Systematic Review

Efficacy of preprocedural mouthrinses in the reduction of microorganisms in aerosol

A systematic review

Vanessa Costa Marui, DDS; Maria Luisa Silveira Souto, DDS; Emanuel Silva Rovai, DDS; Giuseppe Alexandre Romito, PhD, MSc, DDS; Leandro Chambrone, PhD, MSc, DDS; Claudio Mendes Pannuti, PhD, MSc, DDS

ABSTRACT

Background. The authors of this systematic review aimed to evaluate the efficacy of preprocedural mouthrinses in reducing the number of microorganisms disseminated by means of the aerosol generated via dental procedures when compared with a placebo, water, or no mouthrinse.

Types of Studies Reviewed. The authors included only randomized clinical trials. They searched MEDLINE (PubMed), Embase, Google Scholar, and Latin American and Caribbean Health Sciences Literature databases through May 31, 2019. They performed random-effects meta-analysis for reduction of the number of colony-forming units (CFU) in the dental aerosol.

Results. Of 770 potentially relevant articles, the authors included 13 randomized clinical trials in which researchers studied the efficacy of chlorhexidine, essential oils, cetylpyridinium chloride, and herbal products. Meta-analysis of 12 studies showed that mouthrinses with chlorhexidine, essential oils, and cetylpyridinium chloride significantly reduced the number of CFU. Overall, the use of a preprocedural mouthrinse resulted in a mean reduction in the number of CFUs of 64.8% (95% confidence interval, 50.4% to 79.3%; $I^2 = 37\%$) compared with control. None of the included studies presented a low risk of bias.

Practical Implications. Some dental procedures result in dissemination of microorganisms in the aerosol in the dental office. There is moderate evidence that preprocedural mouthrinses significantly reduce the number of microorganisms in the dental aerosol.

Key Words. Mouthrinses; preprocedural; aerosols; chlorhexidine; essential oils; cetylpyridinium chloride; microorganisms; dental office; cross-infection.

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Aerosols are liquid or solid particles of less than 50 micrometers in diameter that stay suspended in the air for extended periods.[1-3] Spatter are airborne particles larger than 50 μm in diameter that are too heavy to become suspended in the air for longer periods.[1,3] Many dental procedures, such as use of the ultrasonic scalers, slow- and high-speed handpieces, and 3-way syringes, generate aerosol and spatter.[4-7] There is evidence that dental aerosol can reach a distance of 1 through 3 meters from its source, causing contamination of distant surfaces.[8,9] In contrast, spatter reaches shorter distances and settles quickly,[1,3] which makes dental aerosol a greater concern for oral health care personnel (OHCP) when it comes to airborne contamination.

Dental procedure–generated aerosol is a potential source of cross-contamination in the dental office. In addition to containing common oral bacteria (such as *Streptococcus* species, *Actinomyces* species, *Veillonella parvula*, and *Fusobacterium nucleatum*), it may contain pathogenic bacteria (such as *Mycobacterium tuberculosis*, *Legionella pneumophilia*, and *Staphylococcus* species) and viruses (such as HIV, hepatitis B virus, hepatitis C virus, herpes simplex virus, influenza virus, and rhinovirus), among other infectious agents.[2,7,10,11] These microorganisms can remain suspended in aerosols and retain infectivity for long periods.[9,12] There is a possibility for these organisms to be inhaled or transmitted via direct contact with conjunctival, nasal, or oral mucosa of OHCP,[1,11,13-15] although,

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to date, there are no documented cases of disease transmission associated with dental aerosols in the United States.

The use of mouthrinses has been shown to be effective in reducing microbial counts in the oral cavity.[16] Consequently, preprocedural mouthrinses are used to decrease the number of microorganisms in the dental aerosol,[4-7] which may help reduce the risk of experiencing contamination in the dental office.

Many chemical agents have been used in mouthrinses as adjuncts of mechanical plaque control. Among these agents, chlorhexidine (CHX),[17] cetylpyridinium chloride (CPC),[18] and essential oils (EO)[19] have antimicrobial properties and have shown efficacy in the reduction of plaque and gingivitis. Many clinical trials have tested the efficacy of these and other mouthrinses in the reduction of microorganisms.[4-7,20] However, as far as we are aware, no systematic review has evaluated the efficacy of these products in reducing the level of oral microorganisms in aerosols. Furthermore, the risk of bias in these studies has not been addressed. Thus, in this systematic review, we focused on the following question: In patients undergoing dental procedures that generate aerosol, does the use of a preprocedural mouthrinse reduce the number of microorganisms in dental procedure–generated aerosol when compared with no mouthrinse or placebo rinse?

METHODS

We registered the study protocol of this systematic review with the International Prospective Register of Systematic Reviews (CRD42018090207). We structured the review text in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines,[21] the *Cochrane Handbook of Systematic Reviews of Interventions*,[22] and the Check Review checklist.[23]

Eligibility criteria

Type of Studies and Participants

We only considered randomized controlled trials for this review. Eligible trials included patients who underwent a dental procedure that generated aerosol (use of ultrasonic scalers, slow- and high-speed handpieces, and 3-way syringes and the removal of orthodontic apparatus, among others).

Intervention and Comparison

The use of a mouthrinse before dental procedure was compared with the use of a placebo, water, or no mouthrinse.

Outcome Measures

The outcome measure was the reduction in the number of viable bacteria present in oral aerosol.

Exclusion Criteria

We excluded studies that did not have a control group and studies that did not randomize for the type of mouthrinse.

Information source and search strategy

We developed search strategies for MEDLINE via PudMed, Embase, Latin American and Caribbean Health Sciences Literature, and Google Scholar databases. We combined medical subject heading terms and key words with Boolean operators to search the databases. We conducted the searches without language restriction through May 31, 2019. The search strategy for MEDLINE is shown in the etable, available online at the end of this article.

In addition to the electronic search, we conducted a manual search using the reference lists of the selected articles. Furthermore, we searched the OpenGrey open access database for unpublished studies.

Study selection

In the first phase, 2 reviewers (V.C.M., M.L.S.) screened titles and abstracts independently. Disagreements were resolved via discussion with a third reviewer (C.M.P.). Studies that appeared to meet the inclusion criteria or that lacked information in their titles and abstracts were selected for assessment of the full-text article in the second phase. The same reviewers independently assessed the full texts to determine if the studies were eligible. We conducted data extraction and risk of bias

ABBREVIATION KEY

ADA: American Dental Association.
CFU: Colony-forming units.
CHX: Chlorhexidine.
CPC: Cetylpyridinium chloride.
DUW: Dental unit waterlines.
EO: Essential oils.
NR: Not reported.
OHCP: Oral health care personnel.
RCT: Randomized clinical trial.

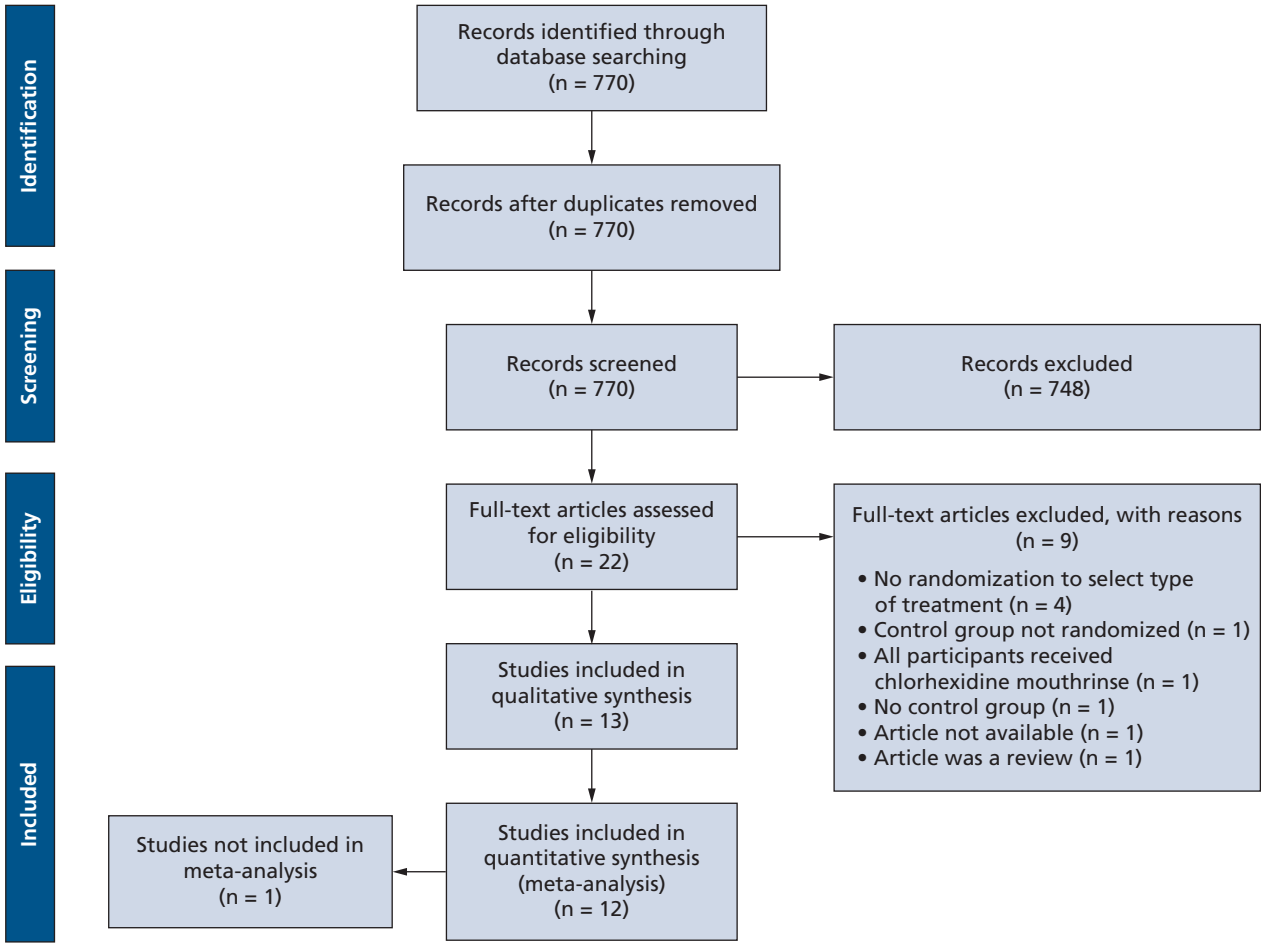

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses[21] flowchart of included studies according to the search strategy.

assessment on studies that met the inclusion criteria. Interinvestigator agreement, calculated with κ coefficient, was 0.85 in the first phase and 0.80 in the second phase.

Data collection

Two reviewers (V.C.M., M.L.S.) independently extracted all data. Disagreements were discussed with a third reviewer (C.M.P.). When necessary, we contacted the authors of the included studies and asked them to provide clarifications or missing data. We extracted and recorded data using extraction forms.[23] We sought the following variables: citation, country and setting of the study, characteristics of the participants, type of dental procedure, type of microbiological sampling, microbiological analysis, antiseptic (including concentration and duration of rinsing), outcome measures, authors' conclusions, and source of funding and conflicts of interest.

We expressed the outcome measure as reduction in the number of colony-forming units (CFU) in the aerosol collection sites (agar plates placed at different locations in the dental room or sterile filters inserted into vacuum air-sampling devices). In the studies that did not have data for before mouthrinse use, we expressed the reduction of CFU as mean percentage of CFU reduction compared with the control, calculated as the number of CFU after the use of the active mouthrinse (CHX, EO, CPC, or herbal) in relation to the number of CFU after the use of the control mouthrinse. In the studies that presented CFU data before and after mouthrinse use, we also expressed reduction of CFU as mean percentage of CFU reduction, calculated as the number of CFU after the use of the active mouthrinse in relation to the number of CFU after the use of control mouthrinse (end of trial data). When authors placed agar plates at various locations or the vacuum air-sampling device presented various levels, we calculated the overall number of CFU as the mean of these different locations or levels.

Table 1. Characteristics of the included studies.

STUDY	COUNTRY	STUDY DESIGN	BASELINE SAMPLE SIZE, NO.; AGE; SEX	PROCEDURE	AEROSOL COLLECTION METHOD	MICROBIAL ANALYSIS	SOURCE OF FUNDING
Mohammed and Monserrate,[34] 1970	United States	Parallel RCT*	40 males; age NR†	Turbine handpiece for 1 min	A sterile impinger was mounted in an upright position, and the adapter end of a sterile sampling tube was connected to a vacuum source. The sampled air was drawn into and through the impinger.	Counting of total numbers of bacterial colonies	None
Fine and Colleagues,[35] 1992	United States	Crossover RCT	18; age and sex NR	Full-mouth dental prophylaxis with ultrasonic scaler for 10 min	A sterile filter contained in a filter cassette was positioned in front of the participant's mouth at a distance of 2 inches.	Counting of total CFU‡ with the aid of a dissecting microscope	Warner-Lambert
Fine and Colleagues, Study 1,[36] 1993a	United States	Crossover RCT	18; age and sex NR	Full-mouth dental prophylaxis with ultrasonic scaler for 10 min	A sterile filter contained in a filter cassette was positioned in front of the participant's mouth at a distance of 2 in.	Counting of total CFU with the aid of a dissecting microscope	Warner-Lambert
Fine and Colleagues, Study 2,[36] 1993a	United States	Crossover RCT	18; age and sex NR	Full-mouth dental prophylaxis with ultrasonic scaler for 5 min	A sterile filter contained in a filter cassette was positioned in front of the participant's mouth at a distance of 2 in.	Counting of total CFU with the aid of a dissecting microscope	Warner-Lambert
Fine and Colleagues,[37] 1993b	United States	Crossover RCT	18; age and sex NR	Full-mouth dental prophylaxis with ultrasonic scaler for 5 min	A sterile filter contained in a filter cassette was positioned in front of the participant's mouth at a distance of 2 in.	Counting of total CFU with the aid of a dissecting microscope	Warner-Lambert
Logothetis and Martinez-Welles,[8] 1995	United States	Parallel RCT	18 (10 males; 8 females); 25-54 y; sex NR	Air polish device for 3 min	8 blood agar plates: mask of the operator and 2, 3 (3 points), 5, 6, and 9 feet from a reference point (patient's head)	Anaerobic culture; counting of CFU with Labline Colony Counter	University of New Mexico Research Allocation Subcommittee
Klyn and Colleagues,[4] 2001	United States	Parallel RCT	15; 21-63 y; sex NR	Full-mouth dental prophylaxis with ultrasonic scaler for 5 min	4 blood agar plates were placed 6 in from the oral cavity, and 1 agar plate was placed 2 ft from the oral cavity.	Culture; counting of CFU	None
Feres and Colleagues,[5] 2010	Brazil	Parallel RCT	60; 30-70 y; sex NR	Full-mouth dental prophylaxis with ultrasonic scaler for 10 minutes	5 blood agar plates: 3 on the support board, 1 on the participant's chest, and 1 on the clinician's forehead	1. Anaerobic culture; counting of CFU with Labline Colony Counter 2. Checkerboard DNA-DNA hybridization (40 species)	Colgate-Palmolive
Reddy and Colleagues,[38] 2012	India	Parallel RCT	30; age and sex NR	Full-mouth dental prophylaxis with ultrasonic scaler	The aerosol produced by the ultrasonic unit was collected at the 3-o'clock, 6-o'clock, and 12-o'clock positions on blood agar plates within a range of 4 ft	Counting of number of CFUs	None
Shetty and Colleagues,[20] 2013	India	Parallel RCT	60; 25-45 y; sex NR	Dental prophylaxis with ultrasonic scaler	3 soy agar plates placed: 6 in from operator's nose level; 6 in from dental assistant's nose level; 12 in from patient's chest level	Counting of number of CFU	None

* RCT: Randomized clinical trial. † NR: Not reported. ‡ CFU: Colony-forming units.

Table 1. Continued

STUDY	COUNTRY	STUDY DESIGN	BASELINE SAMPLE SIZE, NO.; AGE; SEX	PROCEDURE	AEROSOL COLLECTION METHOD	MICROBIAL ANALYSIS	SOURCE OF FUNDING
Gupta and Colleagues,[39] 2014	India	Parallel RCT	24 (16 males; 8 females); mean age 40 y	Full-mouth dental prophylaxis with ultrasonic scaler for 30 min	3 blood agar plates: 1 patient's chest area, 1 doctor's chest area, and 1 assistant's chest area	Counting of CFU	None
Dawson and Colleagues,[6] 2016	United Kingdom	Parallel RCT	18; age and sex NR	Low-speed handpiece	Andersen 6-stage viable particle impactor attached to a vacuum pump. Each of the 6 stages of the impactor contained a petri dish with anaerobe agar. The air intake of the extension tube was positioned at the level of the patient's mouth and at a distance of 30 centimeters.	1. Anaerobic culture (total bacterial growth) 2. Polymerase chain reaction (universal primer) for total bacteria	None
Retamal Valdez and Colleagues,[7] 2017	Brazil	Parallel RCT	60 (24 males; 36 females); 18-70 y	Full-mouth dental prophylaxis with ultrasonic scaler for 10 min	5 honokiol agar plates: 3 on the support board, 1 on the participant's chest, and 1 on the clinician's forehead	1. Anaerobic culture; counting of CFU with Labline Colony Counter 2. Checkerboard DNA-DNA hybridization (40 species)	Colgate-Palmolive and Latin America Oral Health Association

Risk of bias in individual studies

We evaluated the risk of bias of the studies in accordance with the Cochrane Collaboration's tool for assessing risk of bias.[22] The same reviewers (V.C.M., M.L.S.) analyzed the studies independently, and any disagreement between them was resolved via consultation with a third adjudicator (C.M.P.).

Furthermore, we used Grading of Recommendations, Assessment, Development and Evaluation guidelines[24] to assess the strength of evidence across RCTs regarding reduction in the number of CFU. We verified the quality of evidence on the basis of risk of bias, inconsistency, indirectness, and imprecision.

Summary measures and synthesis of results

We performed meta-analyses using Review Manager software, Version 5.3 (Nordic Cochrane Center, Cochrane Collaboration). We conducted random-effects meta-analysis for mean reduction of viable bacteria, which we expressed as mean percentage of CFU reduction. We performed the analysis with the generic inverse variance statistical method, using the mean difference and standard error. We expressed pooled outcomes as weighted mean difference. We assessed statistical heterogeneity among the studies with the Cochran Q statistic and I^2.

RESULTS

In the first phase of the screening process, we retrieved 770 potentially relevant articles from the electronic databases and from hand searching. We did not retrieve any articles from the search in OpenGrey database. After review of titles and abstracts, we excluded 748 articles. We reviewed the full texts of the remaining 22 articles. After the complete reading of these articles, we excluded 9 studies for the following reasons: randomization for type of mouthrinse was not performed,[25-28] the article was a narrative review,[29] groups were not randomized,[30] all participants received CHX mouthrinse,[31] the study lacked a control group,[32] and the full-text was not available even after contacting the authors.[33] We selected 13 studies published in 12 articles[4-8,20,34-39] for qualitative synthesis. We included 12 studies from 11 articles[4,5,7,8,20,34-39] in the quantitative synthesis (meta-analysis) (Figure 1).

Table 2. Participants, interventions, results, and conclusions of the included studies.

STUDY	COUNTRY	TYPE OF PARTICIPANTS	INTERVENTION (NO.)	NUMBER OF CFU* COMPARED WITH CONTROL	AUTHORS' CONCLUSIONS
Mohammed and Monserrate,[34] 1970	United States	Had some form of moderate gingivitis	CPC† (20) No rinse (20)	CPC versus control, 56.7%‡ less CFU	The mouthrinse formulation used in this study appeared to reduce significantly contamination produced during the use of air turbine handpieces.
Fine and Colleagues,[35] 1992	United States	ADA§ Periodontal Case Type I (gingivitis) or II (incipient periodontitis) as determined via clinical examination and radiography; the presence of at least 20 natural sound teeth with a mean plaque index > 1.5 and a mean gingival index > 1.5	EO¶ (18) Placebo (5% hydroalcohol) (18)	EO: reduction of 1.23 CFU (log transformed) Placebo: reduction of 0.18 CFU (log transformed) Difference between groups: EO reduced 1.05 more CFU (log transformed)	The antiseptic mouthrinse used as a preprocedural rinse can reduce significantly the viable microbial content of aerosols generated during dental procedures.
Fine and Colleagues, Study 1,[36] 1993a	United States	ADA Periodontal Case Type I (gingivitis) or II (incipient periodontitis) as determined via clinical examination and radiography; the presence of at least 20 natural sound teeth with a mean plaque index > 1.5 and a mean gingival index > 1.5	EO (18) Placebo (5% hydroalcohol) (18)	EO: reduction of 1.10 CFU (log transformed) Placebo: reduction of 0.07 CFU (log transformed) Difference between groups: EO reduced 1.03 more CFU (log transformed)	Preprocedural rinsing with EO may reduce the risk of cross-contamination with infectious agents in dental operatory.
Fine and Colleagues, Study 2,[36] 1993a	United States	ADA Periodontal Case Type I (gingivitis) or II (incipient periodontitis) as determined via clinical examination and radiography; the presence of at least 20 natural sound teeth with a mean plaque index > 1.5 and a mean gingival index > 1.5	EO (18) Placebo (5% hydroalcohol) (18)	EO: reduction of 1.06 CFU (log transformed) Placebo: reduction of 0.06 CFU (log transformed) Difference between groups: EO reduced 1.00 more CFU (log transformed)	Preprocedural rinsing with EO may reduce the risk of cross-contamination with infectious agents in dental operatory.
Fine and Colleagues,[37] 1993b	United States	ADA Periodontal Case Type I (gingivitis) or II (incipient periodontitis) as determined via clinical examination and radiography; the presence of at least 20 natural sound teeth with a mean plaque index > 1.5 and a mean gingival index > 1.5	EO (18) Placebo (5% hydroalcohol) (18)	EO: reduction of 1.19 CFU (log transformed) Placebo: reduction of 0.17 CFU (log transformed) Difference between groups: EO reduced 1.02 more CFU (log transformed)	Rinsing with an antiseptic at the outset of a simulated dental visit can reduce significantly the level of viable bacteria in an aerosol produced via ultrasonic scaling 40 min later.
Logothetis and Martinez-Welles,[8] 1995	United States	20 permanent teeth and a mean plaque score of 1.8-3.0 on the Simplified Debris Plaque Index	Water (6) 0.12% CHX# (6) EO (6)	CHX versus control, 93.10%‡ reduction EO versus control, 1% reduction	Routine prerinse with CHX can eliminate most of bacterial aerosols generated via use of the air-polishing device, providing protection as far as 9 feet from the center of operation.
Klyn and Colleagues,[4] 2001	United States	ADA Periodontal Case Type I (gingivitis) or II (incipient periodontitis) as determined via clinical examination and radiography	No rinse (15) 0.12% CHX (15)	CPC versus control, 51.43%‡ reduction	The use of either an aerosol reduction device or a preoperative CHX mouthrinse reduces the dissemination of bacteria-containing spray during ultrasonic scaling therapy.

* CFU: Colony-forming units. † CPC: Cetylpyridinium chloride. ‡ Significant reduction when compared with control. § ADA: American Dental Association. ¶ EO: Essential oils. # CHX: Chlorhexidine.

Table 2. Continued

STUDY	COUNTRY	TYPE OF PARTICIPANTS	INTERVENTION (NO.)	NUMBER OF CFU* COMPARED WITH CONTROL	AUTHORS' CONCLUSIONS
Feres and Colleagues,[5] 2010	Brazil	20 natural teeth, 80% of the tooth surfaces had to have visible supragingival plaque, less than 10% had to have visible supragingival calculus, and less than 30% had to have pocket depth and clinical attachment loss ≥ 5 millimeters	Water (15) No rinse (15) 0.12% CHX (15) 0.05% CPC (15)	CHX versus no rinse, 78%‡ reduction CPC versus no rinse, 77%‡ reduction CHX versus water, 70%‡ reduction CPC versus water, 68%‡ reduction	Mouthrinses containing 0.05% CPC and 0.12% CHX are equally effective in reducing the levels of spatter bacteria generated during ultrasonic scaling.
Reddy and Colleagues,[38] 2012	India	Systemically healthy patients, no age and sex criterion	Sterile water (10) Nontempered 0.2% CHX (10) Tempered 0.2% CHX (10)	CHX versus water: reduction of 1.972 CFU (log-transformed) Tempered CHX versus water: reduction of 1.984 CFU (log-transformed)	Preprocedural rinse can significantly reduce the viable microbial content of dental aerosols, and tempered CHX mouthrinse was more effective than nontempered CHX mouthrinse.
Shetty and Colleagues,[20] 2013	India	Minimum of 20 permanent teeth, oral hygiene score from 1.3-3, plaque index from 1-2	Distilled water (20) 0.2% CHX (20) Tea tree oil (20)	CHX versus water, 93.3%‡ reduction	All antiseptic mouthrinses reduced bacterial CFU in aerosol samples. CHX mouthrinses were found to be superior.
Gupta and Colleagues,[39] 2014	India	Mean plaque score of 2-3 on the plaque index and periodontitis (≥ 4 sites with pocket depth ≥ 4 mm)	0.2% CHX (8) Herbal mouthrinse (8) Water (8)	CHX versus water, 72.05%‡ reduction Herbal mouthrinse versus water, 35.86%‡ reduction	Herbal mouthrinse was effective in reducing the aerosol contamination produced via ultrasonic scaling, though less potent than 0.2% CHX mouthrinse.
Dawson and Colleagues,[6] 2016	United Kingdom	Patients who had received comprehensive fixed appliance treatment and scheduled for debonding of the fixed appliances.	No rinse (6) 0.2% CHX (6)	CXH versus no rinse, 77% increase (mean of the 6 stages of the impactor) CHX versus water, 25.3% increase (mean of the 6 stages of the impactor)	The use of preprocedural water or CHX mouthrinse appeared to cause increases in the numbers and diversity of airborne bacteria.
Retamal Valdez and Colleagues,[7] 2017	Brazil	At least 80% of the sites with visible supragingival plaque, fewer than 10% of sites with visible supragingival calculus, fewer than 30% of sites with pocket depth ≥ 5 mm	0.075% CPC, 0.28% zinc lactate, and 0.05% sodium fluoride (15) 0.12% CHX (15) Water (15) No rinse (15)	CXH versus no rinse, 77%‡reduction CPC versus no rinse,70%‡ reduction CHX versus water, 70%‡ reduction CPC versus water, 61%‡ reduction	Preprocedural mouthrinse containing 0.075% CPC, 0.28% zinc lactate, and 0.05% sodium fluoride was effective in reducing bacterial species present in oral aerosols during prophylaxis with ultrasonic instruments.

Included studies

Characteristics of the included studies are shown in Table 1. Overall, 397 participants were enrolled. In most studies, the aerosol-generating device was an ultrasonic device.[4,5,7,20,35-39] In some studies, aerosol was generated by air polisher,[8] air turbine handpieces for dental cavity preparation,[34] and slow-speed handpieces for orthodontic appliance removal.[6] Four different types of active mouthrinses were tested as preprocedural agents in the included studies: CHX, CPC, EO, and herbal mouthrinses.

In some studies, microbiological samples were collected with sterile filters contained in a filter cassette and connected to a specially adapted intake tube, inserted into a vacuum air-sampling device.[6,35-37] One study used a sterile impinger connected to a vacuum source to collect the sampled air.[34] Other investigations used blood agar plates,[4,5,8,38,39] honokiol agar plates,[7] and soy agar plates.[20] In these studies, agar plates were positioned at different locations in the dental room, such as the patient's chest, the clinician's forehead, the reflector, and the chair tray, with varying distances from the reference point (the patient's mouth).

Regarding microbiological analysis, most studies counted the total number of CFU.[4,5,7,8,20,34-39] One study[6] used polymerase chain reaction to assess bacterial counts, and 3 investigations[5,7] used checkerboard DNA-DNA hybridization technique in the assessment of microorganisms.

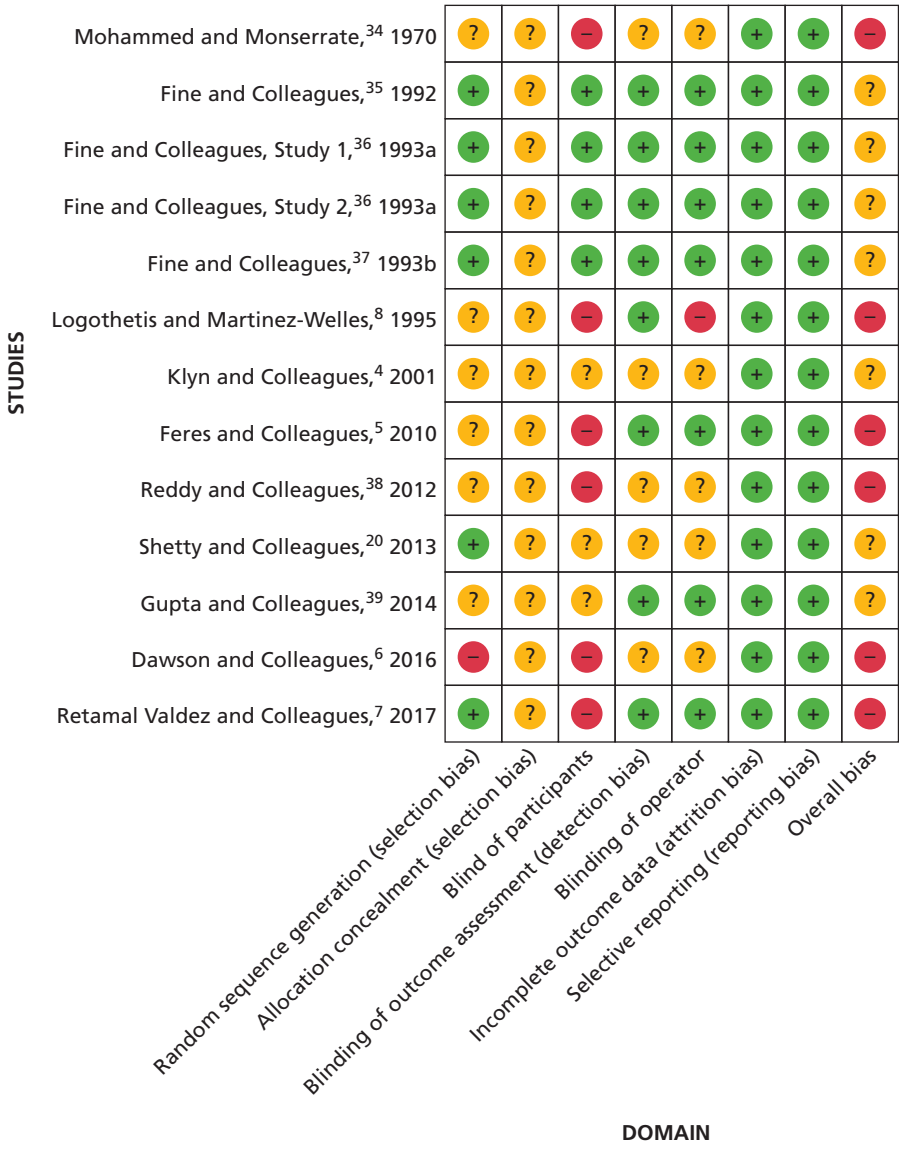

Figure 2. Risk of bias of the included studies. +: Low risk of bias. ?: Unclear risk of bias. −: High risk of bias.

Individual results of the included studies are shown in Table 2. Overall, except for 1 study,[6] all investigations reported that a preprocedural mouthrinse significantly reduced the number of CFU.

Risk of bias

Figure 2 shows risk of bias of the included studies. Some studies reported the method of random sequence generation (computer-generated sequence)[7,20,35,37]; however, no study adequately reported allocation concealment. As regards blinding of participants, only the studies conducted by Fine and colleagues[35-37] used a placebo (5% hydroalcohol). Other studies used water mouthrinse control[5,7,8,20,34,39] or no mouthrinse control,[4-7,34] or the report was considered to be unclear.[4,20,39] Most studies reported blinding of the outcome assessor, with the exception of 5 trials.[4,6,20,34,38] We considered blinding of the operator to be adequate in 6 articles.[5,7,35-37,39]

Overall, we considered 6 studies to have high risk of bias[5-8,34,38] and 7 to have unclear risk of bias.[4,20,35-37,39]

Meta-analysis

Twelve studies were included in the meta-analysis. Dawson and colleagues[6] was not included because the authors used a different method to collect UFC samples: an Andersen 6-stage viable particle impactor attached to a vacuum pump. In their study, data of CFU counts are presented

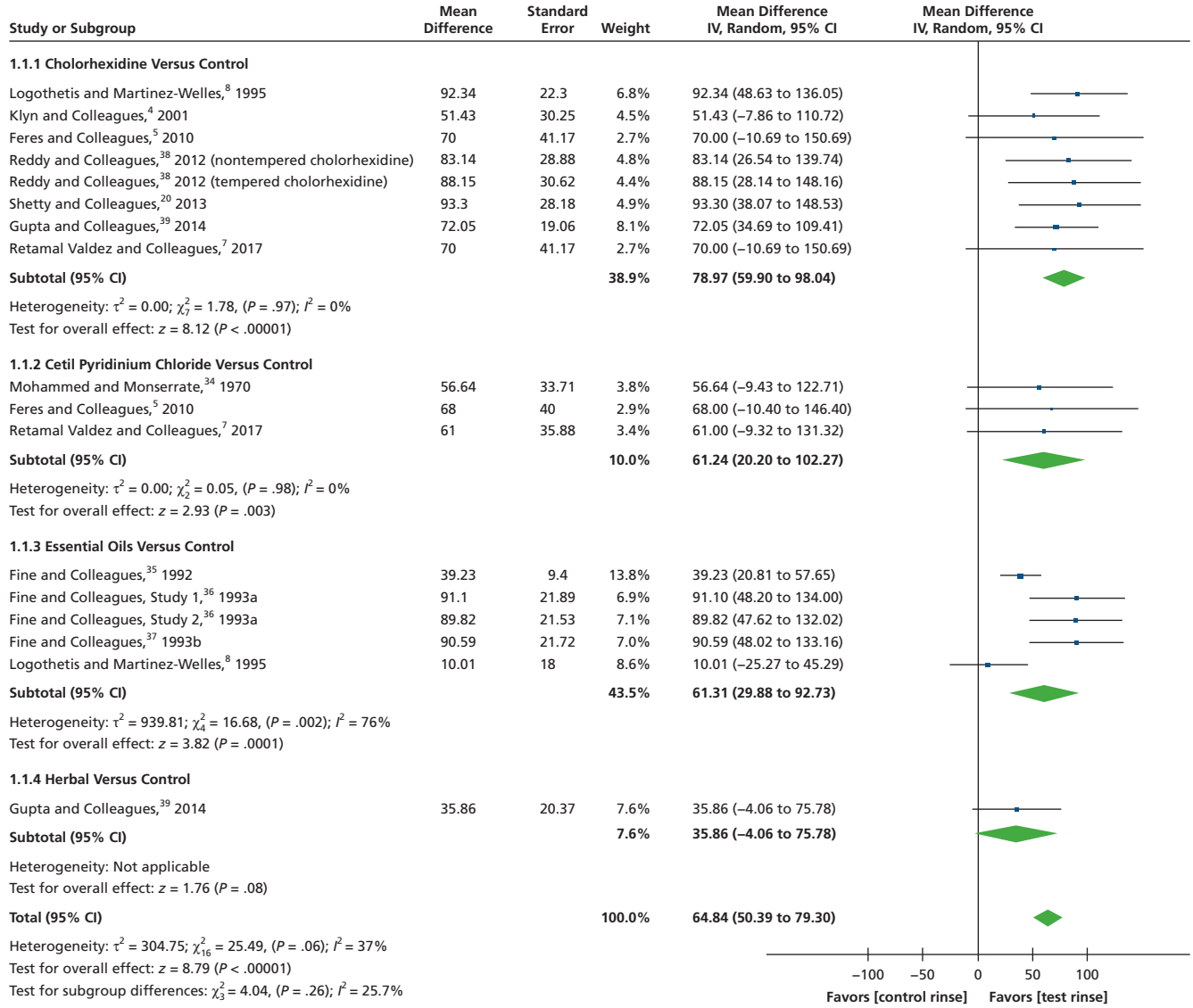

Figure 3. Forest plot of colony-forming units reduction. CI: Confidence interval. IV: Inverse variance.

for each of the 6 stages of the impactor. We analyzed the studies in subgroups, according to the type of mouthrinse. Pooled estimates suggested that, when compared with a control mouthrinse, there was significant percentage reduction in the number of CFU after the use of CHX mouthrinse (mean reduction, 78.9%; 95% confidence interval [CI], 59.9% to 98.04%; $I^2 = 0\%$), the use of CPC mouthrinse (mean reduction, 61.2%; 95% CI, 20.2% to 102.27%; $I^2 = 0\%$), and the use of EO mouthrinse (mean reduction, 61.3%; 95% CI, 29.9% to 92.7%; $I^2 = 76\%$). The use of a herbal mouthrinse did not result in a significant reduction in the number of CFU compared with the control mouthrinse. Overall, a preprocedural mouthrinse significantly reduced the number of CFU (mean reduction, 64.8%; 95% CI, 50.4% to 79.3%; $I^2 = 37\%$, moderate quality of evidence) (Figure 3, Table 3).

DISCUSSION

The results of our systematic review show that there is moderate evidence regarding the efficacy of preprocedural mouthrinses in reducing the number of viable bacteria in the aerosol generated via different dental procedures. With the exception of 1 study,[6] investigators found that different types of mouthrinses were able to decrease the number of microorganisms in agar plates placed in various points in the dental office, as well as on sterile filters attached to a vacuum air-sampling device. The results of our review are important, because a reduction in the number of aerosolized bacteria may

Table 3. Grading of Recommendations Assessment, Development, and Evaluation summary of findings table for preprocedural mouthrinse compared with control in the reduction of colony-forming units in dental procedure–generated aerosol.

CERTAINTY ASSESSMENT							EFFECT, MEAN DIFFERENCE (95% CI*)	QUALITY OF EVIDENCE	IMPORTANCE
Number of Studies	Study Design	Risk of Bias	Inconsistency	Indirectness	Imprecision	Other Considerations			
13	Randomized trial	Serious†	Not serious‡	Not serious§	Not serious¶	None	64.8% reduction (50.4% to 79.3%)	Moderate due to risk of bias	Important#

* CI: Confidence interval. † The proportion of information from studies at high risk of bias was sufficient to affect the interpretation of results. Furthermore, none of the studies were classified as presenting overall low risk of bias. ‡ Low heterogeneity ($I^2 < 40\%$) was found. § Patients, interventions, comparators, and outcomes provided direct evidence regarding the focused clinical question. ¶ The 95% CI did not cross the clinical decision threshold of recommending the intervention. # The outcome (reduction in the number of microorganisms in dental procedure–generated aerosol) was considered important, but not critical, because it is a surrogate of the true outcome (that is, development of an occupational infectious disease among oral health care personnel or patients).

reduce the risk of cross-contamination in the dental office, thus helping protect dentists, dental office personnel, and patients.

Although the use of personal protective equipment and other infection-control measures are common practice among dentists, these measures present limitations. For instance, most surgical masks do not protect completely from exposure to aerosolized microorganisms, especially *M. tuberculosis*, owing to their limited ability to filter 1 μm particles with a filter efficiency above 95% and the presence of small openings or defects.[1] Moreover, when surgical masks become wet, their filtration efficiency decreases.[1] Along the same lines, gloves may have small defects and can be torn during use.[1] Furthermore, aerosolized microorganisms remain suspended in the dental office environment up to 4 hours after a dental procedure,[9,12] so dental personnel may be exposed when they remove protective equipment after a patient's appointment. Consequently, the reduction in levels of aerosolized microorganisms promoted by preprocedural mouthrinses may result in additional protection against cross-contamination in the dental office environment.

To the best of our knowledge, this is the first study that systematically reviewed the efficacy of preprocedural mouthrinses in the reduction of bacteria in dental aerosol. Therefore, it was not possible to compare our results with those of previous reviews. All antiseptics included in this review (CHX, CPC, EO, and herbal products) significantly reduced the number of microorganisms in oral aerosol compared with a placebo. Surprisingly, in 1 study the authors observed that the number of bacteria increased after the use of a preprocedural mouthrinse (either water or CHX).[6] The analysis of the individual studies revealed that there were no significant differences between CHX and CPC in CFU reduction.[5,7] However, in 1 study the authors observed that CHX promoted a significantly higher reduction in aerosolized bacteria than EO.[8] Likewise, CHX mouthrinse promoted a greater reduction in the number of microorganisms than a herbal mouthrinse in 2 studies.[20,39]

The results of our review should be evaluated with caution. The primary outcome of all the studies (reduction in the number of aerosolized microorganisms) is a surrogate outcome for the development of occupational infection among OHCP or patients. Although preprocedural mouthrinses significantly decrease the number of microorganisms in dental procedure–generated aerosol, the influence of this decrease on infection rates is unknown. There is no direct evidence that indicates that a preprocedural mouthrinse decreases the rate of clinical infection in the dental office.[1]

A possible source of confounding in the results of the included articles is the microbial contamination of the dental unit waterlines (DUW).[1] Some investigations have shown colonization of DUW by microorganisms and the formation of biofilms.[40] Although most of the species recovered from DUW are common heterotrophic water bacteria with limited pathogenic potential for immunocompetent people,[40] there are reports of contamination of DUW by oral microorganisms and human pathogens such as *Pseudomonas aeruginosa*, *Legionella* species, and *Mycobacterium* species.[1,40] DUW is used to deliver water to ultrasonic scalers and dental handpieces, which may also become contaminated by these microorganisms. Methods and devices used to control biofilms and the quality of water in DUW have become available to dental offices only in the 2000s.[40] Thus, it was not possible to measure the impact of contaminated DUW in the aerosol generated via dental procedures

in the included studies, particularly the older ones. There is no documented evidence of the efficacy of preprocedural mouthrinses in the reduction of microorganisms originating from DUW.

Finally, 6 of the included studies were considered to have high risk of bias,[5-8,34,38] and 7 included studies were judged to have unclear risk of bias.[4,20,35-37,39] None of the studies adequately reported allocation concealment, which is associated with an overestimation of the intervention effect estimates.[41] Likewise, blinding of participants was considered to be adequate only in the studies conducted by Fine and colleagues.[35-37] Furthermore, 6 studies were sponsored by companies. There is evidence that there is an association between funding and positive conclusions in primary studies included in systematic reviews.[42] In other words, funding may overestimate the findings of clinical studies. Future studies should minimize the sources of bias by means of, for instance, the use of a placebo mouthrinse and implementing 1 of the methods of allocation concealment.

CONCLUSIONS

Preprocedural mouthrinses significantly reduce the number of microorganisms in the dental aerosol. ■

SUPPLEMENTAL DATA

Supplemental data related to this article can be found at: https://doi.org/10.1016/j.adaj.2019.06.024

Dr. Marui is a PhD student, Department of Stomatology, School of Dentistry, University of São Paulo, São Paulo, Brazil.

Dr. Souto is a PhD student, Department of Stomatology, School of Dentistry, University of São Paulo, São Paulo, Brazil.

Dr. Rovai is a PhD student, Department of Stomatology, School of Dentistry, University of São Paulo, São Paulo, Brazil.

Dr. Romito is the head, Department of Stomatology, School of Dentistry, University of São Paulo, São Paulo, Brazil.

Dr. Chambrone is an associate professor, Unit of Basic Oral Investigation, El Bosque University, Bogota, Colombia and a professor, School of Dentistry, Ibirapuera University (Unib), São Paulo, Brazil.

Dr. Pannuti is an associate professor, Department of Stomatology, School of Dentistry, University of São Paulo, Av. Prof. Lineu Prestes, 2227, São Paulo, SP, 05508-000, Brazil, e-mail pannuti@usp.br. Address correspondence to Dr. Pannuti.

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eTable. Search strategy for MEDLINE.

SEARCH NUMBER	SEARCH TERMS
1	anti-infective agents, local OR antiseptics or chlorhexidine OR chlorhexidine gluconate OR essential oils OR listerine OR oils, volatile OR tartar control listerine OR cetylpyridinium OR cetylpyridinium chloride, zinc acetate drug combination OR herbal OR benzethonium OR benzalkonium compounds
2	mouthwash OR mouthrinse OR rinse OR prevention mouthrinse OR mouth rinse OR dental
3	1 AND 2
4	contamination OR air contamination OR aerosol OR aerosols
5	3 AND 4