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Review Article

The impact of COVID-19 on infection control practices in dentistry: adaptations and challenges: a literature review

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ABSTRACT

COVID-19, which emerged in late 2019, has significantly affected global health and daily life, particularly in clinical settings due to its high transmissibility. This necessitated rapid adaptations in infection control measures to protect patients and healthcare providers. This literature review synthesizes studies on the impact of COVID-19 on dental infection control, highlighting the adaptations and challenges faced by practitioners during this period. A comprehensive search strategy was employed, utilizing databases such as PubMed, Scopus, and Web of Science to identify relevant studies published from 2020 to 2024. Inclusion criteria encompassed articles discussing infection control protocols and adaptations in practice. Studies show a shift to stricter personal protective equipment (PPE) use, including N95 respirators and face shields, despite shortages and limited training. High-risk aerosol-generating procedures (AGPs) led to research on reducing aerosol production through high-volume suction and rubber dams. Patient screening and triage became essential, while telehealth facilitated remote consultations. Environmental controls emphasized better ventilation, air filtration, and effective disinfectants like high efficiency particulate air (HEPA) purifiers. Overall, dental practices adapted to COVID-19, accelerating teledentistry to enhance accessibility and reduce infection risks. The COVID-19 pandemic necessitated major changes in dental infection control practices, enhancing PPE use, aerosol management, patient screening, and environmental controls, despite challenges. Teledentistry emerged as valuable for remote care but faces integration barriers. Future research should address these challenges, establish standardized protocols, and assess the long-term effects on infection control.

Keywords: COVID-19, Infection control, Aerosol, PPE, Teledentistry

INTRODUCTION

Importance of infection control in dentistry and traditional practices

Infection prevention is crucial for patient safety, requiring practitioners to establish, update, and monitor protocols to address blood-borne diseases and contagious illnesses.[1] Traditional infection control includes hand hygiene, PPE and instrument sterilization.[2] The world dental federation (FDI) notes that new technologies and data require ongoing updates to infection control practices.[3]

Enhanced PPE and advanced disinfection methods, like N95 respirators, vaporized hydrogen peroxide (VHP), and ultraviolet-C (UVC) light, are crucial for controlling infections and preserving PPE for reuse.[4,5] EPA-registered disinfectants, like sodium hypochlorite, are recommended for surfaces, especially in blood-contaminated areas.

Disinfectant fogging may be used in high-risk areas but isn't routine.[2]

COVID-19 pandemic and its potential impact on infection control practice

The COVID-19 pandemic, caused by the SARS-CoV-2 coronavirus from a family of respiratory disease viruses, has origins that are vital for public health responses and vaccine development. The first human cases reported in Wuhan, China, in December 2019.[6] COVID-19 impacted health, economies, education, and daily life, causing symptoms from mild respiratory issues to severe complications, especially in older adults and those with underlying conditions. Public health responses included testing, quarantine measures, and vaccine development to control the virus's spread.[7]

Dental care workers are at high risk for COVID-19 due to in-person patient interactions and routine procedures, increasing their exposure to the virus, thus the universal standard precaution is to assume that all patients are carriers of infectious agents.[8] Dental healthcare practitioners also are expected to adhere to all the required precautionary measures.[9] The COVID-19 pandemic has posed challenges in dentistry, necessitating new guidelines to prevent contagion. Patient visits dropped significantly as many avoided non-urgent procedures due to fears of infection, leading to a decline in dental services.[10]

Strict infection control measures, including enhanced disinfection, PPE, and aerosol reduction, were implemented. SARS-CoV-2 persistence on surfaces required thorough cleaning. Dentists prioritized emergencies while balancing ethical dilemmas. Updated guidelines were essential to address these challenges.[11] Clear communication of infection control measures is crucial for patient trust and compliance. Transparency in sharing evidence-based information boosts satisfaction and cooperation with safety protocols.[12]

OBJECTIVES

General objectives were to synthesize existing studies on COVID-19's impact on dental infection control practices

Specific objectives were to identify and evaluate key adaptations made in infection control practices due to COVID-19 and to analyze the challenges faced by dental practices during the pandemic.

LITERATURE REVIEW

To develop this literature review, a comprehensive search was conducted using databases such as PubMed, Scopus, Cochrane Library, and Google Scholar. Keywords used included: “COVID-19” OR “SARS- CoV- 2” OR “coronavirus” AND “infection control” AND “aerosol” AND “PPE” AND “dental care adaptations” AND “infection control” AND “teledentistry”. The search was limited to articles published between 2020 and 2024 (or before if they provide foundational knowledge for pre-pandemic infection control standards) which were reviewed to understand the most recent findings. Studies included are those focused on infection control practices in dental settings, especially in the context of COVID-19 and articles presenting new infection control guidelines, challenges, or adaptations specific to dental care.

CHANGES IN PPE

Tian et al reviewed studies on PPE for healthcare workers (HCWs) exposed to infectious diseases. It was found that more body coverage and proper donning and doffing techniques enhance protection. Higher-level masks, like N95 respirators, are essential to safeguard HCWs from coronavirus infections.[13]

Infection control challenges in dentistry due to aerosols were highlighted by Peng et al N95 respirators, face shields, gowns, and gloves were mandated for aerosol procedures, replacing surgical masks, which were insufficient for virus prevention. Stricter protocols were widely adopted in dental practices.[14]

Another study by Vogt et al assessed PPE use among 70 dental practitioners in Washington, finding 86% had prior training, mostly on the job. N95 respirator use rose, with 87% following CDC guidelines, but glove and gown access were limited. A tailored video on PPE donning improved compliance.[15]

The severe shortage of PPE during the COVID-19 pandemic was discussed by Mandrola warning that it could lead to healthcare worker deaths. The article emphasizes PPE's critical role in protecting medical professionals and highlights the urgent need to resolve the shortage to prevent further loss of life among frontline responders.[16]

In Russia, Dyer highlighted rising COVID-19 cases in Russia and the severe PPE shortages faced by HCWs, leading to higher infection and fatality rates among frontline staff. This raised concerns about the healthcare system's preparedness.[17]

Ranney et al addressed critical shortages of ventilators PPE in healthcare systems during the COVID-19 pandemic. It was emphasized that increased production and coordinated distribution efforts among governments, manufacturers, and healthcare facilities are needed to effectively address these shortages.[18]

Park et al analyzed the global PPE shortage during the COVID-19 pandemic, citing supply chain disruptions due to increased demand, production restrictions, export limitations, and logistical issues. They emphasized the need for improved supply chain resilience, increased domestic production, and better policy coordination. The

study suggested strategic stockpiling and equitable distribution measures to mitigate future PPE shortages.[19]

COVID-19's impact on PPE supply in Spanish hospitals was examined by Morales-Contreras et al noting challenges like shortages and price volatility. Strategies included diversifying suppliers and improving supply chain flexibility, stressing the need for better preparedness and procurement policies.[20]

Similarly, Best and Williams highlighted PPE supply chain challenges during pandemics, emphasizing procurement disruptions from global demand surges. The study called for better leadership, planning, and partnerships to build resilient supply chains and prevent future shortages.[21]

Mehrotra et al analyzed PPE shortages during COVID-19, citing supply chain disruptions, demand surges, and production limits. Mitigation strategies included diversifying supply chains, boosting domestic production, and improving international coordination. Enhanced resource planning was emphasized for future preparedness.[22]

AGPS

Virdi et al reviewed the debate on AGPs in dentistry, assessing their risks during COVID-19. The study highlighted the need for clear guidelines and consensus on AGP definitions to improve safety protocols and risk management in dental practices.[23]

A systematic review was conducted by Innes et al on droplet and aerosol generation in dentistry during the COVID-19 pandemic. The study identified procedures that produce aerosols, analyzed their spread and size, and emphasized enhanced protective measures like better ventilation and PPE. It called for updated infection control guidelines to protect against airborne pathogens in dental setting.[24]

Meethil et al identified saliva and respiratory secretions as primary sources of SARS-CoV-2 and other microorganisms in dental aerosols. The study highlighted that while SARS-CoV-2 can be present in these aerosols, effective infection control measures can reduce transmission risks, emphasizing the need for stringent protective protocols during AGPs in dental practices.[25]

Similarly, Han et al found that dental procedures generate significant splatter and aerosols, posing contamination risks for pathogens like SARS-CoV-2. The study stressed the need for proper ventilation and PPE to reduce these risks.[26]

De Almeida et al found that hand instrumentation in rats led to less inflammation and better healing than ultrasonic scalers, suggesting it as a safer and more effective method for dental procedures.[27]

Interventions to reduce contaminated aerosols during dental procedures were evaluated by Kumbargere Nagraj et al The study concluded that high-volume suction, rubber dams, and proper ventilation significantly lowered aerosol contamination. These findings emphasized the importance of these measures in enhancing infection control and minimizing disease transmission in dental practices.[28]

Chestsuttayangkul et al studied the efficacy of dental barriers, like rubber dams and suction devices, in reducing aerosols and splatter during ultrasonic scaling. The findings showed significant reductions in both, highlighting the need for effective protective measures to enhance infection control and safeguard patients and HCWs.[29]

On the other hand, Malmgren et al investigated high-volume evacuation systems and found they significantly reduced viral aerosol spread during dental procedures, enhancing safety. The study concluded that these systems are essential for infection control, especially during aerosol-generating treatments.[30]

PATIENT SCREENING AND TRIAGE

Widyarman et al surveyed Indonesian dental practitioners about pre-treatment screening during COVID-19. They found that temperature checks and health questionnaires were widely used to reduce infection risks. However, challenges like limited resources and inconsistent procedures were noted, highlighting the need for standardized protocols to improve safety in dental settings.[31]

The challenges dentistry faced during COVID-19 were discussed by Kalenderian et al focusing on patient safety and adapting infection control protocols. They emphasized the importance of PPE, modified practices, and patient screening while highlighting opportunities for improved care through telehealth and innovation. The study stressed the need for flexibility and preparedness in dental practices during public health crises.[32]

Chandler found that COVID-19 infection rates among dentists were significantly lower than those of other healthcare professionals, highlighting the effectiveness of enhanced infection control measures. The study emphasized the success of PPE usage, stringent sanitation, and patient screening in preventing virus spread in dental settings.[33]

Emergency dental care triage during COVID-19 was explored by Ball et al focusing on managing emergencies while minimizing virus transmission.

Strategies included prioritizing urgent cases and using remote consultations. Strict infection control protocols and reduced patient contact effectively lowered clinic patient flow and ensured safer emergency care delivery.[34]

Another study by Ostrc et al investigated urgent dental care during COVID-19, implementing strategies to prioritize urgent cases while ensuring safety. Triage protocols managed patient flow and reduced virus transmission risks. The findings highlighted the need for effective communication and coordination among dental professionals to balance urgent care with safety measures.[35]

ENVIRONMENTAL CONTROLS

Ventilation systems in dental clinics during COVID-19 was examined by Plaza-Ruiz et al finding that proper airflow is vital for reducing airborne pathogens like SARS-CoV-2. The study emphasized the need for adequate ventilation, filtration, and maintenance to prevent infections, highlighting the necessity for further research on effective air management in dental settings.[36]

Capparè et al studied the effectiveness of a HEPA 14 air purifier during dental procedures amid COVID-19. The trial found that the device significantly reduced aerosol concentration, enhancing infection control. The study concluded that HEPA 14 filters improve air quality and lower contamination risks in dental settings.[37]

A systematic review on the effectiveness of portable HEPA purifiers in eliminating airborne SARS-CoV-2was conducted by Liu et al. The analysis confirmed that HEPA purifiers significantly reduced airborne viral particles, suggesting they are valuable for mitigating virus spread in healthcare and public settings.[38]

Similarly, Sheraz et al reviewed airborne transmission of SARS-CoV-2, assessing environmental factors like ventilation and air circulation. The study highlighted the effectiveness of HEPA filter air purifiers in reducing airborne viral load, concluding that proper use of air purifiers can significantly lower the risk of indoor virus transmission.[39]

Motwani et al examined disinfection measures for dental operatories during COVID-19, emphasizing enhanced infection control protocols to reduce virus transmission. The study discussed various disinfection strategies, including chemical agents, and cleaning practices, concluding that adherence to these measures is vital for ensuring safety in dental settings.[40]

Similarly, Stawarz-Janeczek et al investigated disinfectants used in stomatology and their effectiveness against SARS-CoV-2. The study emphasized the importance of selecting appropriate chemical agents to reduce viral transmission in dental practices and highlighted the need for protocols that ensure safety for both patients and staff.[41]

Huang et al investigated the effects of dry hydrogen peroxide treatment on the decay of SARS-CoV-2 on non-porous hard surfaces. It was demonstrated that this treatment significantly accelerated the virus's decay compared to untreated surfaces. It was concluded that dry hydrogen peroxide could be an effective method for enhancing surface disinfection protocols in infection control settings and potentially can be used for managing SARS-CoV-2 contamination.[42]

The virucidal activity of four disinfectants against SARS-CoV-2 was evaluated by Huang et al finding all tested disinfectants effectively neutralized the virus on surfaces, albeit with varying effectiveness. The study highlighted the importance of selecting appropriate disinfectants to reduce the spread of SARS-CoV-2 in healthcare and community settings.[43]

TELEDENTISTRY AND REMOTE CARE

Ghai highlighted teledentistry's role during COVID-19 in maintaining dental care while reducing transmission risks. Digital consultations ensured ongoing patient care and promoted technology integration in dental practice.[44]

Talla et al emphasized the integration of teledentistry with traditional care post-COVID-19, highlighting remote consultations' role in maintaining patient care. A hybrid approach was deemed essential for adapting to the new clinical environment.[45]

Hung et al reviewed teledentistry during COVID-19, finding it improved care access and reduced infection risk but faced challenges like tech issues and limited training. Recommendations for improving practices were included.[46]

Özveren et al evaluated teledentistry knowledge among dentists and patients in Turkey. Moderate awareness was found in both groups (dentists were more familiar). The study highlighted teledentistry's potential to enhance dental care accessibility in underserved areas but emphasized the need for increased education and technological support to maximize its benefits.[47]

Tan et al conducted a scoping review on teledentistry adoption among older adults, identifying facilitators like improved accessibility and convenience, alongside barriers such as limited technological literacy and concerns about care quality. Recommendations included enhancing technology education and improving infrastructure to promote wider teledentistry use in this population.[48]

Indonesian dentists' perceptions of teledentistry were investigated by Soegyanto et al noting their potential to improve patient care access during the COVID-19 pandemic. Barriers like technological limitations, lack of training, and data security concerns were identified. Many dentists saw teledentistry as a useful complement to traditional care, but broader adoption needs better infrastructure and training.[49]

Maqsood et al surveyed 506 dental professionals about teledentistry, finding that 50-75% viewed it positively for improving practice and reducing costs. However, 50-70% had concerns about data security and patient consent, preferring videoconferencing for communication. Despite the positive perception, significant integration challenges, particularly in developing countries, were noted.[50]

DISCUSSION

First: changes in PPE requirements

COVID-19 led to significant changes in PPE use in dentistry, with full-body PPE and N95 respirators becoming essential to reduce infection risk.[13] Stricter protocols, including face shields, gowns, and gloves, were widely adopted.[14] PPE shortages, particularly gloves and gowns, were challenges, though educational videos improved compliance and confidence.[15]

The COVID-19 pandemic exposed major vulnerabilities in PPE availability, increasing infection risks for healthcare workers. Hospital administrators often downplayed shortages, leading to underreporting.[16] In one study, these shortages contributed to higher infection and mortality rates among healthcare professionals.[17] The focus was on boosting production and coordinating distribution to meet unprecedented PPE demand for public health protection.[18]

PPE shortages during the pandemic were caused by global supply chain disruptions, increased demand, and production restrictions, highlighting the need for resilient supply chains and domestic production.[19] Spanish hospitals faced similar challenges, with decision-makers grappling with volatile prices and limited supply options.[20] Strategic partnerships, contingency planning, and diversification of supply chains were emphasized to prevent future shortages.[21,22] Overall, the pandemic underscored the critical need for better preparedness and coordinated efforts to ensure adequate PPE availability during health crises.

Aerosol generating procedures

AGPs in dentistry pose significant infection risks during COVID-19, underscoring the need for clear guidelines to classify and manage these risks.[23] Variability in aerosol and droplet production during dental procedures underscores the importance of enhanced ventilation and PPE.[24] Saliva and respiratory secretions are key contributors to aerosol contamination, but strict infection control measures can mitigate these risks.[25] Additionally, the potential for high contamination during AGPs emphasizes the necessity of protective protocols to reduce transmission.[26]

Efforts to reduce AGP risks have led to modifications, with hand instrumentation proving to yield better tissue outcomes than ultrasonic scaling, making it a safer option.[27] **Error! Bookmark not defined.** Additionally, high-volume s uction, rubber dams, and improved ventilation effectively minimize aerosol contamination.[28] The use of dental barriers has also been supported to reduce aerosols, while high-volume evacuation systems play a crucial role in significantly lowering viral aerosol spread.[29,30]

Patient screening and triage

Pre-screening protocols, including temperature checks and health questionnaires, were vital during COVID-19 to reduce infection risks in dental practices, despite challenges from inconsistencies.[31] Adaptation to evolving protocols, such as screening, PPE, and telehealth, was essential for flexibility in public health crises.[32] These measures led to lower infection rates among dentists compared to other healthcare professionals, attributed to strict screening and infection control practices.[33]

Triage systems during the pandemic were essential for managing dental emergencies and minimizing virus transmission, prioritizing urgent cases, and utilizing remote consultations to reduce in-office visits.[34] Effective communication and coordination in managing patient flow during urgent care were emphasized. These approaches ensured that dental practices could balance emergency care needs with infection control protocols.[35]

Environmental control

Ventilation and air purification systems are crucial for reducing airborne pathogen transmission in dental settings. Adequate airflow and filtration are essential for controlling infections like SARS-CoV-2, although further research on air management is needed.[36] The use of HEPA 14 filters has been shown to significantly reduce aerosol concentrations during procedures.[37] Additionally, portable HEPA purifiers have been confirmed to effectively lower airborne viral particles, supporting their role in infection control in enclosed environments.[38,39]

Enhanced surface disinfection protocols have been crucial in minimizing virus transmission in dental clinics. Two studies emphasized the need for proper selection and use of disinfectants, demonstrating their importance for maintaining a safe environment.[40,41] Innovative disinfection methods like dry hydrogen peroxide and effective chemical disinfectants accelerate viral decay and reduce surface contamination risks, highlighting the importance of selecting effective disinfectants to control SARS-CoV-2 in healthcare settings.[42,43]

Teledentistry and remote care

Teledentistry has benefits but poses challenges for older adults, particularly in technology use and device access. Enhanced education and infrastructure are needed to improve accessibility.[44] It offers a hybrid approach, blending remote and in-person visits, essential for adapting to the post-pandemic dental landscape.[45] Studies

noted its effectiveness in reducing infection risk and improving patient management, despite challenges like technological barriers and training.[46] Moderae awareness of teledentistry was found among Turkish dentists and patients, (more in dentists). This underscores teledentistry's potential to enhance accessibility in underserved areas, highlighting the need for further education and support.[47]

Teledentistry offers advantages but faces challenges for older adults, particularly in technological literacy and device access. Enhanced education and improved infrastructure are needed to expand its reach.[48] in one study, dentists acknowledged the potential of teledentistry but encountered obstacles like inadequate training and concerns over data security.[49] Likewise, while 50-75% of surveyed dental professionals in one study viewed teledentistry positively, significant concerns regarding data security and patient consent persisted.[50]

CONCLUSION

The COVID-19 pandemic has transformed dental practices, requiring enhanced infection control measures for patient and practitioner safety. Key changes included strict PPE protocols, recognizing AGPs as high-risk, and implementing effective patient screening and triage systems. The pandemic exposed vulnerabilities in PPE availability due to supply chain disruptions, underscoring the need for better preparedness and resource management. Teledentistry also emerged as a vital tool for maintaining care, though challenges like technological literacy and data security remain.

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