American Journal of Medical Case Reports, 2026, Vol. 14, No. 3, 34-41
Available online at http://pubs.sciepub.com/ajmcr/14/3/1
Published by Science and Education Publishing
DOI:10.12691/ajmcr-14-3-1

Infection Control in U.S. Dental Practice: Current Standards, Guidelines, and Emerging Challenges

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Received January 24, 2026; Revised February 26, 2026; Accepted March 05, 2026

Abstract Infection control is a critical component of dental practice, essential for preventing the transmission of infectious agents among patients, dental health care personnel, and the clinical environment. Dental settings pose unique infection risks due to frequent exposure to blood and saliva, use of sharp instruments, and the generation of aerosols during routine procedures. In the United States, infection control in dentistry is guided by evidence-based recommendations from the Centers for Disease Control and Prevention, the Occupational Safety and Health Administration, and professional organizations such as the American Dental Association. This narrative review summarizes current infection control standards and guidelines relevant to U.S. dental practice, including standard precautions, instrument processing and sterilization, environmental infection control, dental unit waterline management, aerosol and airborne infection control measures, and occupational health considerations. The review also highlights emerging challenges, such as evolving infectious threats, antimicrobial resistance, inconsistencies in guideline implementation, resource and cost constraints, and the lasting impact of the COVID-19 pandemic on dental infection control practices. Strengthening infection prevention efforts through continued education, consistent adherence to established guidelines, and adaptability to emerging risks is essential for maintaining patient and provider safety and ensuring high-quality dental care in the United States.

Keywords: *Infection Control, Dental Care, Cross Infection, United States*

Cite This Article: Dr. Latifa Elbanna, Dr. Sri Valli Durga Bala Vinuthna Darisipudi, Dr. Deepthi Dandu, Dr. Sree Rekha Movva, Dr. Sameera A Khan, Dr. Anam fazal, and Dr. Sandeep Singh, "Infection Control in U.S. Dental Practice: Current Standards, Guidelines, and Emerging Challenges." *American Journal of Medical Case Reports*, vol. 14, no. 3 (2026): 34-41. doi: 10.12691/ajmcr-14-3-1.

1. Introduction

Healthcare-associated infections (HAIs) are infections patients acquire while receiving care for other conditions, and they represent a significant concern for patient safety and healthcare systems worldwide. While most data on HAIs focus on hospitals, dental settings are not immune to these risks: documented transmission of blood-borne pathogens such as hepatitis B and C in dental clinics underscores the importance of stringent infection prevention practices in dentistry to protect both patients and dental health care personnel (DHCP). [1]

Dental procedures inherently expose clinicians and patients to blood, saliva, and respiratory secretions, often in close proximity and through instruments that generate aerosols and splatter. Aerosol-producing devices such as high-speed handpieces and ultrasonic scalers can disseminate fine droplets containing microorganisms throughout the operatory environment, amplifying the potential for cross-contamination and airborne exposure. [2]

In the United States, formalized infection control practices in dentistry evolved significantly in response to emerging infectious threats. The HIV/AIDS epidemic of the 1980s prompted the U.S. Centers for Disease Control and Prevention (CDC) to introduce universal precautions in 1985 to mitigate bloodborne pathogen transmission, a foundation that later transitioned into broader standard precautions integrating lessons learned across healthcare disciplines. [3] The CDC's Guidelines for Infection Control in Dental Health-Care Settings 2003, remain a central reference for dental practitioners, detailing evidence-based practices for preventing transmission of infectious agents in dental environments. [4]

The COVID-19 pandemic brought heightened

awareness to infection control in dental practice due to the virus's efficient transmission through respiratory droplets and aerosols, prompting modifications to existing protocols and broader adoption of enhanced personal protective equipment (PPE) and environmental controls to protect both DHCP and patients. [5] Contemporary surveys indicate sustained implementation of many COVID-era precautions, such as enhanced surface disinfection and use of high-filtration masks, demonstrating their influence on long-term practice behaviour. [6]

Given these evolving standards and ongoing challenges, including aerosol management, variable guideline adherence, and emerging infectious threats, this narrative review synthesizes current infection control standards and guidelines in U.S. dental practice, highlights historical developments and the impact of COVID-19, and identifies key areas where further research and implementation efforts are needed. The objectives of this paper are to delineate the current landscape of infection control in U.S. dentistry, summarize guideline recommendations, and discuss emerging challenges that may shape future practice.

2. Methodology

This article is a narrative review of the literature focusing on infection control in U.S. dental practice. Relevant publications were identified through searches of PubMed/MEDLINE, Scopus, and Google Scholar, with an emphasis on peer-reviewed articles, reviews, and authoritative reports published primarily within the last two decades, while older landmark publications were included for historical context.

Key search terms included combinations of infection control, infection prevention, dental practice, dentistry, healthcare-associated infections, aerosols, CDC guidelines, *and* occupational safety. Priority was given to English-language articles relevant to dental settings in the United States. Studies unrelated to dentistry or lacking relevance to infection control practices were excluded. In addition to the scientific literature, current guidelines and recommendations from the Centers for Disease Control and Prevention (CDC), Occupational Safety and Health Administration (OSHA), American Dental Association (ADA), and Environmental Protection Agency (EPA) were reviewed to ensure alignment with prevailing standards of care. This approach allowed for a comprehensive synthesis of established practices, evolving recommendations, and emerging challenges in dental infection control.

3. Overview of Infection Control Standards in U.S. Dental Practice

Infection control standards in U.S. dental practice are shaped by federal regulations, evidence-based public health guidance, and professional recommendations aimed at preventing healthcare-associated infections (HAIs) and occupational exposures. These standards address the unique risks present in dental settings, including exposure to blood, saliva, respiratory secretions, and aerosols generated during routine procedures. [7]

3.1. Regulatory and Advisory Bodies

The Centers for Disease Control and Prevention (CDC) is the primary authority providing evidence-based infection control guidance for dental healthcare settings. The CDC's Guidelines for Infection Control in Dental Health-Care Settings 2003 remain a foundational reference, outlining standard precautions, instrument processing, environmental infection control, and occupational health measures specific to dentistry. Updates and interim guidance issued during the COVID-19 pandemic further reinforced the importance of aerosol management, respiratory protection, and patient screening. [8]

The Occupational Safety and Health Administration (OSHA) establishes and enforces regulations to protect dental healthcare personnel from occupational exposure to infectious agents. OSHA's Bloodborne Pathogens Standard mandates written exposure control plans, hepatitis B vaccination, training, and post-exposure evaluation and follow-up for dental personnel at risk of exposure to bloodborne pathogens. [9]

The American Dental Association (ADA) supports infection control efforts by issuing policy statements, clinical resources, and continuing education programs that interpret and reinforce CDC and OSHA recommendations for dental practitioners. The ADA also plays an important role in promoting compliance and advocating for practitioner and patient safety. The Environmental Protection Agency (EPA) regulates disinfectants and sterilants used in dental settings, ensuring that chemical agents marketed for surface disinfection and environmental infection control meet safety and efficacy standards. EPA registration of disinfectants is an essential component of environmental infection prevention in dental operatories. [10]

In addition to federal agencies, state dental boards establish infection control requirements within their jurisdictions. While specific regulations vary by state, most align closely with CDC and OSHA guidance and are enforced through licensure requirements, inspections, and disciplinary actions when necessary.

3.2. Standard Precautions in Dentistry

Standard precautions are the cornerstone of infection prevention in dental practice and are applied to all patients regardless of infection status. Hand hygiene is recognized as the most effective measure for preventing transmission of microorganisms and includes handwashing with soap and water or the use of alcohol-based hand rubs when appropriate. [11]

The appropriate use of personal protective equipment (PPE), including gloves, masks, protective eyewear, face shields, and gowns, reduces exposure to blood, saliva, and other potentially infectious materials during dental procedures. Respiratory hygiene and cough etiquette, emphasized during the COVID-19 pandemic, are critical for limiting the spread of respiratory pathogens in dental settings. [12]

Sharps safety practices, including the use of engineering controls, safe handling techniques, and proper

disposal of needles and sharp instruments, are essential for preventing percutaneous injuries and bloodborne pathogen transmission among dental healthcare personnel. Additionally, safe injection practices, such as the use of sterile needles and syringes for each patient and proper medication handling, are necessary to prevent cross-contamination and healthcare-associated infections. [13]

4. Infection Control Guidelines in Dental Settings

Infection control guidelines in dental settings address multiple pathways of pathogen transmission, including direct contact, indirect contact via contaminated instruments and surfaces, and airborne exposure through aerosols. These guidelines are designed to interrupt the chain of infection while maintaining safe and effective clinical care.

4.1. Instrument Processing and Sterilization

Proper instrument processing is a cornerstone of infection prevention in dentistry. Reusable dental instruments must undergo sequential cleaning, disinfection, and sterilization to eliminate organic debris and microbial contamination. Cleaning, performed manually or using ultrasonic cleaners or washer-disinfectors, is essential prior to sterilization, as residual debris can compromise sterilization efficacy. [14]

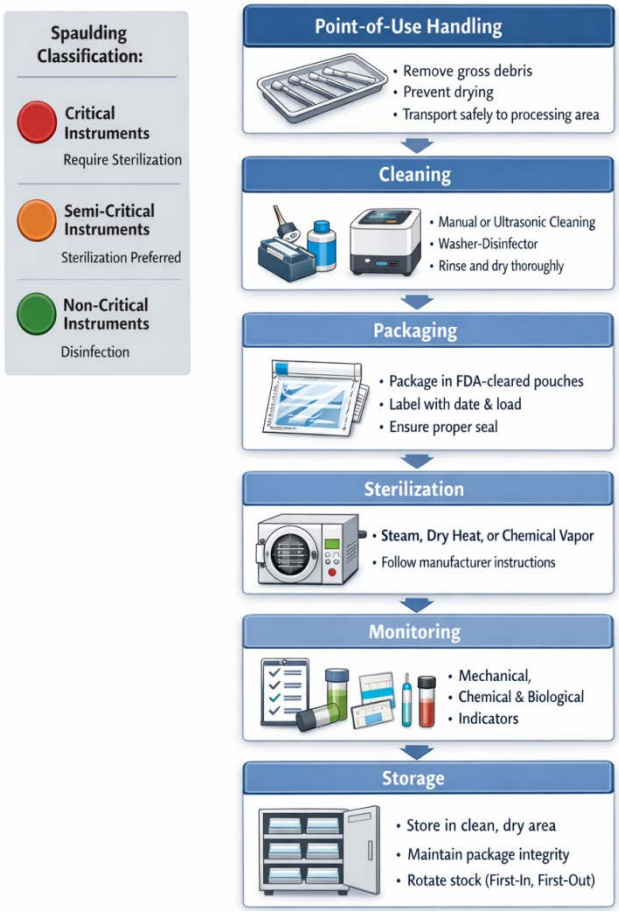


Figure 1. Instrument Sterilization and Processing workflow

Sterilization methods commonly used in dental practice include steam sterilization, dry heat, and chemical vapor sterilization. Routine monitoring and documentation of sterilization processes, using mechanical, chemical, and biological indicators, are recommended to ensure consistent performance and patient safety. The Spaulding classification system provides a risk-based framework for determining appropriate levels of instrument reprocessing. Critical and semi-critical instruments that penetrate soft tissue or contact mucous membranes require sterilization, whereas non-critical items may be adequately managed through intermediate- or low-level disinfection. [15] Figure 1

4.2. Environmental Infection Control

Environmental surfaces in dental operatories can become contaminated through splatter and aerosol deposition. Surface disinfection using EPA-registered hospital-grade disinfectants is recommended between patients for clinical contact surfaces and at least daily for housekeeping surfaces. Dental unit waterlines (DUWLs) represent a well-documented source of microbial contamination, including biofilm formation that can harbor opportunistic pathogens such as Legionella species. Studies have demonstrated that untreated DUWLs frequently exceed recommended microbial limits, prompting guidelines that emphasize routine monitoring, chemical treatment, and adherence to water quality standards (≤500 CFU/mL). Proper waste management, including segregation and disposal of regulated medical waste, sharps, and chemical waste, is essential for minimizing occupational and environmental risks. Dental practices are required to follow federal, state, and local regulations to ensure safe handling and disposal. [16]

4.3. Aerosol and Airborne Infection Control

Many routine dental procedures are classified as aerosol-generating procedures, producing fine particles capable of remaining suspended in the air and potentially transmitting respiratory pathogens. Aerosols generated by high-speed handpieces, ultrasonic scalers, and air-water syringes have been shown to disseminate microorganisms throughout the operatory. [17]

Mitigation strategies include the use of high-volume evacuation (HVE) systems, which significantly reduce aerosol and splatter contamination when used correctly. Ventilation and air filtration, including increased air exchanges, HEPA filtration, and portable air-cleaning devices, have gained prominence, particularly following the COVID-19 pandemic. Preprocedural mouth rinses, such as chlorhexidine, povidone-iodine, or hydrogen peroxide solutions, have been investigated for their ability to reduce microbial load in dental aerosols. While evidence suggests short-term reductions in bacterial contamination, their effectiveness against viral pathogens remains an area of ongoing research. [18]

4.4. Occupational Health and Safety

Protecting dental healthcare personnel is a central component of infection control guidelines. Vaccination,

particularly against hepatitis B virus, is strongly recommended and mandated under OSHA regulations for employees at risk of occupational exposure to bloodborne pathogens. Dental practices are required to maintain written exposure control plans outlining procedures for preventing, identifying, and managing occupational exposures. In the event of an exposure incident, post-exposure protocols include immediate wound care, risk assessment, source patient testing when appropriate, and timely medical evaluation and follow-up. Ongoing training and education are essential for maintaining compliance with infection control standards. Regular training ensures that dental healthcare personnel remain informed about updated guidelines, emerging risks, and proper use of protective equipment and engineering controls. [19]

5. Emerging Challenges in Infection Control

Despite well-established infection control standards, dental practices continue to face emerging and evolving challenges that complicate effective implementation and long-term sustainability of infection prevention measures.

5.1. Aerosol Transmission and Evolving Pathogens

Aerosol transmission remains a significant concern in dentistry due to the routine use of aerosol-generating procedures. Evidence demonstrates that dental aerosols can contain bacteria, fungi, and viruses capable of dispersing throughout the operatory and persisting in the air for extended periods. [20] The emergence of highly transmissible respiratory pathogens, including SARS-CoV-2, has intensified concerns regarding airborne spread and highlighted gaps in ventilation and aerosol mitigation strategies in dental settings. [21]

5.2. Antimicrobial Resistance

Antimicrobial resistance (AMR) poses a growing threat to infection control across healthcare settings, including dentistry. Inappropriate or excessive use of antibiotics in dental practice contributes to the development of resistant microorganisms, complicating the management of odontogenic infections and increasing the risk of treatment failure. AMR also raises concerns regarding the effectiveness of antiseptics and disinfectants used in dental environments. [22]

5.3. Compliance Variability among Dental Practices

Although evidence-based guidelines are widely available, variability in compliance remains a persistent challenge. Studies have documented inconsistencies in adherence to hand hygiene, sterilization monitoring, and dental unit waterline maintenance, often influenced by practice size, resource availability, and training levels. Such variability increases the risk of preventable healthcare-associated infections. [23] Table 1

5.4. Cost and Access to PPE and Equipment

The COVID-19 pandemic exposed vulnerabilities in the supply chain for personal protective equipment (PPE) and infection control supplies. Dental practices reported shortages, increased costs, and difficulty accessing respirators, face shields, and disposable gowns, which directly affected service delivery and compliance with enhanced infection control protocols. Financial constraints continue to influence the adoption of engineering controls such as high-efficiency air filtration systems. [24]

5.5. Dental Unit Waterline Contamination

Persistent contamination of dental unit waterlines (DUWLs) remains a well-recognized challenge due to biofilm formation within narrow-bore tubing. Studies have shown that microbial counts frequently exceed recommended limits when waterline maintenance protocols are inconsistently applied. Ensuring routine monitoring and adherence to maintenance protocols continues to be difficult in busy clinical environments. [25]

5.6. Workforce Training Gaps

Effective infection control depends heavily on continuous education and training of dental healthcare personnel. However, gaps in knowledge and inconsistent training, particularly among auxiliary staff, have been reported, underscoring the need for standardized, ongoing infection control education programs. [26]

5.7. Ethical and Legal Implications

Failures in infection control can carry serious ethical and legal consequences, including breaches of patient trust, professional misconduct claims, and regulatory sanctions. High-profile cases of infection transmission in dental settings have emphasized the ethical obligation of dental professionals to adhere strictly to established standards to protect patient safety. [27]

5.8. Impact of New Technologies and Materials

Advances in dental technologies and materials introduce new infection control considerations. While innovations such as digital impressions, CAD/CAM systems, and reusable medical devices offer clinical benefits, they also require updated cleaning, disinfection, and sterilization protocols to mitigate cross-contamination risks. [28]

6. Lessons Learned from the COVID-19 Pandemic

The COVID-19 pandemic profoundly reshaped infection control practices in dental settings, emphasizing the need for flexibility, preparedness, and evidence-based

responses to emerging infectious threats.

6.1. Changes in Infection Control Protocols

The recognition of SARS-CoV-2 transmission through respiratory droplets and aerosols led to rapid modifications in dental infection control protocols. Enhanced use of respiratory protection, including N95 or equivalent respirators, expanded use of face shields, stricter patient screening, and extended operatory disinfection times were widely adopted during the pandemic. These measures reinforced the importance of aerosol mitigation and respiratory hygiene in dental practice. [29] Figure 2

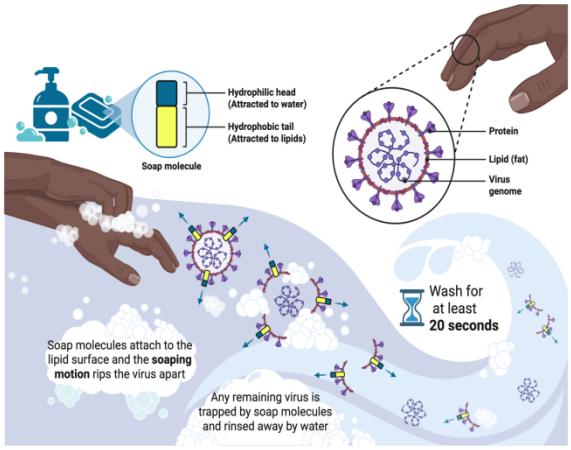


Figure 2. Mechanism of SARS-CoV-2 inactivation by soap

6.2. Permanent versus Temporary Measures

As routine dental care resumed, distinctions emerged between temporary emergency measures and practices likely to become permanent. While some interventions, such as patient deferral during peak transmission periods, were reduced, others, including improved PPE usage, enhanced surface disinfection, and greater attention to ventilation, have been retained in many practices. These sustained changes reflect an increased awareness of infection risks beyond COVID-19 alone. [30]

6.3. Teledentistry and Triaging

The pandemic accelerated the adoption of teledentistry as a tool for patient triage, consultation, and follow-up care. Teledentistry reduced unnecessary in-person visits, limited potential exposure, and improved access to care during periods of restricted clinical operations. Its integration into routine dental practice has demonstrated value for infection control, particularly for screening patients with infectious symptoms and prioritizing urgent care. [31]

6.4. Preparedness for Future Pandemics

COVID-19 highlighted the importance of pandemic preparedness within dental settings, including the need for adaptable infection control protocols, adequate PPE stockpiles, and regular training of dental healthcare personnel. Lessons learned underscore the value of integrating dental practices into broader public health emergency planning and maintaining clear communication channels with public health authorities. Proactive planning and continued investment in infection prevention infrastructure are critical to ensuring continuity of safe dental care during future public health emergencies. [32]

Table 1. Overall View of Infection Control Priorities In U.S. Dental Practice

Domain	Key U.S. Authorities	Core recommendations	Common gaps in compliance
Standard Precautions	CDC	Apply standard precautions to all patients, integrate into all clinical workflows. [7]	Variable adherence across personnel/settings. [23,26]
Hand Hygiene	CDC	Perform hand hygiene at key moments (before/after patient contact, after glove removal), soap/water or alcohol-based hand rub when appropriate. [11,40]	Missed opportunities, inconsistent technique/duration. [23,26,40]
Sharps and Injection Safety	OSHA, CDC	Use safe sharps practices and proper disposal to reduce percutaneous injuries and bloodborne pathogen risk. [7,9,13]	Handling/recapping lapses, workflow- related sharps injuries. [13,26]
Instrument Processing and Sterilization	CDC, ADA	Follow sequential reprocessing like clean → package → sterilize → store, ensure workflows separate contaminated vs clean areas. [7,14,15]	Inadequate cleaning prior to sterilization, process shortcuts, workflow separation issues. [14,26]
PPE (routine care)	CDC, ADA	Use task-appropriate PPE (gloves, mask, eye/face protection, protective clothing) to reduce exposure to blood/saliva/spray. [7,12]	Inconsistent eye protection/mask use, incorrect donning/doffing, uneven adherence. [20,26]
Sterilizer Monitoring and Documentation	CDC, ADA	Monitor sterilization with mechanical/chemical/biological indicators and document results, respond to failures with defined protocols. [15]	Infrequent biological indicator use and/or missing documentation, unclear failure response. [15,26]
Aerosol and Airborne Infection Control	CDC	Mitigate aerosol risks using controls discussed (HVE, ventilation/filtration, and risk- based protective measures, especially post-COVID. [34]	Underuse of effective engineering/work- practice controls, uncertainty and variability in implementation. [20,23,26]
Dental unit waterlines	CDC, ADA	Maintain water quality and control biofilm via maintenance/monitoring. [7,25]	Inconsistent maintenance/testing, documentation gaps. [25,26]
Occupational Health & Sharps Safety	OSHA, CDC	Exposure control plan, vaccination, training, post- exposure pathways, and safe sharps handling/disposal. [7,9,13,19]	Training gaps; sharps injuries, inconsistent sustainment. [13,26,39]

7. Future Directions and Innovations

Advancing infection control in dental practice will require continuous integration of updated guidance, technological innovation, and policy support to address evolving risks and improve consistency in implementation.

7.1. Updated CDC Recommendations

The Centers for Disease Control and Prevention (CDC) continues to update infection control guidance for dental healthcare settings based on emerging evidence. Recent CDC communications emphasize improved ventilation, risk-based use of respiratory protection, and reinforcement of standard precautions beyond pandemic contexts. Future updates are expected to further incorporate lessons learned from COVID-19 and evolving knowledge on aerosol transmission. [33]

7.2. Engineering Controls

Greater emphasis is being placed on engineering controls as a sustainable approach to infection prevention. These include enhanced ventilation systems, increased air exchanges per hour, high-efficiency particulate air (HEPA) filtration, and physical barriers where appropriate. Evidence from healthcare and dental settings suggests that engineering controls can significantly reduce airborne microbial load and exposure risk. Such interventions shift infection control from reliance on individual behavior to system-level protection. [34]

7.3. Digital Monitoring of Compliance

Emerging digital technologies offer new opportunities for monitoring compliance with infection control protocols. Automated sterilization tracking, electronic documentation of biological indicator testing, and digital reminders for hand hygiene and equipment maintenance have shown promise in improving adherence and accountability. Wider adoption of these systems may help reduce human error and variability across dental practices. [35]

7.4. Improved Dental Operatory Design

Innovations in dental operatory design are increasingly focused on infection prevention. Open layouts with optimized airflow, hands-free fixtures, seamless and cleanable surfaces, and separation of clean and contaminated zones are being incorporated into new and renovated practices. Design-based interventions have been recognized as important contributors to reducing cross-contamination and enhancing workflow efficiency. [36]

7.5. Research Gaps

Despite extensive guidance, important research gaps remain. Limited high-quality evidence exists on the long-term effectiveness of certain aerosol mitigation strategies, optimal dental unit waterline interventions, and the real-world impact of preprocedural mouth rinses on viral transmission. Further clinical and translational research is needed to generate dental-specific data that can inform future guideline development. [37]

7.6. Policy Implications

Enhancing infection control in dentistry also has important policy effects. Aligning federal, state, and professional guidelines, increasing support for infection control training, and offering financial incentives for adopting engineering controls can boost compliance and patient safety. Incorporating dental practices into broader public health preparedness plans is increasingly seen as vital for effectively responding to future infectious disease threats. [38]

8. Discussion

8.1. Synthesis of Key Findings

This narrative review highlights that infection control in U.S. dental practice is supported by well-established, evidence-based standards issued by the Centers for Disease Control and Prevention, the Occupational Safety and Health Administration, and professional organizations such as the American Dental Association. Core components, including standard precautions, instrument sterilization, environmental infection control, aerosol mitigation, and occupational health measures, collectively form a robust framework for preventing healthcare-associated infections in dental settings. However, emerging challenges such as aerosol transmission, antimicrobial resistance, and variability in implementation continue to test the effectiveness of these standards. [39]

8.2. Comparison with International Practices

Internationally, infection control principles in dentistry are broadly similar, emphasizing standard precautions, sterilization, and occupational safety. However, some regions, including parts of Europe and Asia, have placed earlier and stronger emphasis on ventilation standards and engineering controls in dental operatories. Reviews of global dental infection control practices suggest that while U.S. guidelines are comprehensive, greater alignment with international approaches to airborne infection control may further strengthen prevention efforts. [40]

8.3. Clinical and Public Health Implications

Effective infection control in dentistry has implications beyond individual patient care. Dental clinics serve large populations and can act as points of community transmission if standards are inadequately implemented. Consistent adherence to infection control guidelines protects patients, dental healthcare personnel, and the broader public, reinforcing dentistry's role within the public health infrastructure. The COVID-19 pandemic underscored the importance of integrating dental practices into public health preparedness and response systems. [41]

8.4. Strengths and Limitations of Current Guidelines

A major strength of current U.S. infection control guidelines is their strong scientific foundation and adaptability across diverse dental settings. Regular updates and interim guidance during public health emergencies demonstrate responsiveness to emerging evidence. However, limitations include variability in implementation, reliance on individual compliance, and gaps in dental-specific research for certain interventions, particularly aerosol mitigation strategies and dental unit waterline management. These limitations highlight the need for continued evaluation and refinement of existing recommendations. [42]

9. Conclusion

Infection control in U.S. dental practice is guided by comprehensive standards and guidelines that address the unique risks inherent to dental care. Current recommendations emphasize standard precautions, effective instrument reprocessing, environmental infection control, aerosol mitigation, and occupational health measures as essential components of safe dental practice.

Continuous compliance with these standards is critical to protecting patients and dental healthcare personnel and to maintaining public trust in dental services. The evolving nature of infectious threats, as demonstrated by the COVID-19 pandemic, underscores the need for adaptive, evidence-based infection control strategies that can respond effectively to new challenges. Ongoing research is essential to strengthen the evidence base for dental-specific infection control interventions, particularly in areas such as aerosol management and engineering controls. In parallel, policy updates and sustained investment in education, infrastructure, and public health integration will be necessary to ensure that infection control practices in dentistry remain effective, resilient, and aligned with future healthcare needs.

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