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Perioperative Safety and Infection Prevention in Endodontic and Dental Practice: Integrating Endodontics, Dental Assisting, Sterilization and Instrument Reprocessing, and Anesthesia Technology in Comprehensive Procedural Care.

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Abstract

Background: Endodontic procedures require a controlled operating field, correctly processed instruments, and safe use of medication. If sedation is used, the dental and anesthesia teams must also share access to the airway. Objective: To examine how endodontics, dental assisting, sterile services, and anesthesia technology can coordinate safety across the dental procedure. Methods: Targeted searches identified clinical guidelines, trials, systematic reviews, and reports of complications published through December 2024. Evidence was assessed by study design and its relevance to adult dental care. Results: Dental dam isolation and controlled irrigation address different hazards during nonsurgical root canal treatment. Reprocessing depends on cleaning, device compatibility, process monitoring, and documented release. Safe injection and dental unit water management address exposures that instrument sterilization alone cannot prevent. When sedation is indicated, patient selection, ventilation monitoring, rescue readiness, and recovery assessment require defined responsibilities. Conclusion: Teams can make safety checks more useful by identifying who verifies each item, what warrants a pause, and who confirms that a problem has been resolved. Implementation should be evaluated with direct observation and follow-up of failures as well as counts of completed checklists.

Keywords: endodontics; dental assistants; infection prevention; instrument reprocessing; procedural sedation; patient safety

1. Introduction

A root canal may begin with a diagnosis and an instrument tray, but safe treatment depends on decisions made before, during, and after the appointment. The endodontic clinician confirms the tooth and treatment plan. The dental assistant prepares the field and helps detect breaches in asepsis. The central sterile services department (CSSD) or designated reprocessing service verifies that reusable instruments are ready for use. When sedation is indicated, appropriately credentialed clinicians and anesthesia staff must maintain ventilation monitoring and the ability to rescue a patient whose sedation deepens. A failure at any handoff can defeat an otherwise sound clinical plan.

Reports of blood-borne pathogen transmission in dental settings are uncommon, but investigations have documented lapses involving injections and handpiece reprocessing. Investigators cannot always attribute transmission to one lapse. These events clarify why dental safety needs controls for medication preparation, water, instruments, and the operative field. This review focuses on adult ambulatory

endodontic and dental care, with additional safeguards for procedures involving sedation and surgical irrigation. [1, 2]

2. Methods

This review drew on targeted searches for PubMed-indexed articles and dated guidelines published through December 31, 2024. Search concepts included pulpal and apical disease, dental dam isolation, irrigant injury, antibiotic stewardship, infection prevention in dental settings, sterilization monitoring, dental unit water, procedural sedation, and recovery. Saudi Ministry of Health guidance was reviewed for local implementation.

Clinical guidelines informed recommended processes. Trials and comparative studies were used when available, including studies of tooth survival and sedation monitoring. Case reports and outbreak investigations were included to describe how uncommon harms can occur. The review did not pool estimates or formally grade certainty. The tables synthesize checks for clinical teams to adapt and evaluate locally.

3. Results

3.1 Diagnosis and Endodontic Field Safety

Before treatment, reconcile patient identity, tooth, procedure, and consent with the clinical record and relevant radiographs. Pulp sensibility, percussion, periodontal findings, and imaging should be interpreted with the symptom history. If findings and the planned tooth do not agree, pause and resolve the discrepancy before an irreversible intervention. A before-and-after study of wrong-site extractions identified communication and cognitive failures and observed fewer errors after an education program. This supports attention to verification but does not establish the effect of a checklist in endodontics. [3, 4]

Medical review must distinguish an uncomplicated pulpal problem from an infection requiring urgent escalation. Diffuse or rapidly progressive swelling, dysphagia, dyspnea, marked trismus, or systemic illness can indicate spread beyond the immediate dental site. Suspected airway compromise or deep space infection requires urgent assessment in a setting that can manage the airway and infection. For stable patients, decide whether local anesthesia alone is sufficient and document why sedation is needed if it is proposed. [5]

For nonsurgical root canal treatment, the American Association of Endodontists and the European Society of Endodontology support dental dam isolation. The dam separates the tooth from saliva and helps protect the patient from instruments and irrigants. Reported aspiration and ingestion of endodontic instruments are uncommon but can require medical intervention. In a Taiwanese observational study, dental dam use during initial root canal treatment was associated with a lower subsequent hazard of extraction (adjusted hazard ratio 0.81; 95% confidence interval, 0.79–0.84). Differences in operators or case selection could contribute to that association. Dam use should be verified as part of the procedure rather than inferred from a chart entry. [3, 6-8]

The dental assistant can help inspect the dam seal, confirm that the clamp is secure, and prepare the instruments and suction. Disinfect the exposed tooth and field before entering the canal. If isolation is lost or the field is contaminated, stop instrumentation and irrigation until asepsis is restored. When using needle irrigation, consider canal anatomy and working length. The needle should fit loosely, and controlled delivery should allow backflow to reduce the risk of apical extrusion. Keep irrigation syringes distinctly labeled and separate from injectable drugs. Sudden severe pain or swelling during irrigation calls for immediate cessation and assessment for tissue injury and airway or eye involvement as appropriate. Case reports inform recognition of hypochlorite injuries, but comparative evidence on their treatment is limited. [3, 9, 10]

Definitive dental treatment is the priority for most pulpal and localized periapical conditions. In immunocompetent adults, the American Dental Association guideline recommends against routine systemic antibiotics for most such presentations when definitive care is available. Systemic involvement

changes the decision and calls for timely treatment directed at the infection and its source. Dental prophylaxis for infective endocarditis is a separate indication reserved for selected patients at highest risk of an adverse outcome when the procedure manipulates gingival or periapical tissue or perforates oral mucosa. The indication and allergy history should be verified before prescribing. [11, 12]

3.2 Infection Prevention at the Dental Chair

Standard precautions apply to each patient. Hand hygiene, appropriate personal protective equipment, sharps injury prevention, environmental cleaning, and safe injection practices are complementary. The dental assistant can confirm readiness of barriers and eye protection, change contaminated barriers, and keep used items separate from clean supplies. High-volume evacuation and isolation can limit contamination at the point of care, but a Cochrane review found very low certainty evidence based on bacterial counts and no studies measuring prevention of disease transmission. These measures complement standard precautions. [1, 13-15]

Prepare injectable medicines in a designated clean area away from contaminated equipment. Use a new sterile needle and syringe for each patient and each entry into a medication container. Single-dose vials are for one patient; if a multidose vial is shared, it should be kept and accessed in a clean medication preparation area away from immediate patient treatment. In dental local anesthesia, needles and anesthetic cartridges are single-patient items; reusable cartridge syringes require cleaning and heat sterilization between patients. Dispose of sharps promptly in a suitable container. When recapping is necessary, use a one-handed technique or a mechanical device rather than two hands. [1, 13]

Dental unit waterlines can support biofilm. For nonsurgical care, the Centers for Disease Control and Prevention (CDC) recommends treatment water containing no more than 500 colony-forming units per milliliter of heterotrophic bacteria. Facilities should use the applicable local standard and follow manufacturer instructions for treatment and verification of water quality. For oral surgery, including surgical endodontics, use sterile coolant or irrigant delivered through a sterile system that bypasses conventional dental unit waterlines. An outbreak investigation after pediatric pulpotomies linked *Mycobacterium abscessus* infections to contaminated dental water; the pediatric cases illustrate a hazard of the delivery system rather than an estimate of routine adult risk. [1, 13, 14, 16]

3.3 Sedation, Anesthesia Technology, and Recovery

Sedation adds risks that differ from those of local anesthesia alone. Before elective sedation, the responsible clinician should assess medical and medication history, prior anesthesia problems, airway and obstructive sleep apnea risk, and the suitability of the location for the planned depth. Review fasting against the applicable guidance and individual aspiration risk. The 2023 fasting update addresses healthy patients undergoing elective procedures; its recommendations are not an automatic rule for patients with delayed gastric emptying or an urgent need for care. The anesthesia technician can check monitors, oxygen, suction, and rescue equipment within local protocols. Staffing must allow a trained person other than the procedural operator to monitor the patient and must support rescue from deeper sedation than intended. [17-19]

During moderate sedation, monitor oxygenation, ventilation, responsiveness, and circulation in accordance with applicable guidance. The 2018 multisociety guideline recommends continuous capnography unless it is precluded or invalidated by the patient, procedure, or equipment. Pulse oximetry measures oxygenation and can remain reassuring while ventilation deteriorates, particularly when supplemental oxygen is used. In a dental trial involving patients with intellectual disabilities under deep propofol sedation, fewer cases had oxygen saturation below 95% with earlier rather than later capnography alerts (13.4% vs 34.8%). Both groups had capnography. A broader meta-analysis also found less desaturation when capnography was added to standard monitoring. These findings support early detection and response, but do not establish an effect on rare major dental anesthesia outcomes. [17, 20, 21]

Before the dental procedure starts, agree on how the operating field will be cleared if the anesthesia team needs access to the airway. Loss of ventilation or inadequate airway access warrants an immediate pause

and coordinated response. Record the total dose of local anesthetic administered across all injections; suspected local anesthetic systemic toxicity requires urgent recognition and rescue using the facility's emergency plan. At transfer, communicate the drugs given, adverse events, and ongoing monitoring needs. Before discharge, the responsible clinician verifies recovery of consciousness, stable ventilation and circulation, and satisfactory oxygenation. Provide written instructions and contact details, and confirm an escort when indicated by the sedation plan. [17, 18, 22]

After endodontic treatment, document the restoration and follow-up plan. Explain expected symptoms and how to obtain urgent assessment if swelling or fever develops or worsens. Difficulty swallowing or breathing requires immediate escalation. These instructions are relevant even when only local anesthesia was used. [3, 5] Table 1 summarizes the clinical checks and decisions that should be communicated across the dental and anesthesia teams.

Table 1. Perioperative safety checks and responses

Stage	Shared check	Action if unresolved
Before treatment	Reconcile patient, tooth, diagnosis, consent, and planned procedure. [3, 4]	Stop before an irreversible step if the site or plan is unclear.
Before sedation when indicated	Confirm suitability, monitoring assignment, and functioning airway and rescue equipment. [17, 18]	Defer or move the procedure if the required staff or equipment are unavailable.
Before root canal instrumentation	Confirm secure dental dam isolation, labeled irrigant, cleared instruments, and suction. [3, 6, 9]	Restore isolation or replace compromised items before proceeding.
During sedation	Track ventilation and oxygenation, with a shared signal to pause dental work. [17, 20]	Interrupt dental work and clear the field for airway assessment and rescue.
Recovery and discharge	Communicate drugs and events; verify recovery criteria, instructions, and escort as indicated. [17, 18]	Continue monitoring and seek clinician review if recovery criteria are not met.

3.4 Instrument Reprocessing and Release

Reprocessing begins as soon as instruments leave the operative field. Discard items labeled single use and place reusable items in a closed, puncture-resistant container for transport to the designated processing area. Follow the manufacturer's instructions for handling and cleaning, and maintain a workflow that separates contaminated items from clean and sterile stock. Cleaning removes soil that can interfere with subsequent processing. Where compatible, automated cleaning can reduce direct handling of sharp instruments. Inspect, dry, and package instruments according to device and sterilizer instructions before processing. [1, 13, 14, 23]

Items that penetrate soft tissue or bone are critical and require sterilization. Heat-tolerant semicritical devices that contact mucosa should also be heat sterilized. Reusable handpieces and attachments must be cleaned and heat sterilized between patients because internal surfaces can become contaminated. If a semicritical device cannot tolerate heat, select a heat-tolerant or single-use alternative where possible. Where no alternative exists and instructions permit, perform at least high-level disinfection using the validated method. Apply the same device-specific reasoning to reusable equipment that contacts the airway. [13, 14, 23]

Endodontic files deserve particular attention. In one practice-based study, debris was visible on many reprocessed files and some tested positive for residual blood. The study assessed residual contamination, not infection in treated patients. It illustrates why a completed sterilizer cycle cannot compensate for inadequate cleaning. Reuse a file only when the device labeling and local policy permit it and a validated

process can be followed. Remove damaged, deformed, or inadequately cleaned devices from use. [13, 14, 24] Release decisions use more than one indicator. Review and record the cycle parameters for each load and use a chemical indicator inside each package, with an external indicator when the internal one cannot be seen. CDC dental guidance recommends biological monitoring at least weekly and for each load containing an implantable device; hold implants pending a negative result whenever possible. Mechanical, chemical, and biological indicators address different aspects of process quality. A satisfactory indicator does not verify that every instrument was cleaned or that a wet or torn package remains usable. Record the sterilizer, cycle or lot, monitoring results, and disposition in a form that allows affected items to be traced. [1, 13, 14]

When required cycle parameters or chemical indicators fail, withhold affected items. A positive biological indicator warrants taking the sterilizer out of service, reviewing the records, and promptly investigating and retesting under the applicable policy. If items have already been released, trace their distribution and decide which must be recalled with the infection prevention team. At the point of use, verify the package condition and identify the load when required by policy. A wet, torn, or otherwise compromised package should be reprocessed rather than opened for use. [1, 13, 14] Table 2 summarizes the controls that connect chairside handling with release from reprocessing.

Table 2. Verification steps for reusable dental instruments

Stage	Check before moving forward	Response to a failed check
Receipt of used items	Verify that single-use items have been discarded and reusable devices arrived in closed transport. [1, 13]	Segregate items that cannot be safely reprocessed or have unclear instructions.
Cleaning and inspection	Use the validated cleaning method; inspect for soil, damage, and retained debris. [13, 23, 24]	Reclean or remove the item from service.
Packaging and processing	Verify device compatibility, package integrity, load identification, and the correct cycle. [1, 14]	Correct packaging or cycle selection before release.
Load release	Check cycle records and chemical indicators; review biological monitoring as required. [1, 13]	Withhold affected items and investigate deviations before release.
Storage and chairside opening	Verify that the package is dry and intact and its load can be identified. [1, 13]	Return compromised packages for reprocessing.

4. Discussion

Safety checks are most valuable when they change what the team does. An assistant who sees a wet package should be able to stop setup and obtain another set. A reprocessing technician who finds an incomplete cycle record should be able to withhold the load without pressure from the clinic schedule. A monitoring concern during sedation should trigger a pause and access to the airway. These decisions depend on clear authority, working equipment, and a plan for resuming care after the problem is corrected. Evidence for general surgical checklists illustrates the limits of adopting a form alone. A multicenter before-and-after study reported lower postoperative complications after checklist implementation. A subsequent study in Ontario did not find significant improvements in mortality or complications after adoption. Neither study evaluated the integrated dental pathway proposed here. A practical dental team briefing can focus on a few decisions with observable responses rather than treating a completed form as evidence that care was safe. [25, 26]

The Saudi Ministry of Health dental manual provides a local framework for infection prevention. A survey of dental clinics in Jeddah during the COVID-19 pandemic reported variation in practices, but relied on clinic reports and did not establish patient-level transmission risks. Clinics can measure the proportion of

observed root canal procedures with intact isolation, the proportion of loads with complete release records, and sedation cases with documented ventilation monitoring or a recorded reason for an exception. Observe a sample of actual work and review how teams handled failures, including whether care was stopped and safely resumed. Track delays, availability of clean sets, and avoidable cancellations as potential unintended effects. [14, 27, 28]

Several recommendations rely on process standards and plausible mechanisms rather than trials of rare harms. The tooth survival study was observational, studies of irrigant injury were mainly case reports, and the dental capnography trial involved a specific population and sedation regimen. Process outcomes such as lower bacterial counts or fewer brief desaturations do not establish reductions in transmission or major anesthesia morbidity. Future multicenter evaluations should define case mix, distinguish detection from actual harm, and examine whether these checks are performed and acted on consistently.

5. Conclusion

Safe endodontic care depends on agreement about the tooth and treatment plan, effective isolation, controlled irrigation, and instruments that have been cleaned, processed, and released correctly. These checks address different sources of harm. An acceptable sterilizer record does not correct a failure in cleaning, and an aseptic operating field does not compensate for unsafe injection or contaminated water. When sedation is required, the team must also plan for loss of ventilation, protect access to the airway, and verify recovery before discharge.

A practical improvement is to assign each verification to a team member and specify what should stop the procedure. The clinician can resolve a diagnostic discrepancy, the dental assistant can identify a breach in field safety, sterile services can withhold a suspect load, and anesthesia personnel can coordinate a pause for assessment and rescue. Hospitals and dental clinics should evaluate whether these checks lead to corrective action and safer care. Direct observation, traceable records, and review of incidents can show where the pathway needs improvement and whether the changes can be sustained.

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