Table 1. Employed search-terms and limits

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| **Search strategy for the systematic review of literature on the bioaerosols and standard dental practice protocol in****post-COVID-19 era** |
| **Search history** |
| **Search****(Database/s)** | ( January 01, 1985, and April 30, 2020) |
| **Cochrane Library databases** | ***Bioaerosol and rubber dam***  | (rubber dam OR dental dam) AND (aerosol OR bioaerosol) AND (bacterial reduction OR microbial reduction) AND (dental operatory OR dental clinic) AND (dry field OR moisture control) AND (saliva OR blood) |
| ***Bioaerosol and high-volume evacuator (HVE)*** | (aerosol OR bioaerosol) AND (extraoral suction OR extra oral evacuator) AND (bacterial reduction OR microbial reduction) AND (dental operatory OR dental clinic) AND (high volume evacuator OR high volume suction) AND (saliva OR blood) AND (evacuators OR suction) |
| ***Bioaerosol and preprocedural oral rinse*** | (aerosol OR bioaerosol) AND (mouth rinse OR oral rinse) AND (mouth wash OR prophylactic mouth wash) AND (dental operatory OR dental clinic) AND (anti-microbial OR antibacterial) AND (anti-viral OR anti-fungal) AND (Chlorhexidine OR CHX OR Essential Oil) AND (Cetylpyridinium chloride OR CPC) AND (scaling OR ultrasonic) AND (high-speed rotary OR high-speed handpiece)AND (microbial reduction OR bacterial reduction) AND (preprocedural oral rinse OR preprocedural mouth rinse) |
| **PubMed via OVID** | ***Bioaerosol and rubber dam***  | Heading (MeSH) and text words: (aerosol OR bioaerosol) AND (rubber dam OR dental dam) AND (bacterial reduction OR microbial reduction) AND (dental operatory OR dental clinic) AND (dry field OR moisture control) AND (saliva OR blood) |
| ***Bioaerosol and high-volume evacuator (HVE)*** | Heading (MeSH) and text words: (aerosol OR bioaerosol) AND (extraoral suction OR extra oral evacuator) AND (bacterial reduction OR microbial reduction) AND (dental operatory OR dental clinic) AND (high volume evacuator OR high volume suction) AND (saliva OR blood) AND (evacuators OR suction) AND (high volume OR low volume) |
| ***Bioaerosol and preprocedural oral rinse*** | Heading (MeSH) and text words: (aerosol OR bioaerosol) AND (mouth rinse OR oral rinse) AND (mouth wash OR prophylactic mouth wash) AND (Chlorhexidine OR CHX OR Essential Oil) AND (Cetylpyridinium chloride OR CPC) AND (scaling OR ultrasonic) AND (high-speed rotary OR high-speed handpiece) AND (dental operatory OR dental clinic) AND (anti-microbial OR antibacterial) AND (anti-viral OR anti-fungal) AND (microbial reduction OR bacterial reduction) AND (preprocedural oral rinse OR preprocedural mouth rinse) |
| **EBSCO host** | ***Bioaerosol and rubber dam***  | (aerosol OR bioaerosol) AND (rubber dam OR dental dam) AND (bacterial reduction OR microbial reduction) AND (dental operatory OR dental clinic) AND (dry field OR moisture control) AND (saliva OR blood) |
| ***Bioaerosol and high-volume evacuator (HVE)*** | (aerosol OR bioaerosol) AND (extraoral suction OR extra oral evacuator) AND (bacterial reduction OR microbial reduction) AND (dental operatory OR dental clinic) AND (high volume evacuator OR high volume suction) AND (saliva OR blood) AND (evacuators OR suction) |
| ***Bioaerosol and preprocedural oral rinse*** | (aerosol OR bioaerosol) AND (Chlorhexidine OR CHX OR Essential Oil) AND (Cetylpyridinium chloride OR CPC) AND (scaling OR ultrasonic) AND (high-speed rotary OR high-speed handpiece)AND (mouth rinse OR oral rinse) AND (mouth wash OR prophylactic mouth wash) AND (dental operatory OR dental clinic) AND (anti-microbial OR antibacterial) AND (anti-viral OR anti-fungal) AND (microbial reduction OR bacterial reduction) AND (preprocedural oral rinse OR preprocedural mouth rinse) |
| **Web of Science** | ***Bioaerosol and rubber dam***  | (aerosol OR bioaerosol) AND (rubber dam OR dental dam) AND (bacterial reduction OR microbial reduction) AND (dental operatory OR dental clinic) AND (dry field OR moisture control) AND (saliva OR blood) |
| ***Bioaerosol and high-volume evacuator (HVE)*** | (aerosol OR bioaerosol) AND (extraoral suction OR extra oral evacuator) AND (bacterial reduction OR microbial reduction) AND (dental operatory OR dental clinic) AND (high volume evacuator OR high volume suction) AND (saliva OR blood) AND (evacuators OR suction) |
| ***Bioaerosol and preprocedural oral rinse*** | (aerosol OR bioaerosol) AND (mouth rinse OR oral rinse) AND (mouth wash OR prophylactic mouth wash) AND (dental operatory OR dental clinic) AND (anti-microbial OR antibacterial) AND (anti-viral OR anti-fungal) AND (microbial reduction OR bacterial reduction) AND (preprocedural oral rinse OR preprocedural mouth rinse) AND (Chlorhexidine OR CHX OR Essential Oil) AND (Cetylpyridinium chloride OR CPC) AND (scaling OR ultrasonic) AND (high-speed rotary OR high-speed handpiece) |

Table 2: Included Studies (Efficacy of rubber dam isolation and bio-aerosol)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Study**  | **Population****No. of patients (No.)**  | **Study type** | **Country** | **Dental Procedure** | **Aerosol-method of assessment** | **Summary microbial reduction with and without rubber dam** **(mean CFU)**  | **Outcome** |
| **Cochran et al., 1989 28** | Adults patients(16) | Case control | USA | 1. The rotary dental instrument with and without rubber dam. during restorative procedures (placement of amalgam and composite resin restorations).2. Rotary dental instrument and air-water syringe with and without rubber dam.The microbial collection was done during handpiece and air-water syringe spray  | Case: Microbial collection on the four culture dishes that were attached to the dental operating light positioned perpendicular to 24 inches away from the patients' mouth Another petri dish containing the same kind of agar placed on the patients' napkin 6-7 inches in front of the patients' chin. Controls: consisted of sets of four dishes attached to the dental light. A petri dish on the bracket table, all exposed to the air  | **With the rubber dam:**0.3 ±0.2 (98%) **Without the rubber dam:**13 ±0.3  | 1. Statistically significant reduction in microorganisms with the use of the rubber dam--70% to 88% 2. Statistically significant decrease in microbes with the use of the rubber dam-95% to 99%Overall, 90% to 98% of all data combined |
| **Samaranayake et al., 1989 29** | Pediatric patients (20) | RCT | UK | The rotary dental instrument with and without rubber dam  |  Blood agar plate positioned at 1m, 2m and 3m distances near the headrest area | **With the rubber dam:**88% reduction at - 1 m from the headrest72% reduction at 2 m from the headrest 0 % - No reduction at 3 m from the headrest | A highly significant (p= 0.001) reduction in bacterial contamination with rubber dam isolation A reduction in bacterial aerosols was most considerable at 1 m from the headrest |
| **Tag El-Din et al., 1997 30** | Pediatric patients (20)  | RCT | Egypt | Rotary instrument (air-turbine-driven handpiece)Standard restorative procedures performed under rubber dam isolationStandard procedures without rubber dam isolationUse of chlorhexidine mouth rinse 30 minutes before the procedureUse of chlorhexidine mouth rinse before application of the rubber dam | Four blood agar culture plates placed equidistantly from the child's headOne each on the chest left and right sides, and behind the patient. Another two plates placed at 1 and 2 meters from the headrest of the dental chair, respectively | **With the rubber dam:**7.9 ±2.8 **Rubber dam + Antiseptic mouth rinse:**5.9±2.0**Without the rubber dam:**19.5 ± 5.8  | The bacterial reduction was 98.8% at 1 meter when the rubber dam was used. The bacterial reduction increased when antiseptic mouth rinse was used before rubber dam application The reduction in CFUs at one meter was 98.8%, 73.8%, and 99.4% in the rubber dam group, the antiseptic group, and the antiseptic with rubber dam group, respectively.The highest bacterial contamination was on the agar plates positioned on the patient's chest |
| **Al- Amad et al., 2017 31** | Adult patients (52) | RCT | UAE | The rotary dental instrument with and without rubber dam, during the standard restorative dental procedure | Fifty-two unused (autoclaved) cotton-polyester scarves (head covers). Cotton swabs moistened with sterile normal saline for sample collection | **With the rubber dam:**NA**Without the rubber dam:**NA | Statistically significant bacterial reduction (mean CFU= 1.67±2.03) using a rubber dam (P=0.009) |

Table 3: Included Studies related to high-volume evacuation(HVE) and bio-aerosols

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Study**  | **Population****No. of patients (No.)**  | **Study type** | **Country** | **Dental Procedure** | **Aerosol-method of assessment** | **Summary microbial reduction with and without high volume evacuation (HVE)****(mean CFU)**  | **Outcome** |
| **Efficacy of High-volume evacuation and bio-aerosol** |
| **King et al., 199734** | Adults patients(12) | *In vivo* (Split mouth design) | USA | Ultrasonic scaling for 5-minutes with the aerosol reduction device Ultrasonic scaling for 5- minutes without the aerosol reduction device | Samples were collected on blood agar plates placed 6 inches from the subject's mouth | **With HVE** 2.6 +/- 3.6**Without HVE**45.1 +/- 28.9Low CFU count on the ***face*** ***shield*** with or without HVE | Significantly higher reduction in the quantity of mean colony forming units (CFUs) with **HVE** However, no significantdifferences in the numberof CFUs found on theinvestigator's ***face shield*** due to operators' position at 9 am and 12 pm operating position  |
| **Muzzin et al., 199935** | Adults patients(30) | *In vivo*  | USA  | All subjects underwent two minutes of air polishing. With the aerosol reduction device on one side of the mouth Without the aerosol reduction device on the opposite side | Microbial samples were collected on blood agar plates positioned 12 inches from the subject's mouthOne plate blood agar plate attached to the face mask | **With HVE** 20.10 +/- 53.90 **Without HVE** 148.00 +/- 145.00**HVE + Face mask** 8.80 +/- 15.10 CFUs**Without HVE + Face mask**40.90 +/- 33.80 CFUs | Air polisher without HVE generated a significantly higher number of CFUs on the face mask plate |
| **Timmerman et al., 200432** | Adults patients(06) | *In vivo*  | Netherland | Ultrasonic scaler with either high-volume evacuation (HVE) or conventional dental suction (CDS)17 treatment sessions, consisting of a 40-min episode | Two plates (blood agar) placed at 40 cm for 5 min After 20 min, the procedure was repeated.Two plates (blood agar) placed at 150 cm for 20 min. This was followed by exposure to two new Petri dishes for the rest of the session. The plates were cultured aerobically and anaerobically for 3 and 7 days, respectively. | Mean CFU before treatment never exceeded 0.6 colonies per plate. At 40 cm, the mean CFU, at 40 mins, was 8.0 for HVE and 17.0 for CDS. The mean CFU at 150 cm at 40 mins was 8.1 with HVE and 10.3 with the CDSThe use of a high‐volume evacuator may, however, help to minimize risks of microbial air contamination | **HVE**Mean Aerobic microbes0.9 (1.3)Mean Anaerobic microbes1.1 (1.2)**CDS (conventional dental suction)**Mean Aerobic microbes1.0 (1.2)Mean Anaerobic microbes3.3 (2.7) |
| **Desarda et al., 2014 36** | Adults patients(80) | *In vivo* | India | Piezoelectric ultrasonic scaling with or without high-volume evacuator. Nutrient agar plate placed on patient's chest at 20 inches and another plate was set at 12 inches on the dental assistant side  | Scaling was carried out for 10 minutesNutrient agar plates (4) were exposed for 20 minutes for microbial sampling  | **With HVE:**12.14 ± 1.93 **Without HVE:**11.08 ± 2.25  | There found no statistically significant differences in colony-forming units (CFU) with and without high-volume suction placed at 12 and 20- inches from the oral cavity |
| **Bio-aerosol reduction-Efficacy of HVE + standard oral hygiene (tooth brushing, flossing)** |
| **Bentley et al., 1994 37** | Adult patient (2) | *In vivo*  | USA | Restorative procedure using handpiece and high-volume evacuator for 30 minutesUltrasonic scaling with conventional salivary ejector for 30 minutes  | Blood agar plates were placed with on the six spokes of the headrest extension device at 12 and 24 inches from patients' mouthAlso, on operators face mask, disposable gowns, head caps.  | Colonies of alpha-hemolytic streptococciHigh-volume evacuation during all the restorative procedures shows negligible bacterial counts reaching plates at 24 inches from the mouthHigher bacterial counts inpatient, who did not brush, or floss for 24 hours compared to the second patient who had brushed and flossed before treatment | High-volume evacuation and preoperative toothbrushing and flossing may reduce bacterial contamination and dissemination |
| **Efficacy of High-volume evacuation and bio-aerosol**  |
| **Yamada et al., 2011 39** | Adult patients (281) At 50 cm single evacuator (n = 102) At 100 cm (n =124) At 100 cm double evacuator (n=55) | *In vivo* | Japan  | **At 50 cm and 100 cm from the mouth of the patient with single HVE:**Third molar surgeryFull-crown preparation, Inlay cavity (Black Class II) preparation,Scaling with an ultrasonic scaler**At 100 cm from the mouth of the patient with two HVE:**Third molar surgery | Test filter | **At 50 cm from patients' mouth (n=102) with single HVE:**Third molar surgery 92% (12/13)Full-crown preparation 70% (21/30)Inlay cavity (Black Class II) preparation35% (9/26)Ultrasonic scaling 33% (11/33)**At 100 cm from the patient's mouth (n=124) with single HVE:**Third molar surgery 90% (35/39)Full-crown preparation, 48% (15/31)Inlay cavity (Black Class II) 29% (6/21), Ultrasonic scaling 12% (4/33)**At 100 cm from the patient's mouth (n=55) with two HVE:**Bioaerosol decreased significantly from 90% (35/39) to 60% (33/55) | Extraoral evacuators are effective in reducing contaminated aerosols during dental procedures |

Table 4: Pre-procedural oral rinse and bio-aerosols

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Study**  | **Population****No. of patients (No.)**  | **Study type** | **Country** | **Dental Procedure** | **Aerosol-method of assessment** | **Microbial Assay** | **Summary microbial reduction with and without pre-oral rinse** | **Outcome** |
| **Fine et al., 1992 42** | Adults patients(18) | Double-blind, controlled, cross-over, clinical study | USA | A 10-minute **ultrasonic scaling**Antiseptic mouthwash **(EO)** or a control (20 ml) for 30 seconds | Aerosolized bacteria were collected on a sterile filter. Filter was Incubated on trypticase soy agar, aerobically at 370C for 24 to 72 hours. Counting the colony-forming units (CFU) | Counting of total CFU with a dissecting microscope | **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) | Rinsing with the antiseptic mouthwash **(EO)** produced a 94.1% reduction in CFUs |
| **Fine et al., 1993 43** | Adults patients(18) | Double-blind, controlled, cross-over, clinical study | USA | Full-mouth dental prophylaxis with **ultrasonic scaler** for 5 minAntiseptic mouthwash **(EO)** or a control  | Aerosolized bacteria were collected on a sterile filter. positioned in front of the participant’s mouth at a distance of 2 inchesCounting the colony-forming units (CFU) | Counting of total CFU with a dissecting microscope | **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) | Pre-procedural rinsing with an antiseptic **(EO)** signiﬁcantly reduce the level of viable bacteria in an aerosol produced via ultrasonic scaling 40 minutes later |
| **Logothetis et al., 1995 44** | Adults patients(18) | RCT | USA | **Air polish device** for 3 minAntiseptic mouthwash **(EO) and (CHX)** or a control | Mask of the operator and at 2, 3, 5, 6, and 9 feet from a reference point (patient’s head)Culture grown on eight blood agar platesCounting the colony-forming units (CFU) | Anaerobic cultureCounting of total CFU with colony counter | **CHX** versus control,93.10% reduction**EO** versus control, 1%reduction | Pre-rinse with **CHX** can effectively reduce most of the bacterial aerosols generated via the use of the air-polishing device, Pre-rinse reduces Aerosol as far as 9 feet from the patients’ head  |
| **Klyn et al., 2001 45** | Adults patients(15) | RCT  | USA | Full-mouth dental prophylaxis with **ultrasonic scaler** for 5 minAntiseptic mouthwash **(CHX vs. control)** | Bio-aerosols were collected on four blood agar plates. Three agar plates were placed at 6 inches from the oral cavity, One agar plate was placed 2 feet from the oral cavity | Counting of CFU | **CHX** versus control,51.43% reduction | The use of preoperative **CHX**mouth rinse reduces the dissemination of bacteria |
| **Feres et al., 201046** | Adults patients(60) | RCT  | Brazil  | Full-mouth dental prophylaxis with **ultrasonic scaler** for 10 minutesAntiseptic mouthwash **(CHX) and (CPC)** or a control | Bio-aerosols were collected on five **blood agar** plates: Three on the support board,One on the participant’s chestOne on the clinician’s forehead | **Checkerboard DNA-DNA hybridization** (40 species)**Anaerobic culture:** counting of CFU with colony counter | **CHX** versus water, 70%microbial reduction**CPC** versus water, 68% microbial reduction**CHX** versus no-rinse, 78% microbial reduction**CPC** versus no-rinse, 77% microbial reduction | Mouth rinses containing **0.12% CHX** and **0.05% CPC** are equally effective inreducing the levels ofspatter containing microbes generated during ultrasonic scaling |
| **Dawson et al., 201648**  | Adults patients(18) | RCT  | UK  | **Low-speed handpiece**Antiseptic mouthwash **(CHX)** anda control (water) | Petri dish with **anaerobe agar**The extension tube was positioned at the level of the patient’s mouth at a distance of 30 centimeters | **Anaerobic culture** **Polymerase chain reaction (PCR)** using universal primer) for total bacterial count | **CXH versus no-rinse**, a 77% increase **CHX versus water**, a 25.3% increase  | The use of preprocedural **0.2% CHX** mouth rinse increases in the numbersand diversity of airborne microbes |
| **Retamel -Valdez et al., 201747** | Adults patients(60) | RCT  | Brazil  | Full-mouth dental prophylaxis using **ultrasonic scaler** for 10 min | Bio-aerosols were collected on five agar plates: Three on the support board, One on the participant’s chest, and One on the clinician’s forehead | **Anaerobic culture:** counting of CFU with colony counter**Checkerboard DNA-DNA hybridization** (40 species) | **CXH versus no-rinse:** 77% reduction**CPC** **versus no-rinse:** 70% reduction**CHX** **versus water:**  70% reduction**CPC** **versus water**, 61%reduction | Preprocedural mouth rinse with **CHX** and **CPC** was effective in reducing microbial species  |

**\*CHX= Chlorhexidine; CFU: Colony-forming units; CPC: Cetylpyridinium chloride; EO: Essential oil**

**Table 5. Risk of Bias of the included studies**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Study | Selection biasBaseline characteristics similarity/ appropriate control selection | Selection biasAllocation concealment | Selection biasRandomization | Performance bias Blinding of Researchers | Detection biasBlinding of outcome assessors | Reporting biasSelective outcome reporting | Incomplete outcome data  |
| *Rubber dam- Bioaerosol*  |
| Cochran et al., 1989 28 | **+** | **+** | **?** | **+** | **?** | **+** | **+** |
| Samaranayake et al., 1989 29 | **+** | **+** | **?** | **+** | **?** | **+** | **+** |
| Tag El-Din et al., 1997 30 | **+** | **?** | **+** | **-** | **?** | **+** | **+** |
| Al- Amad et al., 2017 31 | **+** | **?** | **?** | **?** | **?** | **-** | **+** |
| *High volume evacuator (HVE) -Bioaerosol*  |
| Bentley et al., 1994 37 | **+** | **+** | **-** | **+** | **?** | **+** | **+** |
| King et al., 1997 34 | **+** | **?** | **?** | **?** | **?** | **+** | **+** |
| Muzzin et al., 1999 35 | **+** | **?** | **?** | **?** | **?** | **+** | **+** |
| Timmerman et al., 2004 32 | **+** | **?** | **+** | **?** | **+** | **+** | **+** |
| Yamada et al., 2011 39 | **+** | **+** | **+** | **+** | **?** | **+** | **+** |
| Desarda et al., 2014 36 | **+** | **?** | **+** | **?** | **?** | **+** | **?** |
| *Pre-procedural mouth rinse -Bioaerosol*  |
| Fine et al., 1992 42 | **+** | **?** | **?** | **+** | **+** | **+** | **+** |
| Fine et al., 1993 43 | **+** | **?** | **?** | **+** | **+** | **+** | **+** |
| Logothetis et al., 1995 44 | **+** | **+** | **?** | **-** | **-** | **+** | **+** |
| Klyn et al., 2001 45 | **?** | **?** | **?** | **?** | **?** | **+** | **+** |
| Feres et al., 2010 46 | **?** | **?** | **?** | **+** | **+** | **+** | **+** |
| Dawson et al., 2016 48 | **-** | **?** | **-** | **+** | **+** | **?** | **?** |
| Retamel -Valdez et al., 2017 47 | **+** | **?** | **+** | **+** | **+** | **+** | **?** |

**Risk of bias legends: + (Low risk); - (High risk); ? (Un-clear risk)**