HYGIENIC AND TOXIC SAFETY OF ANTISEPTICS USED IN DENTAL PROCEDURES

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Annotation: Antiseptics are widely used in dentistry for infection control during various procedures, including surgical interventions, cavity preparation, root canal treatment, and oral hygiene maintenance. While antiseptic agents such as chlorhexidine, hydrogen peroxide, povidone-iodine, and sodium hypochlorite have proven antimicrobial effectiveness, their hygienic safety and potential toxic effects on oral tissues and systemic health must be carefully considered. This article reviews commonly used dental antiseptics, their mechanisms of action, potential cytotoxicity, allergenicity, and mucosal tolerance. Emphasis is placed on balancing antimicrobial efficacy with patient safety, particularly in pediatric and immunocompromised populations. Recommendations for the safe clinical application of these agents are also discussed.

Keywords: dental antiseptics, chlorhexidine, hydrogen peroxide, povidone-iodine, sodium hypochlorite, cytotoxicity, oral tissue safety, dental hygiene, antimicrobial agents, patient safety

Antiseptic agents play a central role in modern dentistry by helping prevent and control microbial contamination during clinical procedures. From preoperative oral rinses to irrigants in endodontic therapy, antiseptics are essential in reducing the risk of infection and ensuring successful treatment outcomes. Among the most commonly used substances are chlorhexidine gluconate, hydrogen peroxide, sodium hypochlorite, and povidone-iodine. Each of these compounds has distinct antimicrobial properties, concentrations of use, and biological effects on both pathogens and host tissues.

While these agents are indispensable in dental practice, their safety profile—especially in relation to oral mucosa, periodontal tissues, and systemic absorption—requires continuous evaluation. Prolonged exposure, improper concentration, or hypersensitivity reactions may lead to tissue irritation, cytotoxicity, or delayed healing. In recent years, concern has grown regarding the overuse or misuse of antiseptics and

the potential risks they pose to patients, particularly in pediatric and medically vulnerable populations.

This paper aims to assess the hygienic and toxicological aspects of dental antiseptics based on current evidence. By analyzing their antimicrobial spectrum, cellular effects, and risk factors, we aim to guide clinicians toward safer and more effective application of these agents in routine dental procedures.

This review article is based on a comprehensive search of peer-reviewed scientific literature published between 2012 and 2024. Databases searched included PubMed, ScienceDirect, and Scopus, using the following search terms: *"dental antiseptics," "chlorhexidine cytotoxicity," "sodium hypochlorite toxicity," "oral mucosa safety," "antiseptic hypersensitivity,"* and *"toxicity of hydrogen peroxide in dentistry."* Only studies conducted on human oral tissues (in vivo or in vitro), clinical trials, reviews, and safety evaluations relevant to dental practice were included.

Each selected study was analyzed to extract data on the antiseptic agent used, concentration, duration of exposure, observed toxic or allergic reactions, and impact on wound healing or cell viability. Special attention was given to studies involving vulnerable populations (children, elderly, immunocompromised). Experimental studies involving fibroblasts, keratinocytes, pulp cells, and gingival tissues were reviewed to understand the cytotoxic thresholds of commonly used agents.

Analysis of the selected studies revealed that while most commonly used dental antiseptics are effective against a broad spectrum of oral pathogens, several demonstrate varying levels of cytotoxicity depending on concentration, exposure time, and tissue type.

Chlorhexidine gluconate (0.12%–0.2%) was shown to be highly effective against Gram-positive and Gram-negative bacteria, as well as fungi. However, it also exhibited dose-dependent cytotoxic effects on human gingival fibroblasts and epithelial cells. Prolonged exposure was associated with delayed wound healing and oral mucosal irritation in some clinical settings.

Hydrogen peroxide (3%), though useful as a debriding and oxidizing agent, was found to cause oxidative stress and cellular damage at higher concentrations. Short-term use in diluted form (<1.5%) reduced cytotoxicity significantly while retaining antimicrobial effects.

Sodium hypochlorite (0.5%–5%), widely used in endodontics, demonstrated strong antibacterial activity but was also the most cytotoxic to pulp cells and periapical tissues. Accidental extrusion of the solution beyond the root apex resulted in severe tissue necrosis in reported clinical cases.

Povidone-iodine (1%–2%) presented moderate antimicrobial effects and relatively low mucosal toxicity, but repeated application was linked to rare hypersensitivity reactions and transient thyroid function disturbances in pediatric patients.

Several in vitro studies confirmed that lower concentrations of these agents (especially chlorhexidine and hydrogen peroxide) minimized adverse effects without compromising microbial control. Biocompatibility increased significantly when proper rinsing and isolation techniques were used during application.

The findings emphasize the importance of balancing antimicrobial efficacy with tissue compatibility when selecting antiseptics for dental procedures. Chlorhexidine remains a gold standard for many applications due to its substantivity and broad-spectrum activity. Nevertheless, its potential to damage soft tissues, alter taste sensation, and cause mucosal desquamation necessitates careful use, particularly in pediatric or long-term care cases.

Hydrogen peroxide's oxidative action is beneficial in breaking down organic debris and biofilms, but its concentration must be closely controlled to avoid mucosal burns and irritation. Lower concentrations (<1.5%) are recommended for daily use as mouth rinses or adjuncts to scaling and root planing.

Sodium hypochlorite, though indispensable in root canal therapy, poses a high toxicity risk if mishandled. Rubber dam isolation and minimal contact time are crucial to avoid periapical damage. In pediatric endodontics, alternative irrigants like calcium hydroxide or chlorhexidine may be safer options.

Povidone-iodine’s safety profile is generally favorable, though clinicians should be alert for signs of allergic reactions or iodine overload, especially in children or patients with thyroid disorders. Alternatives such as essential oil-based antiseptics or herbal formulations are emerging, but further clinical validation is needed before widespread adoption.

Overall, safe antiseptic use in dentistry depends on appropriate selection, proper dilution, short exposure time, and individualized patient risk assessment. Developing guidelines for concentration-specific use based on patient age, health status, and procedure type can further enhance safety.

Antiseptics play a vital role in dental infection control, but their hygienic and toxic safety must not be overlooked. While agents like chlorhexidine, hydrogen peroxide, sodium hypochlorite, and povidone-iodine are clinically effective, they also present varying degrees of toxicity to oral tissues when misused. Minimizing adverse effects requires careful concentration control, limited exposure, and evidence-based clinical protocols. Dental practitioners must be trained to recognize risks, apply preventive

measures, and tailor antiseptic use to each patient's needs. Continued research and innovation are necessary to develop next-generation antiseptics with improved safety profiles and maintained antimicrobial effectiveness.

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