilot study was to assess the efficacy of SC+ZG mouthrinse compared to placebo in reducing VSCs in an adult population, using an objective halitosis-measuring device.

METHODS

Study design

The purpose of this pilot study was to assess, using gas chromatography, the efficacy of SC+ZG mouthrinse on VSC halitosis in a gender-neutral adult population, using a randomized, double-blind, placebo-controlled study design. The trial was conducted using a standardized oral malodour research protocol designed by Yaegaki et al.¹ The protocol permitted evaluation of the test product during the optimal timeframe for halitosis assessment and in a single episode. Yaegaki et al. determined that optimal time and peak in VSC concentrations required for oral malodour breath testing occurs after 12 hours of fasting (no eating or drinking) and in the absence of oral hygiene, including rinsing. Furthermore, when testing specifically for the efficacy of halitosis management rinses, Yaegaki et al. indicated that breath should be re-tested 3 hours after administration of the active agent.¹

An advertisement was created for recruitment purposes and provided contact information for potential subjects. The advertisement was displayed at the MCPHS University, Forsyth School of Dental Hygiene Clinic, Boston, Massachusetts, USA, and on electronic reader boards on campus. Subjects were recruited by advertisement response or apprised of the study as a courtesy if they were new clients or drop-ins, who expressed an interest in participating. A prescreening script was developed to guide telephone recruitment. Recruitment started on March 25, 2015, and ended on July 20, 2015. Only subjects meeting the inclusion criteria were permitted to participate in the clinical trial.

Power calculations were conducted to determine the appropriate sample size required to detect treatment effectiveness in a full-scale clinical trial. These calculations showed that a sample size of at least 96 participants (48 participants in each study arm) was required to detect an absolute effect size difference as small as 15% between the treatment and placebo arms, with 80% power and

an alpha threshold of 0.05. Given that only 17 subjects enrolled in the trial, it was decided that a pilot study with a smaller group of participants ($n = 17$) would be conducted. Motivation for conducting the pilot study was twofold. First, the researchers wanted to determine whether a full-scale trial with 96 participants would be warranted in the future. This objective was accomplished by examining the general trends and estimated effect sizes from our analysis, with the understanding that the results of the present pilot study are underpowered and prone to type-II inferential error. Second, given that there are no published studies on the experimental SC+ZG mouthrinse, contributing to the scientific literature was deemed important.

Subjects were randomized to receive active product or placebo. Randomization was performed via a coin toss; heads indicated active rinse and tails placebo rinse. The appropriate rinse was retrieved from the secure storage location and distributed by the second investigator (LDB) and study personnel.

The experimental and placebo mouthrinses were supplied by the manufacturer, TheraBreath/Dr. Harold Katz, LLC, Los Angeles, CA, USA, in identical plastic bottles and contained identical ingredients, except for the proprietary active ingredients in the experimental TheraBreath Plus mouthrinse. Neither the principal investigator nor the subjects knew which research group received experimental or placebo mouthrinse until statistical analysis was completed at trial end.

Following protocol pretesting preparation and baseline breath gas concentration measurements of H_2S , MM, and DMS, using an OralChroma® CHM-2 portable gas chromatograph (GC), 17 recruited subjects were randomly assigned to SC+ZG or placebo rinses. The manufacturer's directions recommended shaking the bottle prior to use. According to the instructions on the supplied bottles, supervised subjects rinsed with 2 capfuls (15 mL) of active product or placebo for 60 seconds and expectorated. Under continued supervision, subjects then gargled with 2 capfuls (15 mL) of active product or placebo for 30 seconds and expectorated. In accordance with the Yaegaki et al. protocol,¹ subjects were not permitted to eat or drink for 3 hours after the rinsing and gargling regimen. Breath assessment was repeated 3 hours after the rinse and gargle regimen, using the portable GC.

Ethical considerations

The study was performed at MCPHS University, Forsyth School of Dental Hygiene, Boston, MA, USA, and underwent a full review by the Human Subject Committee of the Institutional Review Board. In accordance with the Belmont Act, participation in the study was voluntary and subjects could abandon the trial at any time, without repercussion. Furthermore, the study protocol precluded, without prejudice, vulnerable populations based on logistical, safety, medical, and cognitive parameters. These vulnerable populations included prisoners, fetuses, pregnant women,

the seriously ill, and mentally or cognitively compromised individuals. The study was partially funded by a Graduate Student Research Fellowship from the American Dental Education Association (ADEA).

Inclusion and exclusion criteria

The study was open to males and females, ages 18 years and older, who were complaining of halitosis or had been told they have halitosis and met the inclusion criteria. To be included in the study, subjects could not practice tongue scraping or brushing, or had to agree to discontinue doing so 7 days before breath assessments. Subjects were also required to agree to discontinue use of antibacterial and whitening or bleaching toothpaste 7 days before breath assessments and consent to exclusive use of a provided American Dental Association-endorsed dentifrice and new toothbrush. All subjects received detailed verbal and written information regarding the pilot study and gave informed consent in writing.

Excluded from the study were females who were pregnant, planning a pregnancy, lactating or nursing a child. Also excluded were subjects taking antibiotics or other antimicrobial drugs, including sulfa-based drugs, or steroidal or non-steroidal anti-inflammatory or antihistamine drugs, including inhalers, or had used antibiotic or antimicrobial medications within the previous 10 days. Subjects requiring medications in the morning with water and/or food were excluded, as were those with acute or chronic medical conditions. Use of all tobacco products and illicit or recreational drugs were disqualifiers. Subjects wearing dentures or partial dentures, those who presented with gross oral neglect (defined as no dental care for 24 consecutive months) or those who had a dental cleaning within the previous 30 days were inadmissible. Oral or dental pain, mouth sores or irritations, or serious oral conditions also precluded subjects from the trial.

The inclusion and exclusion criteria questionnaire screened for the possibility of allergies, sensitivities, and illnesses that prohibited fasting and, thereby, excluded subjects with the potential for adverse reactions or events. As a precaution, clients who believed or expressed that they could not fast safely were excluded from the trial. Participation in a simultaneous study was not permitted.

Clinical breath assessment

Trained and calibrated investigators conducted baseline breath assessments between 7 am and 9 am and final assessments from 10 am to 12 pm. Subjects practised the oral hygiene study protocol with the supplied toothpaste and toothbrush, except on the night before and the morning of the clinical breath assessment. Additionally, they were instructed not to eat odiferous foods (garlic, onions, curry, etc.) for 48 hours before the test; not to ingest alcohol and caffeine or caffeinated beverages for 18 hours before the test; to fast (no eating, no drinking – not even water, chewing gum or breath mints, etc.) for 12 hours before

Table 1. Organoleptic thresholds preprogrammed on OralChroma® CHM-2 portable gas chromatograph

Volatile sulfur compound	ng/10mL	ppb
Hydrogen sulfide [H ₂ S] (H ₂ S)	1.5	112
Methylmercaptan [CH ₃ SH] (MM)	0.5	26
Dimethyl sulfide [(CH ₃) ₂ S] (DMS)	0.2	8

the test; and not to practise any oral hygiene (no tooth or tongue brushing, no flossing, no use of any mouthwash or mouthrinse) for 12 hours before the test.

Breath samples were collected and tested. If the subject was at or below the organoleptic thresholds in parts per billion (ppb) for all three gases, he or she was excluded from the trial. The OralChroma® CHM-2 portable GC thresholds are listed in Table 1.

If the subject surpassed the organoleptic threshold for any one gas, he or she was randomized, assigned a mouthrinse, and asked to perform the supervised rinse and gargle regimen. The second breath assessment was performed 3 hours later. Subjects were asked to continue to fast and refrain from all oral hygiene practices, in keeping with the protocol, for 3 hours after the rinse and gargle regimen and remain on the premises during the 3-hour wait interval. The treatment (actual treatment or placebo) was considered effective for participants whose post-rinse measurements were H₂S < 112 ppb, MM < 26 ppb, and DMS < 8 ppb.

Gas chromatography analysis

The OralChroma® CHM-2 (Nissha USA, Schaumburg, IL, USA), a portable, chairside GC designed specifically for halitosis detection, was used for gas sample analysis.^{11,13} The unit recalibrated automatically after each breath test. Gas samples were drawn from the mouth using a 1 mL single-use, sterilized syringe; this sample collection technique promoted infection control.^{11,13} Subjects were asked to breathe normally through the nose throughout the entire process. Subjects introduced the sterile syringe up to the barrel top (finger flange) into the oral cavity and held the syringe between the front teeth, not allowing the tip of the syringe to touch any part of the oral cavity. With lips closed tightly around the syringe barrel, subjects waited 30 seconds for oral gases to accumulate. With lips still tightly closed around the syringe barrel, subjects withdrew a first breath sample, immediately pushing the first sample back into the mouth. Without removing the syringe barrel from the mouth and keeping the lips tightly closed, a second sample was drawn. The second gas sample was used for breath assessment. After removing the syringe from the mouth, the tip of the syringe was wiped with a tissue (unscented and emollient-free). Mouth gas was expelled to the 1 mL (cc) line and the sample was injected rapidly into the gas inlet of the OralChroma® CHM-2. The

measurement process was triggered automatically after gas infusion. Results were displayed onscreen in 4 minutes. All data were stored through the unit's software and chromatograms were printed when necessary.

Statistical analysis

The data analysis included descriptive and inferential statistical analysis. To determine if randomization was insufficient to produce similar study arms at baseline, demographics were compared between study arms using analysis of variance (ANOVA) for continuous variables and Fisher's Exact Test for categorical variables. Additionally, mean baseline H₂S, MM, and DMS gas concentrations were compared between study arms respectively using ANOVA. To assess the effectiveness of the treatment, mean changes in concentration (post-treatment minus baseline) of H₂S, MM, and DMS were compared using ANOVA, with the binary effectiveness outcome (post-rinse measurements were H₂S < 112 ppb, MM < 26 ppb, and DMS < 8 ppb) compared between the 2 study arms via Fisher's Exact Test. An alpha threshold of 0.05 was set for all statistical testing. All statistical analyses were performed in STATA® statistics/data analysis software version 14.0 (STATA® College Station, TX, USA).

RESULTS

A total of 17 subjects completed the trial. No adverse events were reported. Nine (n = 9) subjects received the intervention agent and eight (n = 8) received placebo. Collected demographic data included gender, age, race, country of origin, and level of education (Table 2). Results showed no statistically significant differences in demographics between the treatment and placebo arms (all *P* values > 0.05). Inferential analysis of baseline gas concentrations also showed no statistically significant differences in mean H₂S, MM, and DMS gas concentrations between the 2 study arms at baseline (Table 3).

Table 4 shows mean changes in concentration (post-treatment minus baseline) of H₂S, MM, and DMS with 95% confidence bounds and the inferential comparison of mean change in gas concentration between study arms. Looking at the effect size estimates, the mean H₂S gas concentration in the treatment group decreased by 16.4 ppb from baseline to post-rinse, while the mean H₂S gas concentration in the placebo group decreased by only 2.9 ppb. The mean concentration of MM also decreased from baseline to post-rinse in the treatment group compared to the placebo group (28.4 ppb vs 11.2 ppb, respectively). However, inferential comparison between the 2 treatment arms of changes in mean concentration of H₂S and MM gases baseline to post-rinse, were not statistically significant (*P* = 0.467 and 0.262, respectively). The binary effectiveness outcome (post-rinse measurements H₂S < 112 ppb, MM < 26 ppb, and DMS < 8 ppb) results identified one participant in the

Table 2. Demographic characteristics of study population

	Treatment (n = 9)	Placebo (n = 8)	P value
Gender			0.563 ^a
Male	3 (33%)	2 (25%)	
Female	6 (67%)	6 (75%)	
Participant age, mean years (SD)	29 (15.85)	25.13 (3.56)	0.511 ^b
Race			0.608 ^a
White	3 (33%)	2 (25%)	
Black	1 (11%)	3 (37%)	
Hispanic/Latino	1 (11%)	2 (25%)	
Native American	1 (11%)	0 (0%)	
Missing	3 (33%)	1 (13%)	
Country of origin			0.718 ^a
USA	1 (11%)	1 (13%)	
Nigeria	0 (0%)	1 (13%)	
Brazil	8 (89%)	6 (75%)	
Education			0.131 ^a
High school	8 (89%)	4 (50%)	
College/university	1 (11%)	4 (50%)	

^aP values for categorical^bP values for continuous variables via ANOVA

treatment arm and one participant in the placebo arm who met the post-rinse criteria. Inferential comparison of study arms with respect to the binary effectiveness outcome was not statistically significant ($P = 0.735$).

DISCUSSION

Sound methods, namely the use of a randomized, double-blind, placebo-controlled design and objectively obtained gas concentration measurements, were used to compare the efficacy of SC+ZG versus placebo mouthrinse on VSC halitosis. Results of the pilot study revealed some sizable differences in effect estimates between treatment arms when comparing changes in mean gas concentrations from baseline to post-rinse. However, the results were not statistically significant from an inferential perspective. This is very likely due to the study being underpowered to inferentially detect effect sizes as small as those reported in Table 4.

A review of the literature showed that halitosis is common, globally prevalent, and affects almost 50% of the world's population, without discrimination.^{2,3,17,54} These findings are borne out by the trial; neither gender, age, race, birth country, nor education level influenced halitosis.

Gender is not a determinant of halitosis per se, as it occurs in both males and females.^{2-8,17,55-57} However, the increasing level of estrogen in the bloodstream during menstruation influences oral malodour in some women and is responsible for fluctuations in VSCs, the main

constituents of oral malodour.^{1,2,56-59} Liu et al. reported higher overall VSC values for women in 3 of 5 age groups; however, only the age bracket of 35- to 44-year-old women ($n = 400$) showed a statistically significant ($P < 0.05$) increase in VSCs, compared to men ($n = 400$) in the same age bracket.⁵⁷ Liu et al. attributed the trend of higher VSCs in women to the menstrual cycle.⁵⁷ Historically, premenopausal women were excluded from breath research trials, but the Yaegaki et al. standardized breath research protocol permits inclusion of female subjects, even during menses.¹ To compensate for the variation in VSCs during menstrual periods, Yaegaki et al. suggest performing studies that take no longer than 3 hours from initial to final breath assessment.¹ It is unlikely there would be a dramatic shift in the amount of circulating estrogen during the 3-hour assessment window. Therefore, the Yaegaki et al. standardized breath research protocol was used to ensure enrollment of female subjects. In this study, 70% of the subjects were female, with equal numbers in the

Table 3. Baseline gas concentrations

Mean baseline concentrations	Treatment (n = 9)	Placebo (n = 8)	P value ^a
H ₂ S (SD)	56.00 (87.32)	27.95 (1.17)	0.379
MM (SD)	63.89 (24.19)	71.20 (1.58)	0.408
DMS (SD)	95.68 (52.12)	105.48 (43.03)	0.681

^aP values for continuous variables via ANOVA

Table 4. Gas concentrations after rinse and gargle regimen

Change in mean concentration (Post-rinse – baseline)	Treatment (n = 9)	Placebo (n = 8)	P value
H ₂ S ppb (95% CI)	-16.4 (-54.9, 22.1)	-2.9 (-11.7, 5.9)	0.467 ^a
MM ppb (95% CI)	-28.4 (-54.8, -1.9)	-11.2 (-31.8, 9.3)	0.262 ^a
DMS ppb (95% CI)	-3.4 (-47.7, 40.9)	-28.6 (-77.2, 19.9)	0.383 ^a
Binary effectiveness outcome	Treatment (n = 9)	Placebo (n = 8)	P value
Post-rinse concentration with H ₂ S < 112 ppb, MM < 26 ppb, DMS < 8 ppb	1 (11%)	1 (13%)	0.735 ^b

^aP values for categorical variables via Fisher's Exact Test

^bP values for continuous variables via ANOVA

95% CI: 95% Wald Confidence Interval

treatment and placebo groups ($P = 0.563$). Gender had no bearing on the outcomes of this study.

Halitosis has been documented in all age groups: infants,^{6,55,60,61} children,^{6,7,56,60,61} adolescents,^{3,6,56,57} adults,^{3,4,6,8,57,62} and seniors.^{3-6,17,57} The etiologies in these age groups may be distinct, similar or overlapping.^{2-5,7,17,55,56} Halitosis has been reported to increase with age,^{3,54} but Samnieng et al. did not find a statistically significant association between age ($P = 0.833$) in a randomized, controlled study of 428 elderly Thai subjects (mean age 67.6 years, SD ± 5.6 years).¹⁷ Although not a longitudinal trial, the conclusion by Samnieng et al. is supported by other studies.¹⁷ The National Epidemiological Survey on Oral Health in China evaluated halitosis characteristics of 2000 subjects, ages 15 to 64 years.⁵⁷ No statistical difference in oral malodour was detected in relation to age among subjects.⁵⁷ In a study by Quirynen et al. evaluating the characteristics of 2000 clients of a halitosis clinic in Belgium, client age ranged from 2 to 90 years (mean age 39.2, SD ± 14.2).⁶ Finally, in a 7-year retrospective study of 451 clients who visited a Swiss halitosis clinic, Zürcher et al. reported the average age of clients was 43.7 years.⁸ Ages ranged from 21 to 71 years in this trial, with the average age being 29 (SD ± 15.85) years in the treatment cohort and 25.13 (SD ± 3.56) years in the placebo cohort ($P = 0.511$). Age did not play a role in this pilot study.

A review of the race and ethnicities of all study subjects in journal articles referenced confirms that halitosis is universal.^{3-8,17-19,54-57} The most compelling evidence comes from the Global Burden of Disease Study 2010⁶³ and, more specifically, from the systematic analysis of the burden of oral conditions by Marcenes et al.,⁵⁴ the systematic review and meta-regression of the burden of severe periodontitis by Kassebaum et al.,⁶⁴ and the systematic review and meta-analysis of the burden of severe tooth loss by Kassebaum et al.⁶⁵ Measured in disability-adjusted life years (DALYs), with disability defined as halitosis, dysgeusia, and occasional bleeding, and using the metric years living with disability (YLDs) to quantify burden, oral conditions collectively

affected more than 55% of the world population.^{54,66} Global prevalence of untreated caries was 35% in permanent dentition and 9% in deciduous dentition.^{54,66} Severe tooth loss, specified as having fewer than 9 permanent teeth, was estimated to be 2% globally.^{54,65} Severe periodontitis, designated as clinical attachment loss of greater than 6 mm, or probing depth greater than 5 mm, was calculated to affect 11% of the global population.^{54,64,67} Subjects from 3 continents and 4 races participated in this study. No difference was identified between the treatment and placebo groups with respect to race ($P = 0.608$) and country of origin ($P = 0.718$), the inference being that culture and cultural practices do not correlate with halitosis.

Furthermore, education level has little bearing on the prevalence of oral malodour.^{3,17} However, providing oral hygiene education and practising the techniques reduce the incidence of halitosis.^{2,3,5,68} A controlled clinical trial by Seemann et al. with 65 dental students as subjects evaluated the effect of oral hygiene instruction on oral malodour.⁶⁸ The oral hygiene naïve control subjects continued to have bad breath, while those who benefitted from oral hygiene instruction had statistically significant ($P < 0.05$) reduction of mouth odour.⁶⁸ No significant difference was found between the treatment and placebo cohorts in relation to education level in this pilot study ($P = 0.131$). Participants were not instructed on oral malodour reduction techniques during the trial, but were offered vouchers for free dental hygiene care at the Forsyth School of Dental Hygiene Clinic, to be used at their convenience.

Although not reported in this study, based strictly on socioeconomic status (SES), there is no difference in the incidence of halitosis; breath malodour has been identified in all classes of society.^{3,17,54,64} According to Liu et al., social factors of 2000 Chinese male ($n = 1000$) and female ($n = 1000$) subjects did not contribute to oral malodour, nor did place of residence, whether urban or rural.⁵⁷ Speculation about how SES may impact oral malodour centres on a client's financial ability to access professional care, but this is refuted by Marcenes et al.⁵⁴ and Samnieng et al.¹⁷

Limitations

The sample size of this pilot study was small ($n = 17$). Consequently, the trial was underpowered to detect small effect sizes. In order to detect a treatment efficacy of 15% in the treatment group, statistical power calculations dictated a minimum of 48 participants in each study arm. The study protocol is not validated, but a review of the literature did not produce any other standardized halitosis clinical research protocols. Criterion validity, and more specifically concurrent validity, could not be ascertained, because it could not be judged or tested against a standard protocol or test. As there are no published data on the efficacy of SC+ZG specifically and the pilot study was not longitudinal, it was not possible to determine whether the product has a cumulative positive effect over time. Therefore, another consideration is warranted: perhaps a trial of longer duration would show greater efficacy.

Shinada et al.⁵³ tested the efficacy of sodium chlorite with greater frequency and over a longer duration. In that study, subjects used the active rinse or placebo twice a day for 7 days. A one-week washout was observed, subjects switched rinses, and then used the opposite rinse for 7 days. Breath assessments were performed organoleptically and by GC analysis, however no organoleptic scores were provided. Based on the GC readings, the studied rinse did statistically significantly reduce each of the VSC gases responsible for halitosis in both treatment arms at trial end. The active rinse in the Shinada et al. trial was termed “chlorine dioxide,” but described in detail as 0.16% w/w sodium chlorite, with an efficacy of 0.10% w/w of chlorine dioxide. The treatment rinse in the Shinada et al. study did not contain a zinc compound.

Trial data from Doran et al.⁵¹ show that zinc gluconate attenuates oral malodour temporarily. Rolla et al.⁵² evaluated the stability constants of 4 different zinc compound lozenges in vivo ($n = 10$) to determine whether the zinc source impacted the ability to reduce VSCs. Lozenges containing zinc acetate, zinc gluconate, zinc citrate, and amino acid-chelated zinc were tested; all lozenges contained 6.8 mg of zinc. There was no statistically significant difference between the lozenges with high or low stability constants; all zinc lozenges freely ionized with sulfur. However, at 180 minutes zinc gluconate showed the highest VSC percent reduction and zinc citrate the lowest. No *P* values were provided in this study.

Five studies reviewed by Scully¹⁵ and Blom et al.¹⁶ referred to chlorine dioxide as being a mouthrinse used in the trials. This is either an error or a misnomer, as chlorine dioxide is a gas, highly unstable, violently reactive, and toxic.⁶⁹ Without further research into the chemical constituents of the so-called chlorine dioxide rinses, which was outside the scope of the literature review and pilot study, it is difficult to draw comparisons between chlorine-based mouthrinses. It is possible that research done with

rinses with incorrect nomenclature, i.e., chlorine dioxide mouthrinse, was actually performed using a sodium chlorite mouthrinse.

Chlorine dioxide gas dissolved in water and sodium chlorite have similar oxidizing, deodorizing, disinfecting, and biocidal properties.^{70,71} Investigations using different combinations of zinc compounds, CHX, and/or chlorine-based agents used to counter bad breath have been published.^{37,53,70,72-80} However, only one in vivo trial using sodium chlorite solution containing a zinc compound has been sourced to date. Codipilly et al.⁸¹ assessed the efficacy of zinc chloride plus sodium chlorite; zinc chloride; and placebo. Although Codipilly et al. reported that zinc chloride plus sodium chlorite was significantly superior to zinc chloride and placebo, the *P* values were not reported in the study. There are no published studies on the efficacy of SC+ZG specifically, whether in a mouthrinse or any other form, on halitosis.

CONCLUSION

Use of objective and analytical methods of detection are accurate ways of differentiating between oral and non-oral causes of bad breath.^{1-3,9,11,17,82-85} The Yaegaki et al. standardized protocol for oral malodour research seems to be an effective testing method to ascertain the efficacy of experimental mouthrinses.¹

Analysis of the literature underscores the paucity of large RCTs examining treatment of halitosis in general, and with mouthrinses specifically. The quality of evidence in the studies reviewed was graded as low to very low.^{15,16} Substantiated by the findings of Scully¹⁵ and Blom et al.¹⁶, it seems that zinc compounds, CPC, and CHX play an important role in neutralizing VSCs. Only one study tested and reported on the efficacy of sodium chlorite plus a zinc compound, but did not provide statistical evidence.¹⁵ No trials evaluating SC+ZG efficacy were found. Hence there is no evidence, due to lack of published data concerning the efficacy of SC+ZG mouthrinse, other than the data collected and reported in this pilot study.

Halitosis is not affected by age, gender, ethnicity, race or education, according to the literature and the findings of this pilot study. Halitosis is universal and indiscriminate. Data from this pilot study did show a general trend of effect in lowering H₂S and MM gas concentrations from baseline to post-rinse and more so in the treatment than the placebo arm. However, the pilot study was underpowered to detect effect sizes as small as those shown in the statistical analysis. The present analysis does, however, provide incentive for further investigation; a larger scale trial to detect smaller effect sizes and maximum efficacy may be warranted. Moving forward, large, well-designed, methodologically sound, unbiased, and longitudinal clinical trials, which report complete results, are necessary to provide compelling evidence regarding efficacy of halitosis solutions or remedies, irrespective of their delivery technology.

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Therapeutic oral rinsing with commercially available products: Position paper and statement from the Canadian Dental Hygienists Association

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ABSTRACT

Background: Mechanical methods of oral hygiene have been shown insufficient in controlling biofilm and preventing the initiation and progression of gingival inflammation and disease. These findings provide the impetus for additional research and the broader use of therapeutic oral rinses by adults. This position paper updates and replaces the 2006 Canadian Dental Hygienists Association position paper on oral rinsing to guide dental hygienists and other dental professionals in making client recommendations. **Methods:** A literature search using MEDLINE-PubMed, the 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. 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 42 papers for full review. An additional 24 articles identified through hand searching resulted in 66 full-text articles retrieved. Of these, 46 studies were included in the final review. Studies were categorized and reviewed according to a research-stage taxonomy. **Discussion and Conclusions:** The research demonstrates that a commercially available essential oil oral rinse, with a fixed combination of thymol 0.063%, eucalyptol 0.091%, and menthol 0.042%, provides statistically and clinically significant plaque and gingival inflammation reductions beyond that accomplished by mechanical means. While chlorhexidine gluconate rinse remains the gold standard with regard to plaque reduction, its negative side effect profile precludes long-term use. Several other products demonstrated superior efficacy to placebos and require further research. Among non-prescription oral rinses, the essential oil rinse was most effective, safe, and acceptable to study subjects, and should be recommended as a daily complement to tooth brushing and interdental mechanical cleansing for adult clients.

RÉSUMÉ:

Contexte : Il a été démontré que les méthodes mécaniques d'hygiène dentaire ne suffisent pas à contrôler la formation de biofilms ni à prévenir le déclenchement et la progression de l'inflammation et de l'affection des gencives. Ces constatations donnent l'élan nécessaire à des recherches supplémentaires et à l'utilisation plus répandue de rince-bouches thérapeutiques par les adultes. Le présent exposé de position actualise et remplace l'exposé de position de 2006 de l'Association canadienne des hygiénistes dentaires sur le rinçage buccal afin d'orienter les hygiénistes dentaires et autres professionnels dentaires lorsqu'ils formulent des recommandations aux clients. **Méthodes :** Une recherche documentaire a été effectuée en étapes à l'aide des bases de données de MEDLINE-PubMed, du Cochrane Central Register of Controlled Trials et du 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 42 articles pour examen complet. L'ajout de 24 articles supplémentaires par recherche manuelle a permis d'obtenir le texte intégral d'un total de 66 articles. Parmi ces articles, 46 études ont fait partie de l'examen final. Les études ont été classées et révisées en fonction de la taxonomie par phase de recherche. **Discussion et conclusions :** La recherche démontre qu'un rince-bouche aux huiles essentielles, offert sur le marché, composé d'une association médicamenteuse fixe de thymol à 0,063 %, d'eucalyptol à 0,091 % et de menthol à 0,042 %, permet des réductions statistiques et cliniques considérables de plaque et d'inflammation gingivale qui vont au-delà de celles produites par des moyens mécaniques. Bien que les rince-bouches au gluconate de chlorhexidine demeurent l'étalon de référence lorsqu'il s'agit de la réduction de la plaque, leur profil d'effets secondaires négatifs empêche leur utilisation à long terme. Plusieurs autres produits ont montré une efficacité supérieure à celle des placebo et requièrent davantage de recherches. Parmi les rince-bouches vendus sans ordonnance, le rince-bouche aux huiles essentielles était le plus efficace, sécuritaire et acceptable de la part des sujets de l'étude et devrait être recommandé aux clients adultes comme complément quotidien au brossage de dents et au nettoyage mécanique interdentaire.

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

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CANADIAN DENTAL HYGIENISTS ASSOCIATION POSITION STATEMENT

Based on the current research, dental hygienists are encouraged to recommend oral rinsing with a commercially available therapeutic over-the-counter oral rinse (mouthwash) to their adult clients as a long-term complement to usual mechanical plaque control measures. An accumulation of research, including well-conducted long-term clinical studies (≥ 6 months), has shown that oral rinses with a fixed combination of 3 essential oils—thymol 0.063%, eucalyptol 0.091%, and menthol 0.042%, along with other ingredient(s) (e.g., methyl salicylate 0.0660%)—produce statistically and clinically significant reductions in plaque and gingival inflammation beyond that accomplished by mechanical means alone. Other oral rinses demonstrate some reductions in plaque and gingivitis, but the research on these formulations is less conclusive. While prescription chlorhexidine gluconate oral rinse has been the gold standard with regard to reductions in plaque and gingival inflammation parameters, it is recommended for short-term use only due to a negative side effect profile. Dental hygienists can recommend alcohol-containing therapeutic oral rinse products as these have not been demonstrated to have adverse effects; the exception remains for clients who are unable to tolerate alcohol for personal or health reasons. Dental hygiene interventions should be client-specific and should be based on current evidence, which indicates that therapeutic oral rinses are an important complement to home care routines to achieve optimal oral hygiene and promote oral health for adult clients.

INTRODUCTION

Dental hygiene clients find it challenging to maintain satisfactory oral hygiene through mechanical methods and, as a result, therapeutic oral rinsing has been advanced as an important addition to home care for reducing oral biofilm. Oral biofilm is the primary etiology for gingivitis, periodontitis, and caries, and also contributes to halitosis and systemic well-being.¹ Traditional mechanical methods for achieving oral cleanliness, such as tooth brushing and interdental cleansing, have been mainstays in controlling oral biofilm, but have in the last several years been recognized as insufficient in preventing oral disease initiation and progression.^{2,3} The effectiveness of dental flossing, a pillar of oral hygiene recommendations, has recently been questioned in the media because of a lack of supporting research.⁴ The addition of a therapeutic oral rinse to home care routines has been recommended as an important complement to mechanical methods.⁵ However, with many oral rinse formulations available on the market and numerous others in development, product selection for both the client and the dental hygienist is challenging.

This position paper, endorsed by the Canadian Dental Hygienists Association (CDHA), provides a comprehensive review of the research on therapeutic oral rinsing, including commercially available over-the-counter (OTC) and prescription oral therapeutic agents. This review was conducted to update CDHA's 2006 position paper and statement⁶ on home mouth rinsing as a preventive oral health behaviour particularly as it relates to periodontal disease initiation and progression. While the review included research on oral rinse products in early development and not yet commercially available, those findings will be published separately. The present review updates and replaces the 2006 CDHA position paper and statements, written by the same author. A summary of the updates is found in the Appendix.

Studies testing the effectiveness of therapeutic oral rinse agents have been extensively conducted, but readers will note a wide variety of study designs and protocols, which makes the research difficult to compare

and interpret, subsequently complicating evidence-based decision making in clinical practice. Study designs range from very short-term in vitro and in vivo studies to long-term clinical trials lasting 6 months or more. All of these studies contribute to researchers' and clinicians' understanding of the efficacy of oral rinse formulations designed to control oral biofilm and reduce gingival inflammation. This comprehensive review paper aims to summarize, interpret, and make recommendations based on the research published since the previously published 2006 review.

Oral rinse studies can be placed on a continuum from early- to late-stage research. New product formulations, often testing active ingredients before commercial products are developed, are typically initially studied using short-term in vitro studies and, if found to be effective, may proceed to longer-term studies, which are more expensive and ethically bound. Thus, where formulations are found to be ineffective in early-stage research, progression to later-stage trials is not warranted.⁷ Conducting later-stage research on products without confirmed efficacy in early stages may be inappropriate and unethical. In fact, there has been a call from researchers in the field to standardize studies on therapeutic mouthrinses.⁷ This review is framed according to research design stages described in the literature in order to situate oral rinse products on this continuum and clarify for dental hygienists and other readers the practical relevance of oral rinse products.⁷

Research designs

Although attempts to reach consensus on oral rinse research designs have been made, there is a recognized need to better standardize oral antiseptic research to reduce variability in designs and subsequent outcomes.⁷ Research has been conducted to evaluate and describe suitable study designs and other parameters in order to make recommendations for future therapeutic rinse studies.⁷ For example, substantivity studies, plaque regrowth studies, experimental gingivitis models, and long-term (≥ 6 months) home use trials were identified as the most often applied

Table 1. Stages of therapeutic oral rinse research

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 is 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 (1-3x); 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 (1-3x); other oral hygiene suspended; shorter than 21 days insufficient time for gingivitis to occur in all study subjects; should use parallel groups to minimize # times undergoing gingivitis
Stage 4	Home use studies; long term; in vivo; requirements for safety records	Plaque and gingivitis indices (i.e., Plaque index [PI], 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 (1-3x) and while using other mechanical methods; parallel groups

study models and were described as the “classical methods” to evaluate therapeutic oral rinses as these approaches have demonstrated reliability, validity, responsiveness, and interpretability.⁷ It is a given formulation’s degree of development and demonstrated efficacy that should determine the appropriate research design when planning new studies.⁷

Table 1 has been specifically developed for this review and is based on descriptions of these classical methods to help orient the reader and assist in navigating the text. Stage 1 research is designed to determine whether or not a product works and its level of substantivity in order to establish how often the product would need to be administered to inhibit plaque. Stage 2 studies are designed to determine, in the absence of any other oral hygiene measures, a product’s level of plaque inhibition on initially plaque-free sites over the short term, typically 4 days. Stage 3 studies utilize experimental gingivitis models intended to determine the influence of an oral rinse on plaque development and gingival inflammation over at least 3 weeks, again, in the absence of other oral hygiene measures. Stage 4 research is comprised of home use studies designed to replicate “real-life” conditions most closely over the long term, ideally 6 months or more, thus measuring product effectiveness and safety.

Other research parameters

Outcome parameters and measures

In addition to the research design, other parameters in oral rinse studies contribute to standardization. Outcome parameters include various measures to determine a product’s efficacy or effectiveness and should not only be aligned with the study design but also be well accepted, reliable, and valid to allow for interpretation and comparison across studies, which may include subsequent systematic reviews and meta-analyses. In vitro and in vivo outcomes measured in early-stage research include bacterial vitality quantified through vital fluorescence technique

and counting colony forming units (CFU). Clinical plaque measures used in intermediate and long-term research can be conducted by calibrated clinicians using well-validated indices or through the use of computer-based measurement tools like gravimetry (weight/mass measure) and planimetry (surface area measure). Gingival indices may be invasive and include measures of bleeding, or alternatively, may be non-invasive. Gingival crevicular fluid (GCF) and, more recently, its composition are also measured in some studies given the positive association found between changes in GCF and inflammation.⁸ Outcome measures of side effects include discolouration or staining, taste alterations, and other unfavourable consequences.⁷

Study populations

Inclusion and exclusion criteria for study samples would also benefit from standardization as some medical and behavioural factors may influence outcomes. Typically, individuals with systemic diseases, those with a history of severe oral diseases, those who have untreated caries, dentures, are undergoing treatment with antibiotics or other drugs (including those that may significantly impact saliva output), and women who are pregnant or breast feeding should be excluded from oral rinse studies.⁷ Some studies will control for tobacco use given its relationship to periodontal disease progression and its ability to mask gingival inflammation.

Sample sizes

For studies in stages 1 to 3, sample sizes of a minimum of 20 subjects per group are recommended based on anticipated drop-out rates, a normal distribution, a significance level of $\alpha = 0.05$ and a power of 80% to determine if there is a real effect.⁷ Sample size calculations for long-term home use clinical trials require the application of sample size statistical formulas selected in collaboration with experienced biostatisticians.⁹

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 content and/or research expertise and communicated with the author via teleconference throughout the review process.

The first step in the investigation was to develop a PICO question, which subsequently guided the literature search and review. The PICO question was as follows:

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

The literature search was conducted 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 search focused on primary original 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. Papers were selected for retrieval if they focused on:

- *Independent variables:* home, commercially available oral rinse product (prescription or non-prescription)
- *Dependent/outcome variables:* impact on bacteria/plaque/biofilm and 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 researchers, date of publication, stage of research (according to Table 1), active ingredients, outcome measures, results (effect sizes; *p* values), and any other notes regarding the study.

Many natural-compound-based oral rinses are currently being studied but are not yet found in commercially available formulations. Dental hygienists have expressed interest in natural products, perhaps in response to client

inquiries, and these products will be reviewed in a second article focused on non-commercially available rinses, which are primarily natural compound formulations.

RESULTS

The initial electronic search of the databases returned 452 research papers, of which 42 papers were selected for full review. An additional 24 articles were identified through the hand search, which resulted in a total of 66 full-text articles retrieved. Of these, 46 studies were found to:

- focus on the research question
- be original research
- include a commercially available rinse
- include an appropriate outcome measure
- be available in English

and were, thus, included in the review. Twenty studies retrieved in full text were excluded, primarily due to a lack of a commercially available rinse formulation in the study, and were referred to Part 2 of the review. In addition, several studies lacked an appropriate outcome measure or a suitable study population. For example, some studies focused on caries as an outcome measure or included children as a population group. The studies included were reviewed within the study stages framework described above and were summarized according to this taxonomy. Only stage 4 studies examining commercially available non-prescription products were reviewed in the 2006 position paper.

Commercially available products

Oral rinse products have been available commercially for over a century and are supported by a substantial body of research. In fact, systematic reviews and meta-analyses of randomized controlled trials (RCT) have been conducted on several of these products.¹⁰⁻¹³ Research conducted to date on commercially available products has focussed primarily on 3 active ingredients: chlorhexidine gluconate (CHG), essential oils (EO), and cetylpyridinium chloride (CPC). While no Cochrane trials have been conducted on commercial oral rinse products, one on CHG is in the protocol stage.¹⁴

Historically, CHG has been viewed as the gold standard for therapeutic home oral rinse but has been available only by prescription (e.g., PERIDEX™ 0.12%) and has a negative side effect profile primarily due to staining of oral tissues and also to taste alterations and increased calculus accumulation.^{6,7} One EO rinse is available commercially (LISTERINE®) as an OTC product in a consistent formulation of naturally derived compounds, and new formulations have emerged with fluoride and without alcohol (LISTERINE TOTAL CARE®, LISTERINE ZERO®). OTC commercially available CPC formulations (e.g., Crest® PRO-HEALTH™) are also widely available and have been included in various studies in the past.⁶

Stage 1 summary

Stage 1 studies include in vitro and in vivo designs, several of which were conducted with commercially available oral rinse formulations. Many of the products studied demonstrated positive effects in early-stage research and have undergone research in long-term models. However, these studies may be looking at specific bacteria as an outcome measure or at novel concentrations or combinations of established commercial products.

For example, several of these studies focused on CPC rinses. One 24-hour study compared a 0.075% CPC rinse with alcohol (6%) to a version without alcohol and to a negative control to determine differences in plaque reductions.¹⁵ Both formulations significantly reduced plaque ($p < 0.05$) compared to the negative control, but there was no difference between the CPC groups. In another in vitro CPC study, 0.05% CPC with and without alcohol were compared to a negative control in relation to minimal inhibitory concentration (MIC) levels against 25 bacterial species and also to 0.12% CHG with regard to plaque scores. The results showed both CPC rinses to have lower MIC levels than the control and, while the CPC rinses significantly reduced plaque compared to the negative control ($p < 0.001$), the CHG was more effective ($p < 0.05$).¹⁶ In a 5- and 10-day study using 3D confocal laser scanning microscopy and fluorometric analysis, an alcohol-free 0.075% CPC rinse was compared to a placebo control and demonstrated a statistically significant ($p < 0.001$) increase in the number of damaged biofilm cells after 5 days. But, while remaining statistically significant, the effect diminished by the 10-day point.¹⁷ A further study examined viable *Fusobacterium nucleatum* counts following exposure either to an alcohol-free 0.075% CPC rinse or to a control rinse. The CPC rinse showed a significant inactivation of bacterial cells compared to the negative control ($p < 0.05$).¹⁸

Several other CPC studies examined outcomes when combined with other products. For example, an alcohol-free 0.075% CPC with 0.05% NaF rinse was compared to an alcohol-containing (6%) 0.075% CPC also with 0.05% NaF and to a 0.05% NaF-only negative control with regard to planktonic bacteria. Both of the CPC rinses showed greater than 99.9% reductions in viable bacteria following 30 seconds of treatment.¹⁹ Another study compared CHG, EO, 2 CPC rinses, and a commercially available stabilized chlorine dioxide product on CFU of gingivitis-associated oral bacteria. The EO and the 0.07% CPC rinses showed a complete bacterial kill within one minute, whereas the 0.075% CPC rinse showed the weakest bactericidal effects and the stabilized chlorine dioxide and 0.12% CHG demonstrated 100% kill at 5 minutes.²⁰

Additional short-term studies were conducted with other products. For example, in a study comparing 0.2% CHG to a combination 1% povidone-iodine and EO rinse on the impact on *Porphyromonas gingivalis*, all treatment

groups reduced the bacteria, however the EO rinse was the most effective.²¹ Another study compared 3 CHG rinses—an experimental 0.05% CHG rinse incorporating EO and alcohol, a 0.05% CHG rinse, and a 0.2% CHG rinse—to a negative control in order to examine the reduction of total viable bacterial counts and growth of microbial populations, including 14 bacterial and fungal species. The results demonstrated a statistically significant reduction ($p < 0.05$) of viable counts of microbial populations of the test and standard CHG solutions over the control, but the standard CHG formulations were superior to the experimental product.²² An in vitro study examined the maximum inhibitory dilution (MID) capable of inhibiting microbial growth of two 0.12% CHG formulations compared to a polyhexamethylene biguanide-based mouthwash (PHMB), which is a medical antiseptic commercially available in Brazil. No statistically significant difference between the CHG groups ($p > 0.05$) was demonstrated, and the PHMB was statistically significantly less effective.²³ Further, a study comparing 2 versions of a commercially available rinse formulated with soluble bioflavonoids obtained from citrus fruits to a control rinse measured both the MIC against a range of microorganisms and the ability to inhibit microbial growth. The results showed a non-significant ($p > 0.05$) reduction in planktonic and biofilm bacteria by the experimental rinse compared to the control.²⁴

Stage 2 summary

Several plaque regrowth studies have been conducted with commercially available mouthrinses, ranging in duration from 8 hours to 9 days. Some of these trials have extremely small sample sizes,²⁵⁻³² and they have inconsistencies in rinsing exposure times and rinse amounts, which may influence outcomes. Many of the stage 2 studies in this review included CHG either as a test group or as a positive control. Of these, 3 studies compared a standard CHG formula to a novel formula and/or to a control group. For example, a recent 4-day plaque regrowth study compared 0.05% CHG to a 0.05% CHG with 0.05% fluoride solution; both demonstrated equal effectiveness in depressing plaque regrowth.³¹ A 7-day plaque regrowth study compared 0.12% CHG with alcohol to a 0.1% CHG alcohol-free formulation and to a control and showed the 0.12% CHG with alcohol rinse to be statistically significantly ($p < 0.05$) more effective in plaque inhibition than either the non-alcohol version or the control.²⁷ An 8-hour plaque regrowth study demonstrated a 0.2% CHG rinse to be more effective ($p < 0.05$) in reducing bacterial growth and adherence compared to a German-manufactured commercially available amine/NaF rinse (ELMEX®) and a negative control.³²

In several of these plaque regrowth studies, CHG served as a positive control and was compared with another product. In most of these studies, CHG was shown to be statistically significantly more effective than comparison groups. For example, in one 4-day study 0.12% CHG was

compared to 0.05% CPC and a negative control. While both CHG and CPC were statistically significantly superior in reducing CFU compared to the control, CHG demonstrated a statistically significant decrease in values compared to the other groups ($p < 0.001$). With regard to plaque outcomes, CHG suppressed plaque significantly better than both CPC and negative control ($p < 0.05$). While the study was just 4 days in duration, the negative control had significant increases in inflammation from baseline scores ($p < 0.47$), and the CHG was statistically significantly superior to both CPC and the negative control in controlling gingival outcomes ($p < 0.05$).²⁸

Two studies compared 0.12% CHG to EO and amine/stannous fluoride (ASF) rinse groups; both found the CHG to be most effective in plaque suppression, although the EO and fluoride rinses were also found to be statistically significantly better than the control.^{26,30} In a 2008 study, while there was no statistically significant difference ($p > 0.05$) between the ASF and EO, both significantly inhibited plaque regrowth compared to saline ($p < 0.001$). However, statistically significantly greater plaque reductions were shown with the CHG ($p < 0.01$).²⁶ In a 2015 study, an ASF rinse was compared to an alcohol-free EO with fluoride rinse and a 0.2% CHG group and, while the ASF was statistically significantly better at inhibiting plaque than the EO plus fluoride group, CHG was again superior to both the ASF and the EO rinses ($p < 0.001$).³⁰

CHG has also been compared to commercially available natural compound products. A 3-day study compared an herbal mouthrinse available from India (Herboral®), which is a combination of 10 natural herbs, to 0.2% CHG. The study demonstrated CHG to significantly inhibit plaque compared to the herbal rinse ($p < 0.001$).³³ There were 2 studies conducted with a commercially available product (HiOra®) containing 3 natural compounds: Meswak (persica), Betel leaf, and Belleric Myrobalan or, more correctly termed, *Terminalia bellirica*. In a 2015 5-day plaque regrowth study, both the test formulation and the 0.02% CHG rinse significantly ($p < 0.001$) suppressed plaque and inflammation compared to a negative control and, while the CHG outperformed the test rinse, its results were not statistically significant.³⁴ An earlier 2013 study compared the same natural compound rinse to 0.2% CHG and EO, and demonstrated the test rinse and the EO to inhibit plaque regrowth significantly over 4 days compared to placebo ($p < 0.001$). The lowest values were found with CHG, which was statistically significantly better than the test rinse and EO ($p < 0.001$).³⁵ A 5-day plaque regrowth study comparing a commercially available tea tree oil rinse (Tebodont®) to 0.12% CHG, 0.05% CPC, and a placebo demonstrated both CHG and CPC to be significantly more effective ($p < 0.001$) in suppressing plaque than the experimental group and placebo, but there was no statistical difference between them.³⁶

Three plaque regrowth studies examined the effects of CPC rinses. Two of these compared different concentrations of CPC to each other and to controls, whereas another study compared CPC to a European commercially available hexitidine rinse (Hextril™). The 2008 3-day study compared 0.1% CPC to 0.05% CPC and to a negative control. Both CPC rinses were significantly superior ($p < 0.05$) to the control, while no difference was evident between CPC groups.²⁵ A 2011 study compared a 0.075% CPC with 0.05% NaF to an alcohol-free version of the same product and an alcohol-free NaF control rinse. Both CPC rinses performed significantly better ($p < 0.05$) compared to the control rinse in reducing anaerobic bacterial counts.³⁷ Finally, a 3-day study comparing 0.07% CPC to hexitidine 0.1% and a negative control showed both test rinses to be significantly better ($p < 0.001$) in suppressing plaque than the negative control, but there was no statistical difference between treatment groups or differences detected in inflammation.²⁹

Stage 3 summary

Six stage 3 suspended oral hygiene experimental gingivitis studies were included in this review. Of these, 4 were only 2 weeks in length and, therefore, would not necessarily be long enough to induce gingivitis in all participants.⁷ Four of these studies compared EO to CPC and/or a negative control in relation to plaque and gingival parameters.³⁸⁻⁴¹ These showed expected outcomes, with EO and CPC both statistically significantly outperforming the control rinse and also demonstrating that the EO rinse was superior to CPC regardless of the latter's concentration. Specifically, the 2009 2-week study demonstrated the EO rinse to be significantly better ($p < 0.001$) than the 0.05% CPC and control rinses in plaque and gingival parameters.³⁸ Similarly, the 2011 study, also only 2 weeks in length, demonstrated the EO rinse to be significantly better ($p < 0.011$) in both plaque and gingival outcomes than a 0.07% CPC rinse.³⁹ Another 2-week study compared an alcohol-free EO rinse to placebo and showed the EO to significantly outperform the control ($p < 0.001$) in plaque and gingival measures.⁴⁰ Finally, a 2-week trial conducted in 2013 compared an EO rinse to a 0.075% CPC and a negative control. That study also demonstrated significant ($p < 0.001$) reductions in plaque and gingival measures by the EO rinse compared to the control. The EO rinse significantly ($p < 0.001$) reduced bleeding compared to the CPC rinse.⁴¹

Both of the 3-week studies were conducted with CHG. One small ($n = 20$) study compared 0.12% CHG on plaque-free surfaces versus plaque-covered surfaces.⁴² Results were significantly better ($p < 0.05$) with the plaque-free surfaces, demonstrating the importance of surfaces initially being cleaned to inhibit plaque and gingivitis over time.⁴² The final experimental gingivitis study included in the review compared a 0.2% CHG rinse to a triclosan 0.3% plus 0.025% NaF with alcohol rinse and to a 0.2% CHG

rinse also with 0.3% triclosan, 0.3% NaF, and 0.09% zinc chloride. The findings showed 0.2% CHG to be significantly most effective ($p = 0.046$) in reducing plaque and gingivitis, but also had significantly ($p = 0.03$) more stain than the other groups, highlighting the trade-off between efficacy and side effects associated with CHG.⁴³

Stage 4 summary

Short-term (6-week) home use trials: Short-term home use studies were not described by Lorenz and colleagues in their research on appropriate study designs for therapeutic oral rinses,⁷ but 6 studies falling within this category were identified and reviewed, and ranged from as short as 7 days to 6 weeks. Those that were shorter than 3 weeks, again, need to be viewed cautiously with regard to gingival parameters. Two of these studies compared CPC to an EO formulation. A 4-week study comparing an EO rinse to 0.075% CPC and a negative control demonstrated both the EO and CPC rinses to be statistically significantly superior to the control, but the EO rinse was superior to the CPC formulation in plaque and gingival outcome measures ($p < 0.001$).⁴⁴ Another recent 6-week study compared 0.075% CPC to EO rinse and again showed the EO rinse to be superior to the control ($p < 0.001$) and the CPC rinse ($p < 0.05$) in plaque and gingivitis measures.⁴⁵

Several studies compared CPC rinses to a positive or negative control. For example, two 7-day studies compared 0.05% CPC rinse to a control rinse; both showed the CPC rinse to significantly reduce plaque scores compared to the control ($p < 0.05$; $p < 0.05$).^{46,47} A longer 6-week trial also conducted on 0.05% CPC and a control had similar outcomes ($p < 0.05$).⁴⁸ A small ($n = 30$) 28-day study comparing alcohol-free 0.2% CHG to an alcohol-containing 0.2% CHG and a placebo demonstrated both CHG rinses to be significantly better ($p < 0.05$) in reducing plaque and gingival scores than the control.⁴⁹

Long-term (≥ 6 months) home use trials: Nine long-term clinical home use trials investigating commercially available products were included in the review. All of these trials included EO, CPC, and placebos in various combinations typically in addition to usual mechanical oral home care routines. Two studies compared EO rinse to a control group only and showed expected results. The 2013 study demonstrated that the EO rinse group significantly ($p < 0.001$) reduced all outcome measures at all time points including both plaque and gingival parameters. In addition the effect increased over the duration of the study and no negative outcomes occurred.⁵⁰ The 2009 study also showed significantly greater reductions by the EO rinse compared to control ($p < 0.05$) in plaque and gingivitis scores.⁵¹

Additional long-term clinical trials conducted with EO rinses included other test groups. For example, a large trial comparing EO rinse, a 0.07% CPC rinse, and negative control showed a statistically significant reduction in plaque and inflammation by both test groups compared to the control, but the EO rinse group was significantly

superior to the CPC at all time points after baseline ($p < 0.05$). There were no adverse outcomes other than staining reported by the CPC group.⁵² Another large trial compared an alcohol-free EO rinse to a 0.05% alcohol-free CPC rinse and a control and again showed both to significantly reduce plaque compared to the negative control ($p < 0.001$). However, the EO rinse also significantly decreased plaque and gingivitis compared to CPC ($p < 0.001$).⁵³ An earlier, very large trial compared EO rinse with zinc chloride and NaF to a 0.05% CPC also with NaF and to a control. Although the CPC produced a statistically significant reduction in plaque and inflammation scores compared to the control, the EO rinse was significantly better ($p < 0.05$) than the CPC rinse in all parameters and at all time points post baseline, and, again, the improvements increased over time.⁵⁴ Another long-term clinical trial compared an EO rinse to a 0.05% CPC and a placebo control and showed similar results, with the EO rinse demonstrating significantly lower plaque and inflammation scores than the control ($p < 0.001$) and CPC ($p < 0.001$). The CPC did show significantly lower outcome scores ($p < 0.001$) than the control group and no adverse events occurred with either group.⁵⁵

Two other long-term CPC studies were conducted. One compared an alcohol-free 0.075% CPC with 0.05% NaF to a control 0.05% NaF rinse. The CPC rinse group had significant reductions in gingival and plaque scores ($p < 0.05$) as compared to the control group.⁵⁶ In another study comparing a 0.07% CPC rinse to placebo, both the test ($p < 0.001$) and the control ($p = 0.003$) groups had significant reductions in outcomes, but the CPC group significantly reduced plaque compared to the placebo ($p < 0.001$). While bleeding was also lower in the CPC group, the findings were not significant ($p = 0.052$).⁵⁷ However, staining of teeth was also measured using the Gründemann Modification of the Stain Index (GMSI); there was significantly more staining with the test rinse as compared to the negative control at 3 ($p = 0.007$) and 6 months ($p < 0.001$).⁵⁷

Only one of these long-term clinical home use studies did not confirm previous findings, demonstrating no statistically significant difference between the EO rinse and the 0.07% CPC rinse in plaque or gingivitis measures ($p = 0.05$).⁵⁸ However, the study did not include a negative control group as is recommended in the American Dental Association (ADA) guidelines, and when the study was later critically reviewed, it was found to be flawed because of its lack of a control group and its analysis of the results as a traditional comparative study rather than more appropriately as an equivalence study.^{59,60}

Long-term clinical trials are expected to evaluate and report safety outcomes. Other than what has been indicated above, none of the studies reported adverse events as an outcome of the test rinses included. One study examined salivary output and pH associated with EO rinse with

Table 2. Oral rinse systematic reviews (2007 to present)

Study authors, date	Active ingredient(s) (# of studies included)	Overall conclusions
Araujo et al. (2015) ¹⁰	EO (29)	Meta-analysis demonstrates clinically significant, site-specific benefit of adjunctive EO treatment within a 6-month period
Van Strydonck et al. (2012) ¹²	CHG (30)	CHG with oral hygiene versus placebo or control mouthrinse provides significant reductions in plaque and gingivitis scores, but a significant increase in staining score
Van Leeuwen et al. (2011) ¹¹	EO, CHG (19)	EO appears to be a reliable alternative to chlorhexidine mouthwash with respect to parameters of gingival inflammation
Haps et al. (2008) ¹³	CPC (3)	Provides small but significant adjunctive benefit to mechanical cleansing
Stoeken et al. (2007) ⁷⁹	EO (11)	EO provides additional benefit with regard to plaque and gingivitis reductions

alcohol and found no alterations to either outcome.⁵¹

Systematic reviews

Since the 2006 CDHA position paper was published, several systematic reviews and meta-analyses have been carried out on commercially available oral rinse products. These reviews (Table 2) compare CHG, EO, and CPC rinses to each other and/or to placebo and reaffirm the continued focus on these 3 active ingredients found in commercially available products. A recently published systematic review on natural-compound-containing mouthrinses, primarily focused on non-commercial formulations,⁶¹ will be discussed in a separate article. Overall, the results of these systematic reviews and meta-analyses demonstrate that, while CHG consistently reduces plaque beyond that achieved with EO rinse, the latter appears to reduce gingival inflammatory outcomes similarly to CHG without the negative side effect profile.^{10,11} CPC rinses have shown less compelling results with regard to plaque and gingival outcomes.¹³

The most recent of these systematic reviews was published in 2015 and examined 29 RCTs of 6 months in duration conducted with commercially available EO rinse, including both published and unpublished trials. While this research was sponsored by the EO manufacturer, it included a meta-analysis with results from over 5000 participants thereby providing a comprehensive summary of the outcomes of EO rinse as compared to mechanical cleansing alone in both whole mouth means and “site specific” data.¹⁰ In addition, the review provided summary odds ratios for plaque-free and inflammation-free sites and a responder analysis to help guide clinical decision making.¹⁰ All statistical measures showed a statistically and clinically significant adjunctive benefit of EO rinsing over 6 months.¹⁰

In 2012, Van Strydonck and colleagues published a systematic review of 30 studies on CHG.¹² The authors concluded that CHG oral rinses, together with oral hygiene, provide significant reductions in both plaque and gingivitis scores ($p < 0.00001$) compared to placebo-control mouthrinse in clients with gingivitis, but statistically significant side effects were found.¹² Staining was the most

common observation, but increased calculus formation and taste alterations were also frequently reported.¹² In a 2011 systematic review, Van Leeuwen and co-researchers compared EO and CHG, concluding that, in long-term use, EO rinse appeared to be a reliable alternative to CHG with respect to parameters of gingival inflammation without the negative side effects.¹¹ Although the CPC systematic review included products with different concentrations and studies with considerable heterogeneity, from the meta-analysis the authors concluded there was a small but statistically significant additional benefit in reducing plaque accumulation ($p < 0.00001$) and gingival inflammation ($p < 0.00003$).¹³

DISCUSSION

Four stages of research on commercially available oral rinses have been conducted, ranging from short-term in vitro and in vivo studies to long-term (≥ 6 months) home use clinical trials. The studies primarily focused on the more established formulations, including CHG, EO, and CPC rinses, although shorter trials tended to compare novel concentrations and combinations of these and other products.

Commercially available oral rinses are supported by a large body of research, some of which has been funded by product manufacturers. While clinicians should always approach research with healthy skepticism, industry-conducted or sponsored research can be of high quality and, like all scholarly research, is scrutinized by peer review committees prior to publication to ensure scientific rigour. Clinical trials involving human subjects must undergo ethical review and, in most countries, drug trials must be registered so they can be followed through to the publication phase.⁶²⁻⁶⁴ Given this concerted effort to reduce reporting bias, it would be imprudent to discount research solely because it was supported or conducted by industry.

In Canada, most oral rinses are categorized as a “consumer health product” and fall within one of over 80 categories of non-prescription products approved for use.⁶⁵ These products can be identified by their product number on the label, which also indicates whether the product is approved by the Food and Drug Regulations or by the

Natural Health Products Regulations.⁶⁵ In addition, these products must have a valid product licence issued by Health Canada, which requires the brand to demonstrate product safety and efficacy.⁶⁵ Products requiring a prescription are regulated under the Food and Drug Regulations.⁶⁵

The Canadian Dental Association provides reviews of submissions from consumer oral health product manufacturers, verifying that the research methods and product claims are scientifically supported by the evidence.⁶⁶ The ADA has specific and rigorous criteria for granting the ADA seal of acceptance to chemotherapeutic oral rinses. These criteria include proof of objective clinical/laboratory studies demonstrating safety and effectiveness, FDA-approved ingredients, manufacturer assured purity and uniformity and, finally, packaging and advertising claims supported by science.⁶⁷ As part of these rigorous criteria, clinical trials must also be at least 6 months in duration and must demonstrate statistically significant reductions in both plaque and gingivitis. To date, only CHG and EO rinses have received the ADA seal, but because the ADA has moved away from approving prescription products, CHG has lost its ADA seal.⁶⁸

Most of the short-term studies included in this review were *in vitro* or *in vivo* studies examining effects after single exposure to rinses over 8 or more hours without other oral hygiene interventions. These studies primarily compared CPC rinses to negative controls or placebos or to CHG, serving as a positive control, and examined bacterial vitality, MIC to oral microbiota, and/or CFU counts. Overall, this research did not present any unexpected results in that the CPC formulations in various concentrations were consistently significantly more effective than negative controls but less effective than CHG. Interestingly, no differences in outcomes were demonstrated when an alcohol-free formulation was compared to an alcohol-containing counterpart in early-stage research models.

Stage 2 studies examined plaque regrowth over several days of suspended oral hygiene (with the exception of the rinse) and are too short to draw conclusions about gingival inflammatory outcomes, although many of the studies did. The stage 2 studies demonstrated the greatest inconsistencies in study design and also had very small sample sizes, potentially affecting statistical power. These studies were largely conducted with CHG and CPC rinse formulations, but a few less-established products were evaluated. Again, CHG in various concentrations (i.e., 0.05%, 0.1%, 0.12%, and 0.2%) was found to be superior in inhibiting plaque regrowth compared to other products including CPC, A/NaF, EO with fluoride, and a commercially available herbal rinse. One study demonstrated alcohol-containing CHG rinse to be superior to an alcohol-free version.²⁷ In addition, an herbal based product (HiOra[®]) and the antiseptic hexitidine produced, in separate studies, statistically significant results, suggesting that more and possibly higher level research is warranted to investigate

potential therapeutic activity. However, a systematic review conducted on hexitidine concluded that it was consistently less effective than and not a good alternative to CHG.⁶⁹

Research shows that maturing biofilm bacteria is profoundly more resistant to antimicrobials than those in planktonic states. Therefore, it is essential for potentially effective antimicrobial agents to demonstrate activity within biofilm models.²⁴ Few stage 3 experimental gingivitis studies were conducted, which, when conducted well, would have the potential to demonstrate plaque and gingival effects. Instead, most of the stage 3 studies were only 2 weeks in length, and may not have provided sufficient time for gingivitis to occur. Within this model, both EO and CPC formulations significantly reduced plaque and gingivitis compared to controls, but the EO rinse consistently outperformed the CPC. Given the demonstrated effects, additional stage 3 studies with these products are likely unwarranted at least with current formulations.

If they are of sufficient duration, short-term (≤ 1 month) home use studies have the potential to show both plaque and gingival outcomes and are more authentic to real-life conditions than stage 3 studies in that other oral hygiene measures are not suspended. Few of these studies were identified for review. In those that were, however, expected outcomes prevailed with EO, CPC, and CHG rinses all outperforming negative controls and EO rinse significantly reducing plaque and inflammation compared to CPC rinse.

Long-term (≥ 6 months) home use clinical trials provide the most compelling results for clinicians because they have typically gone through all earlier stages of research and likely have the demonstrated efficacy warranting a long-term trial. These studies must report safety, efficacy, and compliance. Of the long-term clinical trials reviewed, most compared EO rinse to CPC and/or a negative control. With only one exception, the EO rinse was superior in reducing plaque and gingivitis when compared to the CPC. Studies examining the addition of zinc chloride and fluoride did not alter these outcomes. Two of the long-term trials demonstrated CPC to have increased staining associated with its use, which has been confirmed in a systematic review on CPC rinse.¹²

It is generally accepted that plaque biofilm is the primary etiology for gingival inflammation and periodontal disease progression.^{3,70} However, some researchers have concluded that EO rinses possess a synergistic anti-inflammatory effect⁷¹ and, notwithstanding well-demonstrated plaque reductions, provide enhanced anti-inflammatory benefits.^{51,72,73} While CHG remains the gold standard in terms of plaque outcomes, EO rinse performs well in reducing plaque and demonstrates comparable outcomes to CHG with regard to gingival inflammation reductions.

EO rinses are a group of plant extracts and, currently, only one EO rinse is commercially available, having a

greater than 100-year history of use. This rinse includes a fixed combination of 3 essential oils: thymol 0.063%, eucalyptol 0.091%, and menthol 0.042%, as well as additional ingredients such as methyl salicylate 0.0660%.⁷⁴ Other EO rinses have not been studied to the same degree and consist of various formulations. As a result, similar conclusions cannot be made. Over a decade of research reviewed here shows a benefit of using EO rinse in addition to mechanical methods, thereby substantiating its use with clients.

To enhance rinse activity, research reviewed recommended that mechanical therapy be performed prior to rinsing to disrupt biofilm and decrease the microbial load, allowing for a more effective penetration by the chemotherapeutic agent into the plaque biofilm.⁷¹ It should be recognized that no mechanical method or therapeutic oral rinse has demonstrated the ability to completely eliminate oral biofilm. Therefore, a daily combination of both interventions should be recommended. This review validates the importance of a multitherapeutic approach involving traditional mechanical methods, such as tooth brushing and interdental cleansing, and therapeutic oral rinsing. Therapeutic oral rinse should be considered complementary to mechanical oral hygiene.

Oral rinses are typically well tolerated by most individuals. Discolouration is the most frequent side effect reported and one discolouration index provided a standardized estimate of the amount in study subjects.⁷ For the most part, EO rinses do not have side effects like CHG and CPC have demonstrated with regard to stain and, therefore, can be used over the long term.^{52,75} The presence of plaque increases CHG side effects and reinforces the necessity of biofilm disruption prior to the start of CHG mouth rinsing.⁴² No studies in the review reported poor tolerance of EO rinses with or without alcohol over the long term, including changes to pH and salivary output.⁵¹ This finding confirms research conducted previously, which demonstrated no increase in the perception of oral dryness (xerostomia) or a decrease in salivary output with EO rinse,⁷⁶ contrary to commonly perpetuated beliefs.

While controversy has existed surrounding mouthwash use (particularly those containing alcohol) and oropharyngeal cancer, epidemiological research has shown no statistically significant association between the regular use of mouthwash and oral cancer. Neither has a trend in risk of oral cancer with increased daily use of mouthwash been demonstrated. Importantly, there was also no association between alcohol-containing oral rinse and oral cancer.⁷⁷

A recent, large European case-control study aimed to assess the association between mouthwash use and other factors, and upper-aerodigestive tract (UADT) cancer risk. Although the study used hospital patients as the controls, these patients had been admitted for conditions unrelated to oral cancer risk. The study corroborated a

dose-effect relationship between tobacco smoking and alcohol consumption (markedly so when combined) and UADT risk, and demonstrated that both socio-economic status and consumption of fruits and vegetables had an inverse relationship to risk of UADT. Interestingly, after adjusting for tobacco smoking and alcohol, the study concluded that poor oral health and poor dental care were independently associated with increased risk of UADT. While the study did not demonstrate an association between prescribed levels (twice daily use) of oral rinsing and oral cancer, the researchers found an association between frequent mouthwash use (≥ 3 times/day) and oral cavity and pharyngeal cancers. This finding was based on only 1.8% of cases and 0.8% of controls reporting such frequent use. Further, the study did not account for alcohol-containing versus non-alcohol-containing mouthwash.⁷⁸ The researchers concluded that the impact of the alcohol content present in most formulations remains to be fully clarified, and they further hypothesized that any risk associated with mouthwash use and oral cancer is likely confined to smokers given that alcohol consumption among “never smokers” has not been shown to be a risk for head and neck cancers.⁷⁸

Ethanol is incorporated in some oral rinses to act as a solubilizer, stabilizer, and preservative, and, although not considered an active ingredient, seems to enhance anti-plaque efficacy.⁷⁷ Recently, more alcohol-free formulations have been made commercially available, but there is less research demonstrating equivalency of these products. It is important to recognize that commercial EO rinses have been safely in use for over a century and have not demonstrated adverse effects in long-term clinical trials. While this paper does not attempt to review the literature surrounding an association between mouthwash use, alcohol, and cancer-related health risks, it will be important to review this literature going forward in order to make more definitive statements surrounding safety. Dental hygienists should consider all risks when evaluating therapeutic oral rinsing benefits for their clients, particularly clients who currently engage in high-risk behaviours such as tobacco smoking and high levels of alcohol consumption.

CONCLUSION

Based on this review, dental hygienists can confidently recommend a commercially available EO mouthrinse for their adult clients, with alcohol where not prohibited by client characteristics (i.e., alcoholism, religious beliefs, ability to expectorate), for long-term, twice daily use to reduce plaque and gingival inflammation, regardless of current home care routines. Clients presenting with high-risk behaviours, such as tobacco smokers, should be viewed holistically and cautioned about demonstrated and potential oropharyngeal cancer risks. Several additional commercial products including CPC have consistently shown efficacy superior to placebos, but not comparatively to EO and CHG and not in long-term clinical trials with

stringent study protocols. These conclusions are aligned with several recently conducted systematic reviews and ADA accepted guidelines and related seals of acceptance. Therapeutic oral rinses should be used together with mechanical cleansing (tooth brushing and interdental cleansing) in order for clients to achieve the highest level of

plaque and gingival inflammatory control. Incorporating an effective therapeutic oral rinse as a complement to home care routines will help dental hygiene clients reduce oral biofilm and achieve more desirable oral health outcomes.

APPENDIX: UPDATES TO THERAPEUTIC ORAL RINSING RECOMMENDATIONS

2016 updated recommendation	2006 recommendation	Rationale
1. <i>Revised:</i> Over-the-counter (OTC) commercially available therapeutic oral rinses should be viewed as part of an overall plaque control strategy along with mechanical plaque removal methods.	1. Over-the-counter (OTC) commercially available chemotherapeutic oral rinses should be viewed as adjunctive to mechanical plaque removal methods.	Research supports the use of therapeutic oral rinses to complement mechanical methods as it shows a benefit beyond what can be accomplished by mechanical means alone.
2. <i>Revised:</i> While recommendations should remain specific, therapeutic oral rinses are indicated as a complementary oral hygiene component for all adult clients (with exception to those with a contraindication to use).	2. OTC rinses are particularly indicated for clients with uncontrolled plaque, bleeding, inflammation and/or gingivitis; all oral hygiene recommendations should be client specific.	Virtually all study subjects have experienced a reduction in plaque and inflammation with the addition of a therapeutic oral rinse beyond that achieved by mechanical methods alone; even clients with minimal plaque and inflammation can expect improvements.
3. <i>No change:</i> For OTC rinses, a fixed combination of 3 essential oils: thymol 0.063%, eucalyptol 0.091%, and menthol 0.042%, and additional ingredients, such as methyl salicylate 0.0660%, has been demonstrated in rigorous long-term studies to be most effective and safe, with acceptable side effects.	3. For OTC rinses, a fixed combination of 3 essential oils: thymol 0.063%, eucalyptol 0.091%, and menthol 0.042%, and additional ingredients, such as methyl salicylate 0.0660% (Listerine), has been demonstrated in stringent long-term studies to be most effective, safe, with acceptable side effects.	More research conducted since 2006 has accumulated in long-term clinical trials and systematic reviews to substantiate this recommendation.
4. <i>Revised:</i> Several commercial products have shown efficacy superior to placebos (e.g., CPC [in specific % formulations], hexitidine, and one herbal formulation [HiOra®]) and require further stage-appropriate research.	4. Several additional OTC rinse products, including AmF/SnF2, some products containing cetylpyridinium chloride, and triclosan, have shown efficacy superior to placebos but not within stringent study protocols. They therefore warrant further investigation.	Research has demonstrated efficacy of some additional products, but these require further, higher stage research to substantiate findings.
5. <i>Revised:</i> Dental hygienists can recommend alcohol-containing products as these have not been demonstrated to have adverse effects; the exception remains for clients who are unable to tolerate alcohol for personal reasons; clients demonstrating high-risk behaviours such as tobacco smoking should be cautioned regarding (over)use of oral rinses.	5. Dental hygienists can recommend alcohol-containing products as these have not been demonstrated to have adverse effects; the exception remains for clients who are unable to tolerate alcohol for various medically related reasons.	Additional research substantiates this recommendation; no reductions in salivary output or perception of dryness (xerostomia) have been demonstrated; while no adverse outcomes have been reported with prescribed levels of oral rinses, epidemiological data continue to be monitored regarding oropharyngeal cancer risks associated with smoking, alcohol use, poor oral health, poor oral hygiene, and the use of oral rinses.
6. <i>No change:</i> Dental hygienists will need to continue to monitor this field of inquiry as research and development in the area will likely continue; dental hygienists need to recognize the limitations of short-term, early-stage research study methods when determining the efficacy and safety of rinse formulations.	6. Dental hygienists will need to monitor this field of inquiry closely as vigorous research and development in the area will likely continue. Dental hygienists need to recognize the limitations of short-term and less stringent long-term study protocols when determining the efficacy and safety of rinse formulations.	The stages of research framework adopted for use in this paper further substantiates this recommendation. A second review focussed on non-commercially available oral rinse products will be published, which will be of interest to dental hygienists.

DUALITY OF INTEREST

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

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Current status of the classification of periodontal diseases

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ABSTRACT

Periodontal diseases and conditions remain challenging to classify. The treatment options should follow a diagnosis that accurately represents the client's periodontal status and history. The most widely used diagnostic classification stems from recommendations made in the 1999 International Workshop for a Classification of Periodontal Diseases and Conditions.¹ Recently, the American Academy of Periodontology (AAP) has suggested interpretations to this periodontal disease classification in an attempt to address its limitations, such as the primary emphasis on clinical attachment levels as the main classification criterion, as well as the difficulty in distinguishing between aggressive and chronic periodontitis and in determining localized versus generalized periodontitis.² The suggested AAP modifications will be presented during the next World Workshop in Clinical Periodontics to be held in November 2017. This article reviews the history of periodontal disease classification and presents recommendations for clinicians on how to classify different forms of periodontal diseases.

RÉSUMÉ

La maladie et les affections parodontales demeurent difficiles à catégoriser. Les options de traitement devraient suivre un diagnostic qui représente avec exactitude l'état parodontal et l'anamnèse du client. Le système de classification le plus utilisé provient de recommandations faites à l'Atelier international sur la classification des maladies et des conditions parodontales de 1999. Récemment, l'Académie américaine de parodontologie (AAP) a proposé des définitions pour ce système de classification de maladie parodontale afin de tenter de remédier aux lacunes, telles que la focalisation sur les niveaux d'attachement en tant que critère principal pour la classification et la difficulté de distinguer entre la parodontite agressive et la parodontite chronique et de déterminer si la parodontite est localisée ou généralisée. Les modifications suggérées par l'AAP seront présentées lors du prochain Atelier mondial en parodontie clinique qui aura lieu en novembre 2017. Cet article passe en revue l'historique de la classification de la maladie parodontale et présente des recommandations aux cliniciens sur la façon de catégoriser les formes variées des maladies parodontales.

Key words: diagnosis, disease classification, periodontal disease

BACKGROUND

The professions of dentistry and dental hygiene exist largely due to 2 main diseases: dental caries and periodontal disease, both of which affect large segments of the population. Periodontitis is defined as the inflammatory process resulting in bone loss around teeth. The presence of gingival inflammation, bleeding on probing (BOP), clinical attachment loss (CAL), periodontal pockets, and alveolar bone loss are the criteria needed to diagnose periodontitis.¹ Although the identification of periodontitis is a relatively straightforward process in clinical practice, its classification into different forms of disease and severity remains a challenging clinical issue.

Disease classification systems are structures that help to categorize and subcategorize diseases based on their etiology and pathogenesis. Classification systems provide a framework for the treatment planning and management of the client's disease process. For example, the management

of localized, moderate chronic periodontitis differs from the management of the generalized aggressive form of periodontitis. Classification systems are important tools that make communication between clinicians, researchers, clients, and insurance companies possible.

Although the 1999 Classification of Periodontal Diseases and Conditions¹ is currently the most commonly accepted and used classification of periodontal disease worldwide, it has its limitations, resulting in confusion and challenges for private practitioners, students, and educators. After requests from the educational community, the American Board of Periodontology, and practising clinicians, a task force was convened by the American Academy of Periodontology (AAP) Board of Trustees to develop a clinical interpretation of the current periodontal classification system.² This article presents the current understanding of periodontal classification that is

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Figure 1. Clinical presentation of a client with untreated and treated periodontitis



1A = generalized moderate chronic periodontitis 1B = generalized aggressive periodontitis

1C = a client whose periodontitis has been treated and presents with healthy reduced periodontium

based on the recent AAP update paper along with some additional recommendations. One must note, however, that the task force recommendations² may be altered during the forthcoming World Workshop in Clinical Periodontics in 2017 and should therefore serve only as an interim aid in the interpretation of the current classification.

EVOLVING PERIODONTAL DISEASE CLASSIFICATION

Classification systems should not be considered as static references. Because knowledge of the etiology and the types of periodontal disease keeps growing, the classification system should evolve as well and adapt to current data. Since 1966, at least 6 different classifications of periodontal disease have been suggested (Table 1). In 1966, the AAP World Workshop in Periodontics suggested only one form of periodontitis: chronic marginal periodontitis.³ In 1977, 2 distinct disease categories were recognized: juvenile and chronic marginal periodontitis.^{4,5} In 1986, prepubertal periodontitis was recognized as a subclassification of juvenile types of periodontal disease. Adult, necrotizing, and refractory forms of periodontitis were also added as categories.⁶ By 1989, the number of categories had grown to 5. Prepubertal and juvenile forms were added as subcategories under early-onset periodontitis along with the new subcategory of rapidly progressive periodontitis. Significantly, a new category of periodontitis associated with systemic disease was added. The age of the client was the main factor in making a diagnosis of either adult or early-onset periodontitis, with a cut-off point of 35 years for the early-onset form. Gingival diseases were not included in this classification system, and there was extensive overlap between disease categories.^{7,8} The first European Workshop on Periodontology, in 1993, attempted to simplify the previous AAP classification by introducing a 3-category classification, consisting of early-onset periodontitis, adult periodontitis, and necrotizing periodontitis.⁹

The 1999 International Workshop for a Classification of Periodontal Diseases and Conditions¹⁰ resulted in a significantly revised classification that was accepted by the AAP and continues to be used by many clinicians and universities in North America as a guide to

categorize clients with various periodontal conditions. This classification added categories for gingival diseases, abscesses of the periodontium (gingival, periodontal, and pericoronal abscesses), periodontitis associated with endodontic lesions, and developmental and acquired deformities and conditions (local factors related to teeth, mucogingival deformities, and occlusal trauma). Many categories in this classification represent findings rather than actual diagnoses. Adult periodontitis and early-onset periodontitis were replaced with chronic periodontitis and aggressive periodontitis, respectively (Figure 1, Table 1). The 1999 classification stated that 1) the rate of disease progression should not be used to exclude clients from a diagnosis of chronic periodontitis and 2) the age of the client was not to be used as a criterion in assigning a chronic versus aggressive periodontitis diagnosis.

PROPOSED CHANGES TO CHRONIC AND AGGRESSIVE PERIODONTITIS CATEGORIES

The 1999 classification first introduced the chronic periodontitis and aggressive periodontitis categories.^{10,11} In the task force's proposed changes for the new classification, the diagnostic terms of chronic and aggressive periodontal disease are being retained but the criteria for each will be adapted to provide clearer diagnostic guidelines within both academic and clinical areas.²

For example, the proposed new classification, with more comprehensive recommendations to follow in 2017, recommends the reintroduction of age of onset as a distinguishing factor in the diagnostic classification of aggressive periodontitis.² Clients younger than 25 years of age at the time of disease onset and with generally low levels of biofilm and calculus will meet the criteria for the diagnosis of aggressive periodontitis (Figure 2). In contrast, clients who present with disease onset at an older age, together with greater levels of biofilm and calculus, will meet the criteria for chronic periodontitis (Figure 3). Within this category, it is now recognized that disease progression may follow specific patterns: 1) slow and continuous; 2) a random burst seen with disease progression around localized teeth in a short period of time; or 3) multiple

Table 1. Evolution of the periodontal disease classification system

1966	1977	1986	1989	1993	1999
					I. Gingival diseases a. Dental plaque-induced gingival diseases b. Non-plaque-induced gingival lesions
I. Chronic marginal periodontitis	I. Chronic marginal periodontitis II. Juvenile periodontitis	I. Adult periodontitis II. Juvenile periodontitis a. Prepubertal b. Localized juvenile periodontitis c. Generalized juvenile periodontitis	I. Adult periodontitis II. Early-onset periodontitis a. Prepubertal i. Generalized ii. Localized b. Juvenile periodontitis i. Generalized ii. Localized c. Rapidly progressive periodontitis III. Periodontitis associated with systemic diseases	I. Adult periodontitis II. Early-onset periodontitis III. Necrotizing periodontitis	II. Chronic periodontitis a. Localized b. Generalized III. Aggressive periodontitis a. Localized b. Generalized IV. Periodontitis as a manifestation of systemic diseases a. Associated with hematological disorders b. Associated with genetic disorders c. Not otherwise specified V. Necrotizing periodontal diseases a. Necrotizing ulcerative gingivitis b. Necrotizing ulcerative periodontitis
		III. Necrotizing ulcerative gingivo-periodontitis IV. Refractory periodontitis	IV. Necrotizing ulcerative gingivo-periodontitis V. Refractory periodontitis		VI. Abscesses of the periodontium a. Gingival abscess b. Periodontal abscess c. Pericoronal abscess VII. Periodontitis associated with endodontic lesions a. Combined periodontic-endodontic lesions VIII. Developmental or acquired deformities and conditions a. Localized tooth-related factors b. Mucogingival deformities and conditions around teeth c. Mucogingival deformities and conditions on edentulous ridges d. Occlusal trauma

bursts seen with disease progression at higher frequencies. Within both categories, disease may be further classified as localized or generalized (extent) and as mild, moderate or severe (severity).

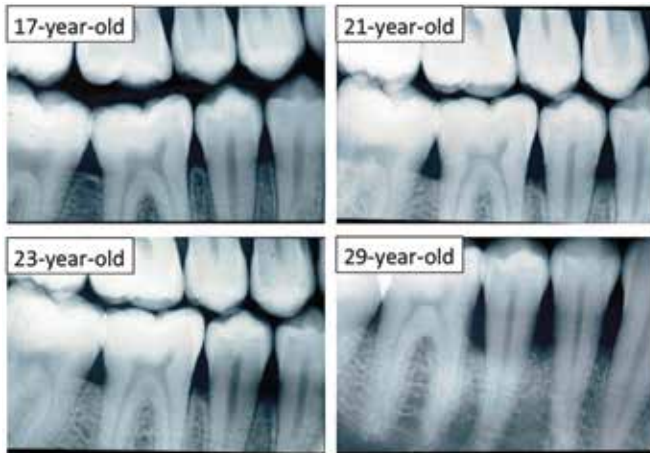
It will be imperative for clinicians to base diagnostic decisions on the gathering of appropriate clinical and radiological data given the lack of definitive bio or genetic markers discriminating between aggressive and chronic periodontitis.^{2,12} The diagnostic information will then be

used to guide treatment decisions such as use of antibiotics or host modulation as adjuncts during initial therapy or earlier surgical interventions.

NEW PARAMETERS TO GUIDE DIAGNOSTIC DECISIONS

Chronic periodontitis has been characterized by the presence of periodontal pockets and/or gingival recession resulting from inflammation and bone loss. The extent and severity of disease are also considered. In the 1999 classification, clinical attachment levels (CAL) are used to categorize the

Figure 2. Progression of generalized aggressive periodontitis with onset before age 21*



*At age 29 this client had generalized 5 mm to 7 mm pocketing and was referred to a periodontist.

disease as follows: 1) slight = 1 mm to 2 mm CAL; 2) moderate = 3 mm to 4 mm CAL; 3) severe \geq 5 mm CAL.¹ The parameters of CAL have proven to be both challenging and time consuming in the clinical practice setting. In instances when the cemento-enamel junction (CEJ) may lie apical to the gingival margin, the exact location for the purpose of measurement becomes subjective, and negative recession needs to be recorded which is often not done or possible with digital recording systems. Subjectivity is also an issue in situations where the CEJ may not be present due to a restoration, cervical lesion or the buildup of calculus. As a result, there are inconsistencies among clinicians who may choose to record probing depth either alone or together with recession, which is often recorded as a single mid-buccal or mid-lingual measurement to better consider the management of time.

Figure 3. Radiographic images of the posterior sextants of a 48-year-old client with generalized advanced chronic periodontitis*



*This client is a smoker who presented with generalized 5 mm to 9 mm pockets, generalized calculus deposits, and bleeding on probing.

In contrast, the task force update proposes that the diagnosis of chronic periodontitis include one or more of the following parameters: the presence of inflammation, BOP, increased probing depths (3 mm or more, which may or may not involve recession) as well as evidence of radiographic bone loss. There is a large margin for error if only the CAL data are utilized to determine the extent and severity of disease. In addition, clients with gingival recessions due to aggressive tooth brushing or other factors become periodontitis clients. Therefore, in the new classification the clinician can use signs of inflammation (such as BOP), radiographic evidence of bone loss, pocket depths, and CAL in formulating a diagnosis (Table 2). Using probing depths instead of CAL alone will eliminate much of the confusion in the process of making a diagnosis. In addition, this update to

Table 2. Clinical and radiographic criteria for diagnosing clients with chronic periodontitis and those with reduced periodontium

	Mild chronic periodontitis	Moderate chronic periodontitis	Advanced chronic periodontitis	Healthy reduced periodontium	Gingivitis on a reduced periodontium
Probing depths	>3 mm and <5 mm	\geq 5 mm and <7 mm	\geq 7 mm	\leq 3 mm	\leq 3 mm
Clinical signs of inflammation/bleeding on probing	Yes	Yes	Yes	No	Yes
Radiographic bone loss	Up to 15% of root length or \geq 2 mm and \leq 3 mm	16% to 30% or >3 mm and \leq 5 mm	>30% or >5 mm	Bone loss is present	Bone loss is present
Clinical attachment loss	1 mm to 2 mm	3 mm to 4 mm	\geq 5 mm	Clinical attachment loss is present	Clinical attachment loss is present

the classification of periodontal diseases and conditions allows usage of the term “periodontal health or gingivitis on reduced periodontium.” Clients following successful periodontal treatment may present with gingival recession and bone loss but no longer have any clinical findings of gingival inflammation, BOP or pocketing. According to the 1999 classification system, these clients would fall into the chronic periodontitis category, but following the recommendations of the task force update, these clients should be diagnosed with a healthy reduced periodontium. The term “gingivitis on a reduced periodontium” should be used when gingival inflammation and BOP are present on a reduced periodontium (recession, CAL, bone loss but no pockets deeper than 3 mm) (Table 2).²

HOW TO DETERMINE IF PERIODONTITIS IS LOCALIZED OR GENERALIZED

The 1999 classification introduced the subcategories of localized versus generalized disease within the chronic and aggressive periodontitis categories. A diagnosis of localized disease was defined as involvement of $\leq 30\%$ of sites, whereas a diagnosis of generalized disease was defined as involvement of $>30\%$ of sites.⁹ Within the category of aggressive periodontitis, the localized pattern is often very characteristic involving first molars and incisors so sites were not initially included in this classification.

The heterogeneity in the presentation of chronic periodontitis presents more difficulty in utilizing sites instead of teeth to determine whether the disease is localized or generalized. For chronic periodontitis, therefore, utilizing the percentage of affected teeth versus the percentage of affected sites is now being recommended.² For example, localized chronic periodontitis must have either a clear and distinct pattern of affected teeth (for example, periodontitis only on maxillary molars) or $\leq 30\%$ of affected teeth. In contrast, generalized chronic periodontitis does not have a distinct pattern of disease or affects $>30\%$ of teeth (Figure 3).

CONCLUSIONS

The AAP task force update does not suggest any change in the categories of the 1999 classification system. Currently, the task force has introduced a new framework for making periodontal diagnoses clearer and more consistent. These suggested changes will be reviewed by the next World Workshop in Clinical Periodontics in 2017. The new guidelines using BOP, probing depths, and bone loss together with CAL rather than CAL alone will simplify the diagnostic criteria used for a periodontal diagnosis. The guidelines will also introduce definitions such as healthy but reduced periodontium and gingivitis on reduced periodontium and, therefore, will reduce overdiagnosis of periodontitis. In addition, adding age as an additional factor to be considered will help in making more clear-cut decisions between a diagnosis of aggressive and chronic periodontitis. Furthermore, using teeth rather than sites to determine whether periodontitis is localized or generalized

better reflects the client’s periodontal status. We propose that, once approved by the World Workshop and the AAP in 2017, these modifications to the diagnosis guidelines be adopted immediately by practising clinicians and the teaching faculty in Canadian universities and colleges.

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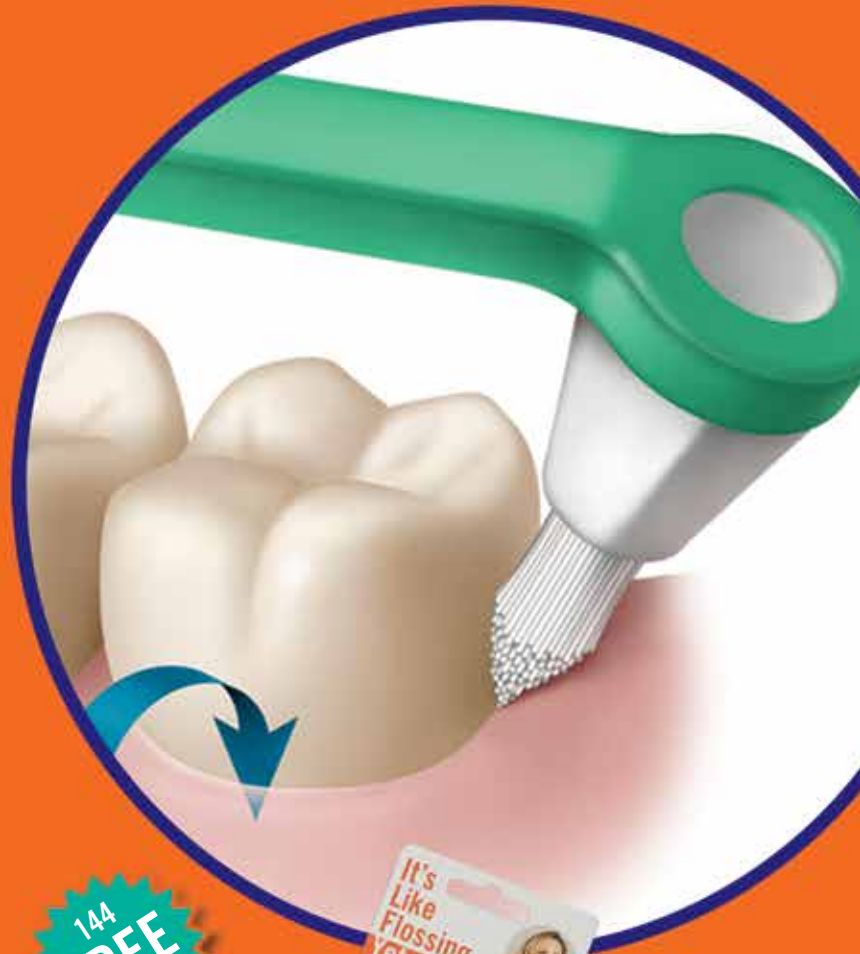
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THE EROSION EPIDEMIC

THE GROWING IMPACT ON PATIENTS' ORAL HEALTH

DENTAL EROSION HAS REACHED EPIDEMIC LEVELS

- Recent research has shown that approximately **30% of dental patients** aged 18-35 years had at **least one tooth with advanced erosive tooth wear**²
- Current research shows that **dental erosion in children** can range from **10% to 80%**³
- Effective management of dental erosion is largely dependent on a thorough understanding of its cause and **early recognition of its signs and symptoms in your patients**⁴

As a dental hygienist, it is paramount to ask patients questions about their daily routines. Find out if they are drinking sports drinks each afternoon at the gym or snacking on fruit several times a day⁵

- Sarah DeBowes RDH, BS
Dimensions of Dental Hygiene Magazine

THE STRONG RELATIONSHIP BETWEEN DIET AND TOOTH EROSION

- Frequent consumption of **acidic beverages is an ongoing problem** for children, teenagers, and adults³
- The dramatic increase in consumption of acidic soft drinks, fruit juices, fruit drinks, sports drinks, and carbonated beverages is now thought to be the **leading cause of dental erosion in children and adolescents**³

THE pH FACTOR IN EROSION

- A neutral, enamel-safe pH level ranges from 6.75 to 7.25⁵
- Tooth structure begins to soften and demineralize when the pH levels fall between 6.0 and 5.5⁵
- The lower the pH level, the higher the acidity level - when patients consume foods and beverages with high acidity, their risk of erosion increases⁵
- Teeth erode in the pH range of 2.0 to 4.0³
- With each unit decrease in pH there is a 10-fold increase in enamel solubility that can result in 100-fold increase in enamel demineralization as the pH approaches 2.0 from 4³

FAST FACTS

- Patient's perceptions that flavoured water is as safe for teeth as plain water is **false**⁵
- Children's teeth have a thinner enamel layer leaving them more susceptible to rapid erosion³

WHY FLUORIDE ALONE WILL NOT PREVENT ENAMEL EROSION

- Fluoride is not able to prevent enamel erosion because highly acidic environments solubilize fluorapatite and calcium fluoride³

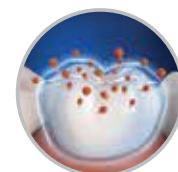
STANNOUS FLUORIDE PROTECTS AGAINST ENAMEL EROSION

- EUROPEAN CONSENSUS DENTISTRY REPORT

A new Consensus Report of the European Federation of Conservative Dentistry recognizes the protective benefits of stannous fluoride dentifrice against erosive tooth wear. Products [toothpastes] containing stannous fluoride have the potential for slowing the progression of erosive tooth wear²

STANNOUS FLUORIDE -- WITH AN ADDITIONAL MECHANISM OF ACTION THAT'S DIFFERENT FROM OTHER FLUORIDES

Unlike other fluorides, stannous complexes, like stannous fluorophosphate, form on enamel surfaces and block acid-susceptible dissolution sites. These stannous complexes effectively:¹

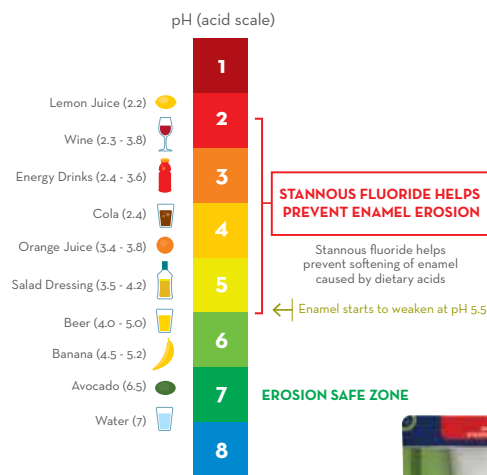


with SHMP

- Coat enamel surface
- Form acid resistant layer
- Lowers reactivity of enamel surface towards dissolution

THE RISK OF ACID IN PATIENT DIETS¹

Acid Scale Erosion Danger Zone



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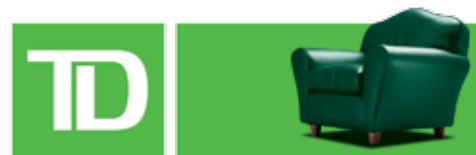
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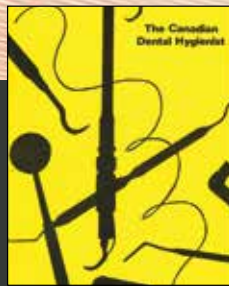
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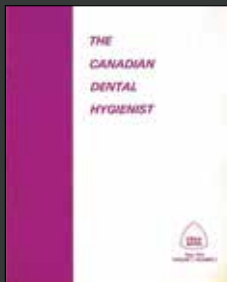
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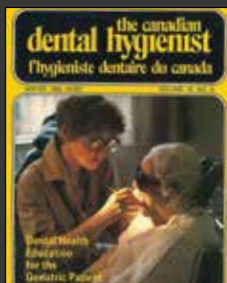
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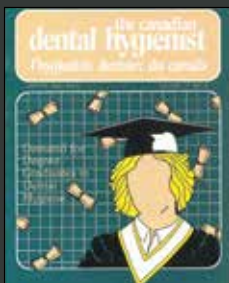
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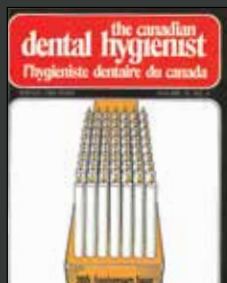
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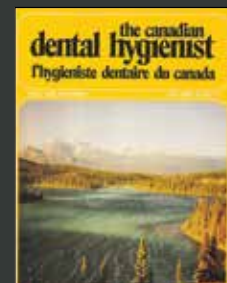
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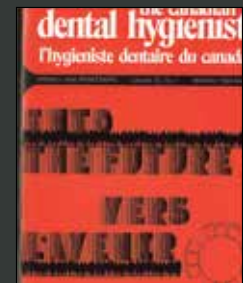
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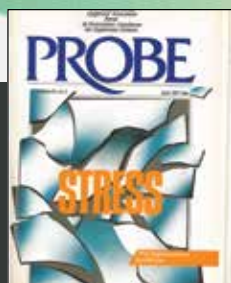
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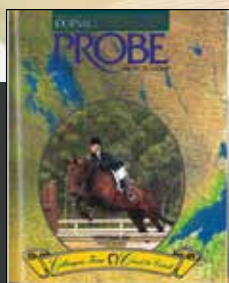
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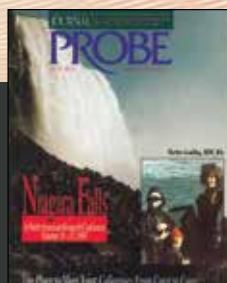
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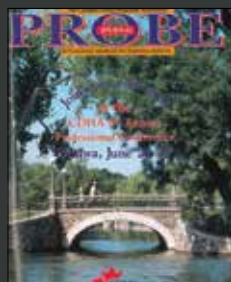
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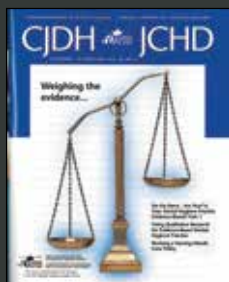
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