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EVIDENCE BRIEF

# Dental Burs – Cleaning and Sterilization

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## Key Messages

- According to Spaulding's classification, dental burs are critical instruments and the level of reprocessing required for dental burs is cleaning followed by sterilization. Cleaning and Sterilization are two distinct steps of reprocessing and both steps are of equal importance to ensure the safe reuse of dental burs.
- Cleaning: While results were variable in terms of the level of effectiveness, automated cleaning using washer-disinfectors and ultrasonic cleaners are most effective for cleaning contaminated dental burs. Manual cleaning is an inconsistent approach and is considered the least effective cleaning method.
- Sterilization: Steam sterilization using autoclave is the most effective sterilization method for dental burs, across the reviewed studies.
- Glass Bead Sterilizers, chemiclave sterilization, ultraviolet light, microwave ovens and boiling are unacceptable methods of sterilization.

## Issue and Research Question

Infection prevention and control processes are one of the most important facets in dental care. Proper reprocessing of dental instruments, including the most commonly used dental burs, is crucial to prevent or minimize the transmission of pathogenic agents and to assure patient-provider safety. With increasing incidence of infectious and/or contagious diseases including COVID-19, it is important to ensure that reusable dental burs are sterile, given their use in performing aerosol generating dental procedures that range from non-invasive restorative procedures to invasive surgical procedures. Dental burs are available in a variety of shapes and sizes, and the type of burs used in a clinical procedure vary depending on the procedural requirements. Dental burs can thus be contaminated with necrotic tissue, dental tissue, blood, saliva, bone and microorganisms associated with the oral cavity during procedures, and can then act as a potential source of cross-contamination in dental settings.[1, 2]

Effective decontamination and reprocessing of dental burs using evidence-based methods that are in accordance with organizational or jurisdictional policies and guidelines is mandated to prevent cross-contamination in dental settings. Decontamination methods include cleaning, disinfection and/or sterilization.[3] According to Spaulding's Classification, dental burs are "critical" instruments and the level of reprocessing required based on the intended and actual use of the instrument is, cleaning followed by sterilization, in accordance with the Manufacturer's Instructions for Use (MIFU).[4–7] Both cleaning and sterilization processes are of equal importance. Cleaning warrants that the instrument is free from any retained debris, the presence of which can compromise the complete sterilization process, whereas effective sterilization ensures the destruction of all microorganisms including their spores.[8] Several

methods are used to attain the sterility of dental burs, however, a synthesized literature review of the relative effectiveness of various sterilization methods is not available. Hence, this evidence brief reviews available scientific and grey literature to assess the most effective method(s) for cleaning and sterilization of dental burs to ensure proper reprocessing. The brief incorporates grey literature relevant to Canada and Ontario (including guidelines from Public Health Ontario, Canadian Standards Association (CSA), Provincial Infectious Diseases Advisory Committee (PIDAC), and Public Health Agency of Canada) with available scientific evidence, summarizing best practices for proper reprocessing of dental burs.

# Methods

A literature search was conducted on May 31st, 2023 by Public Health Ontario (PHO) Library Services for English- language articles published from the year 2000 to the date of search. The search involved four databases including MEDLINE, Embase, Environment Complete, and Scopus. The following search terms were included, but were not limited to: dental burs, reprocess, infection control, sterilization and decontamination. The full search strategy is available upon request from PHO.

Articles were eligible for inclusion if they were experimental in design and assessed the effectiveness of various cleaning and/or sterilization methods for dental burs. Studies specifically looking at the effect of sterilization processes on the cutting efficiency of burs and the number of times dental burs can be effectively reprocessed were not included as it is studied as a separate research question. Articles published before the year 2000 were excluded due to outdated medical reprocessing methods.

The following sources of grey literature were searched by one reviewer: Ontario's Public Health Units, Canadian Health Department and Agencies, U.S. State Government Websites and International Public Health Resources. Articles were retrieved by running search queries in the custom search engines provided by PHO Library services and the first 50 articles retrieved by each search query were reviewed and relevant articles were identified, followed by data extraction.

Two reviewers independently screened title and abstracts of the scientific literature. Consensus was achieved through discussion. Full text articles were retrieved, and reviewed by one reviewer, followed by extraction of relevant information from each article.

One reviewer conducted quality appraisal. The Checklist for Reporting In-vitro Studies (CRIS) was used to report the experimental in-vitro studies, and the Authority, Accuracy, Coverage, Objectivity, Date and Significance Framework (AACODS Framework) was used to critically appraise the grey literature. Due to limited data on efficient Quality Assessment tools for in-vitro experimental studies, CRIS, a modified Consolidated Standards of Reporting Trials (CONSORT) guideline, was used for reporting in-vitro studies in experimental dental research, since the parameters in the guideline were relevant to the included studies and allowed comparability across the experimental studies. We included all studies, including the ones rated comparably weak. Inherent limitations of the tool evaluated certain studies as weak, but these studies are presented in this document considering the value added in a dental public health context. Quality appraisal results are available upon request.

# Main Findings

The database search identified 401 articles, of which 16 articles met the inclusion criteria. All included articles are experimental studies that assessed the effectiveness of various reprocessing methods for dental burs, which included cleaning and/or sterilization techniques.

The experimental findings are divided into four sections. Firstly, the microbes that are commonly observed to contaminate dental burs in dental settings are identified from the studies. Secondly, the

effectiveness of various cleaning methods for dental burs are presented. Thirdly, the effectiveness of different sterilization techniques and their effect on the viability of the microorganisms commonly found or inoculated on dental burs, have been described. Lastly, findings from studies assessing the sterility of new and unused burs are discussed.

Experimental findings on the effectiveness of various cleaning and sterilization methods for dental burs are assessed to be in support and/or in accordance with organizational and jurisdictional policies/guidelines (obtained from grey literature), relevant to oral healthcare professionals in Ontario, facilitating a comprehensive approach in order to effectively translate this evidence into practice.

## Microbes

Most of the used dental burs are contaminated with potential pathogens and can act as a source of cross-contamination. Microorganisms commonly found on dental burs and identified in most of the reviewed experimental studies include: *Streptococcus species (S.mutans, S. sanguis), Staphylococcus species (S. aureus, S. epidermidis), E. coli, Lactobacilli, Candida albicans,* and *Bacillus subtilis*. The techniques used in the studies to identify the microbes and other contaminants on dental burs include, microbiological culture, staining, visual examination of debris via scanning electron microscopy (SEM) , measurement of residual protein and bacterial growth estimation in colony-forming units per milliliter (CFU/mL).

## Cleaning

Cleaning is the physical removal of foreign material (e.g., dust, soil) and organic material (e.g., blood, secretions, excretions, microorganisms). Cleaning physically removes rather than kills microorganisms and it can be accomplished with water, detergents and mechanical action.[5] For proper reprocessing of dental instruments, thorough cleaning is a critical step and is a prerequisite to sterilization, since residual debris on reusable instruments will persist without proper cleaning, and it can impede the effectiveness of the downstream steps.[1]

In a number of identified studies, dental burs were subjected to the following cleaning processes prior to the sterilization cycle: washer-disinfector,[9–11] ultrasonic cleaning,[2,9,10,12–14] manual scrubbing,[2,10–12,14] enzymatic cleaners,[1, 2, 10, 11]and cleaning stone,[14] and in a few papers, a combination of these cleaning methods were reported. Among all the cleaning methods reviewed, the most effective cleaning method for dental burs was washer-disinfector, followed by ultrasonic cleaner and enzymatic cleaning. The least effective method was manual scrubbing. Manual scrubbing is described across studies in terms of the number of strokes done using a bur brush (20-40 strokes), often done under running water.

Gul et al. (2018) compared four methods of decontamination of diamond burs: manual scrubbing using bur brush under running water (Group 1); ultrasonic cleaning (Group 2); manual scrubbing + enzymatic solution (Group 3), and manual scrubbing + ultrasonic cleaning + enzymatic solution (Group 4).[2] Following cleaning, each group was subjected to steam autoclave and 77.1%, 82.8%, 77.1% and 68.5% of the dental burs among the test groups 1, 2, 3, and, 4 respectively, showed contamination. The study found no association between type of pre-cleaning and the frequency of contamination on burs ($p = 0.57$). Frequency of contamination was significantly associated with specific sites on the burs ($p < 0.05$), with the head of burs being the most frequently contaminated site ($p < 0.003$).[2]

Whitworth et al. (2004) evaluated the effectiveness of various pre-sterilisation cleaning methods on contaminated dental burs by comparing manual scrubbing (in air and in water), enzymatic agent and washer-disinfector.[11] The burs were inoculated with *Streptococcus sanguis* and the test bacteria was rendered non-viable following cleaning using washer-disinfector. The study found washer-disinfectors to

be the most significantly effective pre-sterilisation cleaning method for dental burs ($p<0.001$).[11] Sheriteh et al. (2010) compared the effectiveness of four cleaning methods on orthodontic tungsten carbide de-bonding burs inoculated with *S.mutans*: manual scrubbing (immersed in sterile water), ultrasonic cleaning, washer- disinfector and enzyme soak.[10] The pre-sterilization cleaning was followed by sterilization in a vacuum phase autoclave at $134^0$C for 3 min. The study found all four methods to be effective in removing viable *S.mutans*.[10] Wirth et al. (2022) found the use of a cleaning stone in combination with manual or ultrasonic cleaning resulted in the least amount of remaining tooth debris on diamond-coated burs.[14] Sajjanshetty et al. (2014) assessed the effectiveness of two cleaning methods – manual scrubbing (40 strokes using a bur brush under running water) and ultrasonic cleaner (containing non ammoniated, non-ionic and phosphate free solution) – on the decontamination of dental burs.[12] The study observed the effect of manual scrubbing and ultrasonic cleaner on the level of contamination of three types of microbes - *Streptococcus mutans, Lactobacillus species,* and *Candida albicans* and found that manual scrubbing reduced contamination by 61%, 50% and 27%, and ultrasonic cleaner reduced the contamination by 69%, 61%, and 44%, respectively.[12] Mathivanan et al. (2017) decontaminated dental burs by immersing the burs in surgical spirit (a preparation of denatured ethyl alcohol 96% with 1% methanol) for 15 minutes and found minimal reduction of *Streptococcus* species from $2.7 \times 10^7$ CFU to $1.9 \times 10^4$ CFU.[15]

A study by César et al. (2012) evaluated the antimicrobial effect of ozonated water on the sanitization of diamond dental burs contaminated with *Escherichia coli, Staphylococcus aureus, Candida albicans* and the spores of *Bacillus atrophaeus*.[16] The use of ozonated water (10mg/L) for 10 minutes and 30 minutes of duration was observed to be effective in microbial reduction, with the largest percentage reduction (99.93%) observed on the *E. coli* strain after sanitization for 30 min and the smallest percentage reduction (90.15%) on the *B. atrophaeus* spores after sanitization for 10 min. The study concluded that ozonated water was effective in reducing the microbial levels and was dependent on the duration of exposure to the ozonated water. However, due to lack of supporting evidence, more studies are warranted to ascertain the effectiveness of ozonated water on the sanitization of dental burs.[16]

In order to ensure effective reprocessing of reusable dental burs, thorough cleaning prior to sterilization is crucial. Based on evidence, automated cleaning is found to be more effective than manual cleaning. The experimental studies found washer-disinfectors to be the most effective cleaning method for dental burs, followed by ultrasonic cleaners. This finding is in accordance with the Canadian Standards Association's Standards for Medical Device Reprocessing.[4] If cleaning cannot be done immediately, point-of-use cleaning shall be done by keeping dental burs immersed in a manufacturer recommended cleaning or disinfecting solution (tepid water, detergents or enzymatic cleaners) to prevent organic matter from drying on it,[4,5] thus increasing the effectiveness of the downstream cleaning steps.

## Sterilization

Sterilization is the level of reprocessing required for critical medical equipment/devices, such as dental burs, after thorough cleaning. Sterilization results in the destruction of all forms of microbial life including bacteria, viruses, spores and fungi.[5]

The sterilization methods that are most commonly tested for effectiveness for dental burs are: steam sterilization using autoclave,[8,12,13,15,17,18] hot air oven,[12,15] and glass bead sterilizer.[12,15,19] Other methods that were tested include: Radical Vapor Reactor (RVR),[20] and gas sterilization.[9] Effectiveness of sterilization is often measured and reported in the literature as the total viable count (TVC) of microbes on sample burs and is represented by the number of colony forming units (CFU) per milliliter. Quality assurance and continual monitoring of the sterilization processes using color changeable chemical tape,[12,15] or Browne's test strip chemical indicator,[15] was done in two studies.

Among the sterilization methods used across the included studies, autoclaving was consistently identified as the most effective process to sterilize dental burs. However, the findings varied across studies with complete sterility attained in some, while a few studies reported only a reduction in microbial contamination rather than complete elimination of microbial contamination.

Mathivanan et al. (2017) subjected used burs to sterilization using autoclave and found a maximum reduction of *Streptococcus* species ($p < 0.001$) from $4 \times 10^6$ CFU to nil in number.[15] Sajjanshetty et al. (2014) subjected contaminated burs to autoclave for 16 minutes at $121^0$C under 16 psi, after cleaning under running tap water with detergent, and found a maximum percentage reduction of 80% and 76% in the mean colony forming units/ml of *Streptococcus mutans* and *Lactobacilli*, respectively.[12] Morrison and Conrod (2010) studied the effectiveness of various sterilization techniques by subjecting used dental burs to ultrasonic cleaning followed by sterilization using three different types of autoclaves.[13] The study found 15%, 35% and 52% of the burs to be contaminated with *Staphylococcus species* after Harvey Chemiclave 6000 (20 min, 138 kPa, 132°C), Statim Steam Sterilizer (6 min, 130°C), and Pelton & Crane Delta XL steam autoclave (12 min, 216 kPa, 134°C), respectively.[13] Al-Jandan et al. (2015) used two sterilization sessions - High and Low steam pressure autoclaving – to evaluate and compare the rate of bacterial contamination of reused burs with new unused burs, in a hospital-based dental setting.[8] Following high-pressure autoclaving, the new unused burs showed 100% sterility whereas 5% of the reused burs showed positive bacterial contamination (*Staphylococcus epidermis*). After low-pressure autoclaving, the reused burs showed 100% sterility but one of the new unused burs demonstrated bacterial contamination (*Brevibacterium* species).[8] Wirth et al. (2022) subjected diamond burs to decontamination using cleaning stone with either manual or ultrasonic cleaning, followed by a single cycle of steam sterilization and observed complete elimination of the test bacteria.[14] A study by Simha et al. (2022) found maximum reduction in the contamination of diamond dental burs by *Streptococcus mutans, Candida albicans* and *Staphylococcus aureus*, after subjecting the burs to steam sterilization using autoclave (at 121°C , 16 psi for 16 minutes), when compared to glutaraldehyde (2.4%) and hot air oven.[18] Kumar et al. (2015) observed that burs sterilized using Autoclave and Glutaraldehyde (2.4%) showed complete sterility.[19] However, chemical sterilization of critical or semi-critical instruments using high level disinfectants like 2% glutaraldehyde is not permitted in Ontario.[21]

Hot air oven is also effective for sterilization of dental burs. Mathivanan et al. (2017) subjected used burs to sterilization using hot air oven and found *Streptococcus* species to be reduced from $4 \times 10^6$ CFU to nil in number.[15] Sajjanshetty et al. (2014) subjected contaminated burs to hot air oven (for 60 minutes at $160^0$C), after cleaning under running tap water with detergent, and found a percentage reduction of 72%, 65%, and 69% in the mean colony forming units/ml of *S.mutans , Lactobacilli* and *C. albicans*, respectively.[12]

The effectiveness of sterilization using a glass bead sterilizer was assessed in a few studies. Kumar et al. (2015) found 83.3% of the burs under study to be contaminated following glass bead sterilization.[19] Sajjanshetty et al. (2014) submerged contaminated burs in a glass bead sterilizer (at a distance of 2mm from the wall of the sterilizer for 15 seconds at $230^0$C) , after cleaning under running tap water with detergent, and found a percentage reduction of 73%, 74%, and 80% in the mean colony forming units/ml of *S.mutans , Lactobacilli* and *C. albicans*, respectively.[12] Mathivanan et al. (2017) subjected used burs to sterilization process using glass bead sterilizer and found the *Streptococcus* species to be reduced from $1.5 \times 10^2$ CFU to $1 \times 10^7$ CFU.[15]

However, According to Provincial Infectious Diseases Advisory Committee on Infection Prevention and Control, Glass Bead Sterilizer, chemiclave sterilization, ultraviolet light, microwave ovens and boiling are unacceptable methods of disinfection or sterilization.[5]

Other sterilization methods outlined in the literature include gas sterilization, radical vapor reactor, and non-thermal atmospheric pressure air plasma device. Hogg and Morrison (2005) found 100% of the fissure burs and 45% of the round burs under study to be contaminated with *Streptococcus* species despite subjecting the burs to a combination of cleaning methods (manual + ultrasonic cleaning + washer- decontaminator) followed by gas sterilization.[9] A study by Okita et al. (2022) found that Radical Vapor Reactor (RVR) can completely sterilize burs inoculated with *S.mutans* in 10 minutes and demonstrated that RVR treatment can meet the sterility assurance level.[20] Sung et al. (2013) evaluated the effectiveness of non-thermal atmospheric pressure air plasma device in sterilizing diamond dental burs by inoculating the burs with *E. coli* and *B. subtilis*, followed by exposure to plasma for different lengths of time (30, 60, 90,120,180 and 240 seconds).[22] The study found the device to be effective on burs inoculated with *E. coli* and *B. subtilis* after 60 and 120 seconds, respectively.[22]

Due to lack of conclusive and/or supportive evidence, more studies are warranted to validate the effectiveness of these methods.

Overall, sterilization is the required level of reprocessing for dental burs and steam sterilization using autoclave is observed to be the most effective sterilization method for dental burs across the reviewed studies. Under steam sterilization (autoclave), the preferred method is dynamic air removal steam sterilization rather than gravity displacement, according to CSA.[4]

## Sterility of New and Unused Burs

Newly purchased dental burs are required to be inspected, cleaned and sterilized as per standard protocol unless specified as "sterile" by the manufacturer.[4, 5] Dental burs are available in the market as single-use or reusable. Single-Use dental burs must not be reprocessed due to the lack of validated reprocessing instructions, whereas reusable burs are sold with instructions for proper cleaning and sterilization.[5] According to the Centers for Disease Control and Prevention (CDC),[23] "If a device does not have reprocessing instructions, it should be considered single-use and disposed of after one use". Studies have found microbial contamination in newly purchased dental burs, thus warranting cleaning and sterilization before the initial use. Morrison and Conrod (2010) assessed the sterility of new unused dental burs directly from a manufacturer by incubating the new burs in nutrient broth.[13] Following incubation, 42% of the new burs were found to be contaminated with unidentified microbes.[13] Hauptman et al. (2006) conducted a study to assess the sterility of burs directly from the manufacturers with the objective to determine the types of bacteria, if any, that are found on new unsterilized dental burs.[17] One hundred burs that were used as the control group were sterilized by autoclave while still inside the manufacturer's package and 100 unsterilized burs in the test group that were to be evaluated for the identification of any microbial contamination were taken directly from the manufacturer's package and cultured. None of the sterilized burs were found to be contaminated, while 8 of the 100 unsterilized burs showed microbial growth with seven out of the eight bacteria identified on the burs belonging to the genus *Bacillus,* which can be potentially harmful for patients who are immunocompromised or at risk for infection due to systemic illnesses.[17]

# Discussion and Conclusions

The studies that were reviewed used a range of experimental methods to determine the effectiveness of various cleaning and sterilization processes for dental burs. Inconsistencies and variability across the studies in terms of the bur type, test microbes, cleaning and sterilization processes, and mechanisms for validating or evaluating sterility, makes comparability across the studies difficult. Additionally, a few studies assessed the effectiveness of methods that lacked conclusive or supportive evidence, warranting further studies to ascertain the effectiveness of those methods. Most of the studies had dental burs

inoculated with test microbes to imitate a clinical scenario, while only a few studies used burs that were contaminated in a clinical setting and those burs that were contaminated through a clinical procedure did not always attain complete sterility. Overall, the literature suggests that proper cleaning prior to sterilization is crucial for effective reprocessing of dental burs. The most effective cleaning and sterilization method for dental burs is washer-disinfector and steam sterilization using autoclave, respectively.

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