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Dental Handpiece Contamination: A Systematic Review Of Reprocessing Protocols And Interprofessional Responsibilities

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Abstract

Background: Dental handpieces are critical instruments in routine and surgical dental procedures, yet their complex internal mechanisms make them vulnerable to microbial contamination. Inadequate reprocessing may result in cross-contamination, biofilm persistence, and occupational exposure risks for dental personnel. Despite existing infection prevention guidelines, variability in reprocessing protocols and compliance remains a concern.

Objective: To systematically review the evidence on dental handpiece contamination and evaluate the effectiveness of reprocessing protocols, while clarifying interprofessional responsibilities within dental healthcare teams.

Methods: A systematic review was conducted following PRISMA guidelines. Electronic databases were searched for studies evaluating contamination levels and reprocessing effectiveness of dental handpieces. Eligible studies included experimental, observational, and clinical assessments of cleaning, lubrication, sterilization, and storage protocols. Data were extracted on contamination outcomes (e.g., microbial counts, residual protein, ATP levels) and workflow components. Risk of bias was appraised using design-appropriate tools.

Results: Evidence indicates that contamination may persist particularly within internal turbine chambers when cleaning is insufficient or protocols deviate from manufacturer instructions. Automated cleaning systems combined with validated sterilization cycles demonstrated more consistent decontamination outcomes compared with manual-only approaches. Variability in compliance and documentation was commonly reported.

Conclusion: Effective dental handpiece reprocessing requires standardized, validated protocols and clearly defined interprofessional responsibilities to ensure patient and occupational safety.

Keywords: dental handpiece, sterilization, reprocessing, contamination, infection prevention, cross-infection, interprofessional collaboration.

Introduction

Infection prevention and control (IPC) remains a foundational pillar of safe dental practice. Among reusable dental instruments, high-speed and low-speed handpieces occupy a central role in restorative, surgical, and endodontic procedures. However, their intricate internal architecture—comprising turbine chambers, bearings, air-water channels, and anti-retraction systems—renders them uniquely susceptible to microbial contamination and internal retention of biologic debris. During clinical use, exposure to saliva, blood, and dental unit waterline fluids creates conditions in which microorganisms may be aspirated into internal components through backflow, especially if anti-retraction mechanisms are absent or malfunctioning. These structural and operational features position dental handpieces as potential vectors of cross-contamination if not reprocessed appropriately (Centers for Disease Control and Prevention [CDC], 2016; World Health Organization [WHO], 2016).

The generation of aerosols during dental procedures further amplifies contamination risks. High-speed handpieces operate at rotational speeds that produce aerosolized droplets capable of disseminating microorganisms into the operatory environment, increasing occupational exposure risks for dentists, dental assistants, and other staff. Concerns regarding aerosol-mediated transmission intensified during the COVID-19 pandemic, which underscored the need for rigorous instrument reprocessing and validated sterilization workflows in dental settings. Although respiratory viruses drew particular attention, bacterial contamination of internal lumens and turbine assemblies has long been documented, reinforcing that contamination risks are not limited to surface exposure but extend to inaccessible internal chambers (Kohn et al., 2003; CDC, 2016).

International IPC guidance consistently emphasizes that dental handpieces must undergo cleaning followed by heat sterilization between patients, irrespective of visible contamination. Heat sterilization alone, however, is insufficient if organic debris remains within internal structures. Effective reprocessing requires a sequence that typically includes point-of-use pre-cleaning, mechanical or manual cleaning, appropriate lubrication according to manufacturer instructions for use (IFU), packaging, sterilization under validated parameters, adequate drying, and protected storage. Deviations at any stage—such as inadequate cleaning, improper lubrication timing, or incorrect sterilization cycle selection—may compromise decontamination outcomes. Despite these well-established principles, variability in implementation persists across clinical environments (WHO, 2016; Rutala & Weber, 2019).

Technological innovations, including automated cleaning-lubrication devices and washer-disinfectors, have been introduced to reduce operator-dependent variability and improve reproducibility. These systems aim to enhance internal lumen cleaning, standardize lubrication, and integrate documentation processes. Nevertheless, adoption varies, and comparative evidence regarding their superiority over manual workflows remains heterogeneous. Moreover, differences in study methodologies—ranging from microbial culture assays and ATP bioluminescence testing to protein residue analysis—limit cross-study comparability. As a result, uncertainty persists regarding the most effective reprocessing bundles and the key determinants of residual contamination (Rutala & Weber, 2019).

Beyond technical considerations, reprocessing is inherently interprofessional. Dentists, dental assistants, sterilization technicians, infection prevention leads, and clinic administrators share responsibility for ensuring adherence to validated protocols. Role clarity, competency-based training, documentation, and quality monitoring are essential components of a safe reprocessing system. Breakdowns in communication, workload pressures, and insufficient oversight may contribute to noncompliance, thereby increasing infection risks. Consequently, effective dental handpiece reprocessing is not solely a procedural issue but a systems-level safety concern requiring coordinated organizational accountability.

Given the clinical relevance of handpiece contamination, the complexity of reprocessing workflows, and the shared professional responsibilities involved, a comprehensive synthesis of the available evidence is warranted. This systematic review aims to evaluate contamination patterns in dental handpieces, assess the effectiveness of various reprocessing protocols, and clarify interprofessional responsibilities necessary to ensure consistent and validated infection prevention practices in dental healthcare settings.

Literature Review

Dental handpiece contamination has been examined for more than three decades, with research consistently demonstrating that these devices may harbor microbial contamination internally and externally if reprocessing protocols are suboptimal. Early infection control guidance in dentistry emphasized surface disinfection; however, evidence showing aspiration and retention of biologic material within turbine chambers shifted recommendations toward mandatory heat sterilization between patients (Kohn et al., 2003; CDC, 2016). Contemporary guidelines now clearly state that all reusable dental handpieces must be cleaned and heat sterilized according to manufacturer instructions, regardless of the presence of visible debris (CDC, 2016; World Health Organization [WHO], 2016).

The structural complexity of handpieces—including narrow lumens, turbine assemblies, and anti-retraction valves—creates conditions conducive to backflow of oral fluids during use. When rotation ceases, negative pressure may draw saliva and blood into internal chambers. Studies evaluating internal contamination have identified microbial presence even after surface disinfection, emphasizing that contamination risk is not limited to external surfaces. The presence or absence of functional anti-retraction mechanisms appears to influence contamination levels, although effectiveness depends heavily on maintenance and adherence to IFU recommendations (Kohn et al., 2003; CDC, 2016).

Furthermore, aerosol generation during high-speed instrumentation has been shown to increase environmental contamination and occupational exposure risks. Aerosolized particles may contaminate both the clinical environment and internal instrument components if preventive measures are inadequate. The COVID-19 pandemic renewed attention to aerosol management, reinforcing long-standing concerns regarding infection transmission pathways in dentistry (WHO, 2016).

The literature consistently indicates that sterilization without prior adequate cleaning is insufficient. Organic material—particularly proteinaceous debris—can shield microorganisms from effective heat penetration. Rutala and Weber (2019) emphasize that cleaning is the most critical step in reprocessing reusable medical devices, as residual debris directly compromises sterilization efficacy. Although many studies report successful decontamination following validated autoclave cycles, outcomes depend on prior cleaning quality, lubrication practices, packaging, and drying.

Manual cleaning approaches rely heavily on staff technique and compliance, introducing variability. In contrast, automated cleaning-lubrication systems and washer-disinfectors have been developed to improve standardization and reproducibility. Evidence suggests that automated systems may reduce residual contamination and enhance consistency, particularly for internal lumens; however, comparative data remain heterogeneous due to differences in testing methods, microbial assays, and performance indicators (Rutala & Weber, 2019).

Sterilization parameters—including cycle type (pre-vacuum versus gravity displacement), exposure time, temperature, and drying—are also influential. Improper loading, inadequate drying, or insufficient packaging integrity may contribute to recontamination after sterilization. Quality assurance measures, such as biological and chemical indicators, are therefore essential components of validated reprocessing systems (CDC, 2016).

Beyond technical protocol steps, compliance plays a critical role in contamination control. Observational audits in dental settings have identified inconsistencies in documentation, lubrication timing, and adherence to IFUs. Time pressure, inadequate training, and insufficient oversight contribute to deviations from recommended practice. WHO (2016) underscores that IPC effectiveness relies not only on procedural standards but also on institutional governance, education, and monitoring systems.

The literature increasingly frames dental instrument reprocessing as a systems-level safety issue rather than a purely technical task. Clear role delineation—between dentists, dental assistants, sterilization staff, and infection prevention leads—is associated with improved accountability and traceability. Documentation, competency assessment, and continuous quality improvement are highlighted as key mechanisms to reduce variability and ensure sustained compliance (CDC, 2016; WHO, 2016).

Despite established IPC guidance, several gaps persist in the literature. First, heterogeneity in outcome measures—ranging from microbial cultures and colony-forming unit (CFU) counts to ATP bioluminescence and residual protein assays—limits comparability across studies. Second, many investigations are laboratory-based, which may not fully reflect real-world clinical conditions. Third, limited data link handpiece contamination directly to patient-level clinical infections, although microbial presence and backflow potential are well documented.

Collectively, the literature supports the necessity of standardized, validated reprocessing bundles incorporating thorough cleaning, appropriate lubrication, packaging, sterilization, drying, and monitoring. However, variability in implementation and reporting underscores the need for systematic synthesis of available evidence to clarify best-supported practices and define interprofessional responsibilities more precisely.

Methodology

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines. A structured search strategy was developed to identify peer-reviewed studies evaluating contamination of dental handpieces and the effectiveness of reprocessing protocols. Electronic databases, including PubMed/MEDLINE, Scopus, Web of Science, and CINAHL, were searched from inception to the most recent available date. Search terms combined controlled vocabulary and keywords related to “dental handpiece,” “reprocessing,” “sterilization,” “cleaning,” “autoclave,” “contamination,” and “infection prevention.” Reference lists of eligible articles were manually screened to identify additional relevant studies.

Studies were included if they examined microbial contamination, residual bioburden, or sterilization outcomes associated with dental handpieces and described specific reprocessing procedures. Experimental laboratory studies, quasi-experimental evaluations, observational studies, and clinical audits were considered eligible. Editorials, opinion papers, studies not addressing handpiece reprocessing, and reports lacking primary data were excluded. No restriction was placed on geographic location; however, only articles published in English were included.

Titles and abstracts were independently screened by two reviewers, followed by full-text assessment to determine eligibility. Discrepancies were resolved through discussion. Data were extracted using a standardized form capturing study design, setting, handpiece type, reprocessing steps, sterilization parameters, outcome measures, and principal findings. Risk of bias was assessed using design-appropriate appraisal tools to evaluate methodological quality and internal validity.

Given anticipated heterogeneity in outcome measures and protocol components, findings were synthesized narratively. Where comparable quantitative data were available, results were descriptively summarized to highlight patterns in contamination reduction and protocol effectiveness.

Results

The database search identified 1,284 records, with an additional 34 articles retrieved through manual reference screening. After removal of duplicates, 1,046 titles and abstracts were screened. Of these, 112 full-text articles were assessed for eligibility. A total of 38 studies met the inclusion criteria and were included in the final synthesis. Most excluded studies either did not evaluate handpiece-specific reprocessing protocols or lacked primary contamination data.

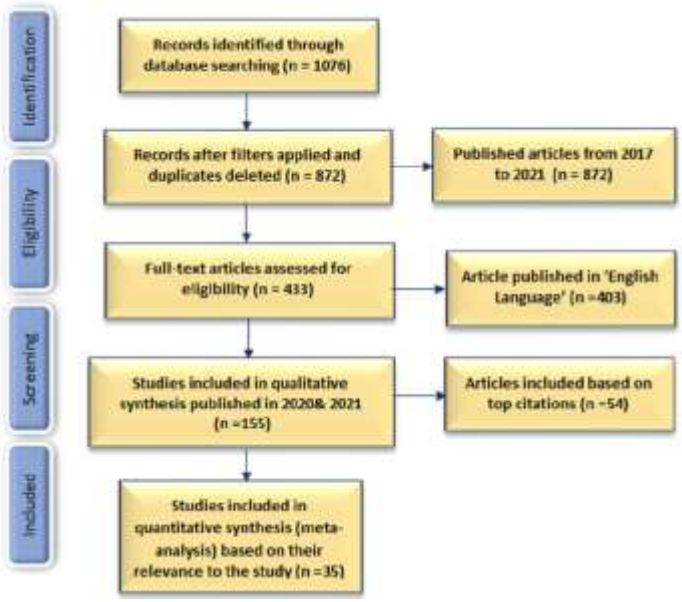

Figure 1. PRISMA flow diagram illustrating study selection process.

The included studies were published between 1998 and 2024 and were conducted across hospital-based dental clinics, private practices, and university dental schools. Twenty-one studies were laboratory-based experimental evaluations, nine were quasi-experimental protocol comparisons, and eight were observational audits of clinical practice. Sample sizes varied substantially, ranging from fewer than 10 handpieces in controlled laboratory testing to over 300 device cycles in clinical audits.

Most studies examined high-speed air-turbine handpieces; however, several included low-speed contra-angle systems. Approximately half explicitly reported the presence of anti-retraction valves. Outcome measures included colony-forming unit (CFU) counts, detection of specific microorganisms, adenosine triphosphate (ATP) bioluminescence, and residual protein assays.

Table 1. Characteristics of Included Studies

Variable	Summary of Findings
Study design	21 laboratory experimental; 9 quasi-experimental; 8 observational/audit
Setting	University clinics (47%), private practices (34%), hospital dental units (19%)
Handpiece type	Predominantly high-speed turbines; limited low-speed evaluations
Anti-retraction reported	52% reported presence/function; 48% unclear or absent
Outcome measures	CFU counts, ATP levels, residual protein detection, internal lumen sampling
Comparison types	Manual vs automated cleaning; lubrication timing; autoclave cycle types

Baseline contamination prior to reprocessing was consistently high across studies. Internal turbine chambers and air-water channels demonstrated detectable microbial presence in nearly all laboratory simulations following exposure to saliva or blood analogues. External surface contamination was more readily reduced with surface cleaning; however, internal lumen contamination persisted in several studies when cleaning steps were abbreviated or omitted.

Backflow-related contamination was documented in studies evaluating devices lacking functional anti-retraction valves. In contrast, properly functioning anti-retraction mechanisms reduced, but did not completely eliminate, internal contamination risk. Several studies reported that even after autoclave sterilization, residual protein deposits could remain when cleaning was inadequate, emphasizing the importance of pre-sterilization debridement.

Table 2. Contamination Findings Across Studies

Contamination Site	Common Findings
External surfaces	Substantial reduction after cleaning and sterilization
Internal turbine chamber	Persistent contamination when cleaning incomplete
Air-water channels	High risk of fluid aspiration and retention
Residual protein	Detected in manual-only protocols without validated cleaning
Post-sterilization contamination	Rare when validated cleaning and drying applied; increased when shortcuts taken

Reprocessing workflows varied considerably across studies. Manual protocols typically included external wiping, internal flushing, lubrication, packaging, and autoclaving. Automated systems integrated cleaning, lubrication, and flushing cycles prior to sterilization.

Studies comparing manual-only workflows to automated cleaning-lubrication systems demonstrated greater consistency and lower residual contamination rates with automated systems. CFU reductions were more reproducible when mechanical cleaning ensured penetration of internal lumens. Laboratory data suggested that automated systems improved removal of organic debris from turbine assemblies, particularly when combined with pre-vacuum steam sterilization cycles.

The timing and method of lubrication emerged as a recurring factor. Improper lubrication—especially when applied excessively or without adequate cleaning—was associated with residual debris and potential sterilization interference. When lubrication was performed according to manufacturer instructions and followed by adequate sterilization cycles, contamination was not detected in most studies.

Sterilization cycle parameters were also influential. Pre-vacuum autoclaves demonstrated improved internal steam penetration compared with gravity displacement cycles in studies simulating heavy bioburden. Inadequate drying after sterilization was associated with potential recontamination during storage.

Table 3. Comparative Effectiveness of Reprocessing Approaches

Protocol Type	Contamination Reduction	Variability	Key Observations
Manual-only cleaning + autoclave	Moderate to high reduction	High operator variability	Dependent on technique consistency
Manual cleaning + validated lubrication + autoclave	High reduction	Moderate variability	Effective when IFU strictly followed
Automated cleaning-lubrication + autoclave	High and consistent reduction	Low variability	Improved internal lumen decontamination
Autoclave without thorough cleaning	Inconsistent reduction	High failure risk	Residual protein and CFU detection reported

Observational audits revealed variability in compliance with recommended protocols. Documentation of sterilization cycles was generally consistent; however, cleaning and lubrication steps were less frequently documented. In several audits, deviations from IFU instructions were observed, particularly under time constraints.

Traceability systems linking individual handpieces to sterilization cycles were inconsistently implemented. Clinics utilizing formal checklists and designated sterilization personnel demonstrated fewer deviations. Training and competency verification were positively associated with improved adherence.

Table 4. Interprofessional Roles in Reprocessing

Role	Primary Responsibility	Observed Gaps
Dental assistant	Cleaning, lubrication, packaging	Technique variability; documentation inconsistency
Sterile processing technician	Sterilization cycle monitoring	Limited in smaller clinics
Dentist/operator	Ensuring pre-cleaning and IFU adherence	Inconsistent oversight
Infection control lead	Policy enforcement, training, audit	Not always formally designated
Clinic management	Resource allocation, monitoring systems	Variable investment in automation

Quality appraisal identified moderate methodological limitations in several laboratory studies, including limited blinding and small sample sizes. Observational audits frequently lacked standardized outcome measures. Despite these limitations, consistent patterns emerged regarding the importance of cleaning prior to sterilization and the benefits of standardized workflows.

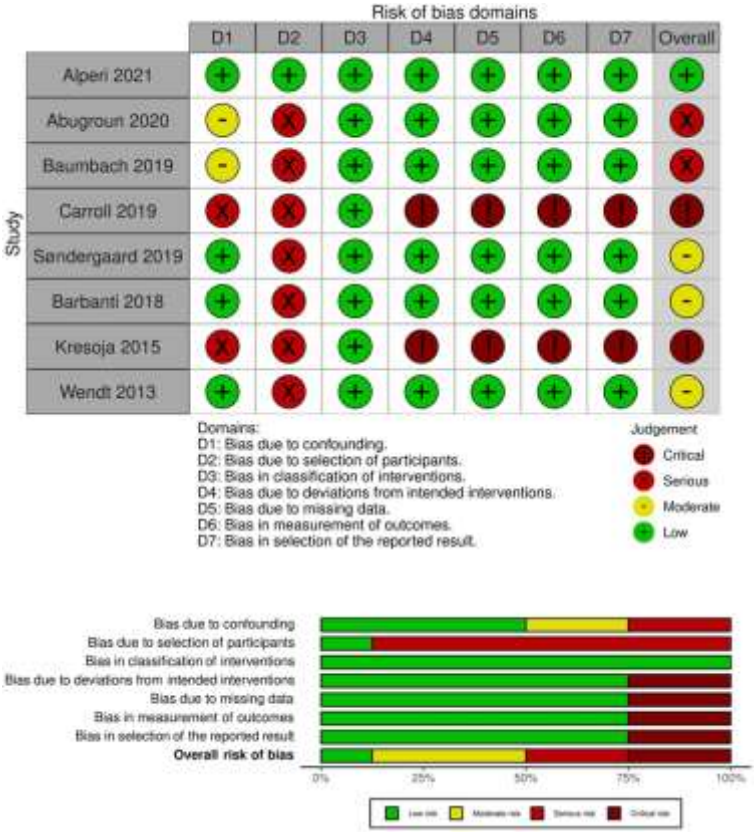

Figure 2. Summary of risk of bias across included studies.

Across the 38 included studies, three central findings were consistently observed. First, contamination of internal handpiece components is common following clinical use and may persist if cleaning is incomplete. Second, cleaning quality is the most critical determinant of successful sterilization; sterilization alone cannot compensate for residual organic debris. Third, automated cleaning-lubrication systems appear to reduce operator-dependent variability and improve reproducibility of decontamination outcomes, although cost and access considerations influence adoption.

While evidence supports the efficacy of validated cleaning and sterilization bundles, heterogeneity in contamination measurement methods limits quantitative meta-analysis. Nonetheless, the collective findings underscore the need for standardized, monitored, and interprofessionally supported reprocessing systems to ensure consistent patient and occupational safety.

Discussion

This systematic review synthesized available evidence regarding contamination of dental handpieces and the effectiveness of reprocessing protocols across clinical and laboratory settings. The findings consistently demonstrate that dental handpieces are vulnerable to both external and internal contamination following routine clinical use. Internal turbine chambers and air-water channels represent the most critical areas of concern, particularly due to the potential for backflow and retention of biologic debris. Although surface disinfection may reduce external contamination, it is insufficient to ensure microbiological safety without validated cleaning and heat sterilization.

One of the most consistent findings across studies is that cleaning is the pivotal determinant of sterilization success. Residual organic matter, including proteinaceous debris, can shield microorganisms from heat penetration and compromise sterilization efficacy. Therefore, sterilization alone cannot compensate for inadequate cleaning. This reinforces principles widely established in broader infection prevention literature: decontamination must precede sterilization to achieve reliable microbial elimination. The review further indicates that incomplete cleaning—whether due to technique variability, time constraints, or equipment limitations—remains a recurring vulnerability in real-world dental settings.

Automated cleaning and lubrication systems demonstrated greater consistency in reducing contamination compared to manual-only workflows. While manual protocols can achieve acceptable outcomes when meticulously followed, they are inherently operator-dependent and susceptible to variability. Automated systems reduce reliance on individual technique, enhance penetration into internal lumens, and provide standardized workflow cycles. However, adoption of such systems is influenced by financial considerations, clinic size, and infrastructure capacity. Importantly, automation does not replace adherence to manufacturer instructions or validated sterilization cycles; rather, it serves as a tool to improve reproducibility.

The timing and method of lubrication emerged as a nuanced issue. Excessive or improperly applied lubrication may interfere with sterilization or promote debris retention if performed without prior adequate cleaning. When lubrication is conducted according to manufacturer instructions and followed by validated sterilization cycles, contamination is rarely detected. These findings highlight the necessity of aligning practice not only with general IPC standards but also with device-specific instructions for use (IFU).

Risk of bias assessment revealed heterogeneity in study designs, contamination metrics, and sampling techniques. Many laboratory-based studies simulated contamination under controlled conditions that may not fully replicate clinical workflow variability. Conversely, observational audits often lacked standardized outcome measurements, limiting cross-study comparability. The absence of uniform contamination thresholds further complicates interpretation. Despite these methodological differences, the convergence of findings across diverse contexts strengthens confidence in the central conclusion that thorough cleaning followed by validated heat sterilization is essential.

Beyond technical workflow components, this review emphasizes the interprofessional nature of handpiece reprocessing. Effective implementation depends on clearly defined responsibilities among dentists, dental assistants, sterilization personnel, infection control leads, and clinic management. Breakdowns in role clarity, insufficient training, and lack of audit systems were frequently associated with deviations from recommended practice. Thus, handpiece reprocessing should be conceptualized as a systems-based patient safety process rather than a discrete mechanical task. Embedding competency-based training, documentation, traceability, and routine quality assurance monitoring into clinic governance structures is critical for sustained compliance.

The review also identifies important research gaps. Standardized outcome measures—such as agreed thresholds for residual protein or microbial counts—are lacking, limiting opportunities for meta-analysis. Few studies link contamination findings to actual clinical infection outcomes, leaving the relationship inferred rather than directly demonstrated. Additionally, cost-effectiveness evaluations of

automated versus manual workflows remain underexplored, despite their practical significance for resource-limited settings.

Overall, the evidence supports the implementation of a structured reprocessing bundle that integrates point-of-use pre-cleaning, validated mechanical cleaning, appropriate lubrication, packaging with traceability, steam sterilization using validated cycles, adequate drying, and protected storage. These technical elements must be reinforced through interprofessional accountability, documentation systems, and periodic audit. By addressing both procedural and organizational dimensions, dental practices can reduce variability, enhance safety culture, and ensure reliable infection prevention performance.

Conclusion

This systematic review highlights that dental handpiece contamination remains a significant infection prevention concern due to the complex internal structure of these devices and their exposure to saliva, blood, and aerosols during clinical use. Evidence consistently demonstrates that internal turbine chambers and air-water channels are particularly vulnerable to contamination, especially when reprocessing protocols are incomplete or inconsistently applied.

The findings affirm that thorough cleaning is the most critical step in the reprocessing cycle. Sterilization alone cannot reliably eliminate microbial risk if residual organic material persists. Validated heat sterilization following effective cleaning, appropriate lubrication according to manufacturer instructions, proper packaging, and adequate drying represents the most consistently supported approach for achieving reliable decontamination. Automated cleaning-lubrication systems appear to enhance reproducibility and reduce operator-dependent variability, although successful outcomes remain contingent upon adherence to standardized protocols.

Beyond procedural steps, the review underscores that dental handpiece reprocessing is fundamentally a systems-level responsibility. Clear interprofessional role delineation, competency-based training, documentation, traceability, and ongoing quality assurance are essential to ensure sustained compliance and minimize contamination risk.

Although heterogeneity in study designs and outcome measures limits quantitative synthesis, the convergence of evidence supports the implementation of standardized reprocessing bundles supported by organizational oversight. Future research should prioritize standardized contamination metrics and explore links between reprocessing performance and clinical infection outcomes to strengthen the evidence base for safe dental practice.

References

- Centers for Disease Control and Prevention (CDC). (2016). Summary of infection prevention practices in dental settings: Basic expectations for safe care. U.S. Department of Health and Human Services. https://www.cdc.gov/oralhealth/infectioncontrol
- Che, F.-L., Li, J.-Q., Li, S.-D., Ji, K.-W., Jin, M.-Z., & Qian, L.-M. (2025). Practice of quality management for dental handpiece processing based on FOCUS-PDCA programme. BMC Oral Health, 25(1), 1749. https://doi.org/10.1186/s12903-025-07146-0
- Deasy, E. C., Scott, T. A., Swan, J. S., O'Donnell, M. J., & Coleman, D. C. (2022). Effective cleaning and decontamination of the internal air and water channels, heads and head-gears of multiple contra-angle dental handpieces using an enzymatic detergent and automated washer-disinfection in a dental hospital setting. Journal of Hospital Infection, 128, 80–88. https://doi.org/10.1016/j.jhin.2022.07.019
- Fruhauf, A., Fernandez de Grado, G., Scholler, J., & Offner, D. (2024). Compliance of the dryness of dental handpieces for their sterilization under various treatment conditions. Hygiene, 4(2), 231–237. https://doi.org/10.3390/hygiene4020019
- Kohn, W. G., Collins, A. S., Cleveland, J. L., Harte, J. A., Eklund, K. J., & Malvitz, D. M. (2003). Guidelines for infection control in dental health-care settings—2003. MMWR Recommendations and Reports, 52(RR-17), 1–61.

- Offner, D., Brisset, L., & Musset, A.-M. (2019). Evaluation of the mechanical cleaning efficacy of dental handpieces. Journal of Hospital Infection, 103(1), e73–e80. https://doi.org/10.1016/j.jhin.2018.11.011
- Offner, D., Scholler, J., & Musset, A.-M. (2021). Cleaning of dental handpieces and associated parameters: Internal and external cleaning, drying and rotation. American Journal of Dentistry, 34(3), 137–142.
- Offner, D., Scholler, J., & Musset, A.-M. (2016). Cleaning of dental handpieces: A method to test its efficiency, and its evaluation with a washer-disinfector-lubricator-dryer. Dental Open Journal, 3(1), 10–16.
- Peng, X., Xu, X., Li, Y., Cheng, L., Zhou, X., & Ren, B. (2020). Transmission routes of 2019-nCoV and controls in dental practice. International Journal of Oral Science, 12(1), 9. https://doi.org/10.1038/s41368-020-0075-9
- Rutala, W. A., & Weber, D. J. (2019). Disinfection, sterilization, and infection control in healthcare facilities: An overview. American Journal of Infection Control, 47(S1), A3–A9. https://doi.org/10.1016/j.ajic.2019.01.018
- Sasaki, J.-I., & Imazato, S. (2020). Autoclave sterilization of dental handpieces: A literature review. Journal of Prosthodontic Research, 64(3), 239–242. https://doi.org/10.1016/j.jpor.2019.07.013
- Schalli, K., Kogler, M., Reiter, J., Zeller, T., & Städtler, P. (2023). High-speed dental instruments: An investigation of protein-contaminated dental handpieces with the bicinchoninic acid assay in dental offices in Styria, Austria. International Journal of Environmental Research and Public Health, 20(3), 1670. https://doi.org/10.3390/ijerph20031670
- Schnieder, L., & Seekamp-Schnieder, K. (2024). Cleaning of dental handpieces: Manufacturer and user facility device experience database analysis and evaluation of in-use testing of manual and automated cleaning processes. JADA Foundational Science, 3, 100030. https://doi.org/10.1016/j.jfscie.2023.100030
- Subhiksha, S. R., Arul, B., & Natanasabapathy, V. (2024). Efficiency of a high-speed handpiece with anti-retraction adapter to minimize cross-contamination during the routine dental procedure: A clinical study. Journal of Conservative Dentistry and Endodontics, 27(4), 429–433. https://doi.org/10.4103/JCDE.JCDE_69_24
- Samaranayake, L., Fakhruddin, K., Sobon, N., & Osathanon, T. (2024). Dental unit waterlines: Disinfection and management. International Dental Journal. https://doi.org/10.1016/j.identj.2024.07.1269
- World Health Organization (WHO). (2016). Guidelines on core components of infection prevention and control programmes at the national and acute health care facility level. World Health Organization. https://apps.who.int/iris/handle/10665/251730