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The Role of Dentists in the Fight Against Infectious Diseases

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ABSTRACT

The article examines the role of dentists in the fight against infectious diseases. It is determined that infection control in dentistry is an ever-growing concern. Dental patients are at high risk in terms of their ability to transmit as well as acquire an infectious disease. No less worrying is the cross-infection and transmission of the disease from patient to patient. When solving these problems, it is necessary to determine how the dentist and his staff can be protected from infection and transmission of the disease to patients and what steps should be taken to minimize cross-contamination with instruments.

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INTRODUCTION

There are two obvious considerations when solving the problems of cross-infection and transmission of the disease from patient to patient: how the dentist and his staff can be protected from infection and transmission of the disease to patients and what steps should be taken to minimize cross-contamination with instruments.[1]

Due to the nature of dental procedures, contact with blood and saliva aerosols is unavoidable. Direct contact with liquid-contaminated environmental surfaces, tools and equipment is also a potential source of pathogen transmission. In dental practice, the dentist, dental assistant, maintenance and service personnel, as well as patients are at risk of transmission of infection. Thus, step-by-step infection control measures are needed to reduce the risk of transmission of infections in dental practice.

KEYWORDS:
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MATERIALS AND METHODS

To write the article, an array of literature covering the issues of infection control in the practice of dentists was analyzed, comparative as well as analytical research methods were used in the process of work.

RESULTS

Healthcare workers are at the forefront of the COVID-19 outbreak, at a marked risk of infecting by the virus. However, the specific characteristics of the dental unit expose practicing dentists (dentists, assistants and hygienists) and their patients to a high risk of cross-infection, especially through the transmission of respiratory infectious diseases, for example, recently caused by SARS-CoV. Moreover, WHO highlighted concerns about safe dental practice when it ranked oral care practitioners at "very high risk of exposure" to SARS-CoV-2. Thus, the COVID-19 outbreak has shown that disease prevention through transmission-based measures is crucial[2]

Many factors are involved in cross-transmission. Microbial species, virulence, risk of transmission, region of exposure and frequency of exposure are the main factors influencing infecting with a disease. In addition, these factors combined can increase the risk of infection for both patients and oral care professionals, since they can be a host/reservoir of pathogenic and non-pathogenic microorganisms.[1]

Saliva, respiratory secretions, and respiratory droplets are ejected during coughing, sneezing, and talking, which represent important pathways for the spread of SARS-CoV-2 worldwide. Aerosols are fine particles suspended in the air, which can exhibit different characteristics depending on humidity, airflow and temperature. As for the size of aerosols, they can vary from droplets (> 5 microns) to droplet germs (1-5 microns). It is claimed that these very small particles remain suspended in the air for several hours, are transported over long distances and pollute surfaces at a distance of up to 1 m. In addition, SARS-CoV-2 virus can remain viable even after 24-72 hours, depending on the surface of the material.[4]

In dental institutions, the transmission of microorganisms can occur in the following ways: direct contact, blood-blood contact or water of the dental unit and aerosols. For SARS-CoV-2, the most common route of transmission is inhalation of droplets or aerosols from infected people.

A general dental practice that predisposes oral care practitioners to infection: saliva, blood, aerosol/droplets, and infected instruments. In addition, many procedures with the formation of aerosols are performed using high-speed and low-speed tips, ultrasonic scalers and air-water syringes. Consequently, these procedures can lead to the spraying of saliva and/or blood and the spread of infectious agents in dental offices. It is important to take into account that ACE2-positive epithelial cells from the ducts of the salivary glands are potential targets for SARS-CoV-2, which suggests that the salivary glands may behave as reservoirs of infection, and saliva as a source of virus spread.

Aerosol plays a crucial role in airborne infections and should be avoided, especially right now. In addition, during the outbreak of SARS-CoV-2, auxiliary approaches to biosafety should be used, such as: individual dental biosafety barrier and rabberdam in addition to performing minimally invasive procedures that can reduce aerosol formation, pathogenicity and spread. In addition, during the procedures, along with the usual aspiration, an ultra-high volume of aerosol and spray suction should be used.

Biosafety protocols have been revised to reduce the risk of transmission of COVID-19 to patients and dental staff. It was necessary to carry out protective measures before, during and immediately after dental care. Current protocols recommend initial phone screening to identify patients with suspected or symptoms consistent with COVID-19 infection and, in positive cases, avoid emergency dental care. Everyone who enters a dental facility should be screened for fever and COVID-19 symptoms or contact with people with SARS-CoV-2 infection.[5]

Physical distancing should be taken in waiting rooms and in the dental office, where only the operator and the assistant are within six feet of the area of formation of the therapeutic aerosol. Dentists should minimize the formation of aerosols through the use of hand tools, cofferdam, high-volume aspiration, as well as make extraoral radiographs, since intraoral ones can cause coughing. It is advisable to conduct dental practice with preventive and/or minimally invasive access.

During aerosol-generating procedures, dental personnel should use an N95 respirator or a respirator providing an equivalent or high level of protection, a full-face shield, safety glasses, a bathrobe or protective clothing and gloves. Proper cleaning and disinfection of the premises (including the waiting room), as well as the change of protective barriers after each patient should be ensured.[6]

Removal of personal protective equipment (PPE) should be carried out in the following correct order: remove gloves, bathrobe or protective clothing, the patient should leave the ward or care area, wash his hands, remove eye protection and surgical mask or respirator, and perform hand hygiene. However, even if all biosafety measures are observed, SARS-CoV-2 can remain in the air, putting the dental team at risk after the removal of the PPE and the following patients.

In case of emergency dental care to a patient with COVID-19 or suspected of it, in addition to the above-mentioned assistance, dental treatment should be provided in a separate room with a closed door. Since it is impossible to completely avoid the formation of aerosols, the procedure should ideally be carried out in an isolation ward for airborne infections, and a limited number of people participate in it. In addition, it is important to schedule a patient appointment at the end of the day and not schedule other patients at this time.

DISCUSSION

Taking into account the nature of dental procedures, which often require irrigation of the oral cavity and the use of high-speed tips and ultrasonic scalers, the probability of the spread of oral microbiota on the surface and through aerosols is high. In addition, since SARS-CoV-2 has been shown to be carried in high titers in saliva in both symptomatic and non-symptomatic individuals, the risk of cross-infection in dental clinics is of serious concern. There are several biophotonics approaches that have been demonstrated to effectively disinfect surfaces and aerosols in clinical settings.

Ultraviolet C (UVC; wavelength 100-260 nm), which has strong microbicidal properties, was a particularly effective approach to decontamination of patients' wards.[7]

In one study, it was found that after applying UV radiation using a mobile UV device, the risk of positive microbial culture in patients' wards decreased by 88%, which indicates the effectiveness of UV radiation for disinfection purposes. This conclusion was confirmed by other authors who found that 99.9% of bacteria can be destroyed in patients' wards within 5 minutes after applying UV radiation. The authors of both studies argued that "shading" could be a mitigating factor that could reduce the effectiveness of UV radiation, however, they acknowledged that the use of reflective UV paint could improve the overall exposure area. It is important to note that the use of UFS has also been approved for use against SARS-CoV-2. For example, one group of authors determined that a low dose of UVC 3 MJ/cm2, reflecting an exposure time of 30 s, was enough to reduce the viability of SARS-CoV-2 by 99.7%. Taken together, these results strongly suggest that UVC can be an effective biophotonics approach to surface disinfection in high-risk dental clinics.

Some studies also suggest that UVC may be a possible approach for the disinfection of SARS-CoV-2 in aerosols. For example, another group of authors determined that the UVC can inactivate 99.9% of seasonal coronaviruses in the air. Although they did not directly evaluate the effectiveness against SARS-CoV-2, the authors were confident that due to the genomic similarity between seasonal coronaviruses and SARS-CoV-2, this method would be equally effective.

As an alternative biophotonic approach to UVC, antimicrobial blue light (aBL; wavelength 405 nm) attracts attention because of its inherent antimicrobial properties. The dominant mechanism of antimicrobial effects mediated by aBL is the photoexcitation of endogenous porphyrins, which induce the production of reactive oxygen species (ROS). In dentistry, aBL has been shown to be a potentially effective approach to the treatment of gingivitis and periodontal diseases, as evidenced by in vitro assessments, as well as clinical studies.[8]

In fact, aBL has also been used as a disinfection method in hospitals, which may indicate that it may be a viable approach for disinfection of dental clinics. In the study, individual authors found that 7-day exposure at very low light aBL (0.0096 MW/cm2 – 0.2310 MW/cm2) on all surfaces present in the hospital ward resulted in an average decrease in viability by 60%, with some surfaces being completely decontaminated. These findings suggest that aBL may be a potential approach for decontamination of dental clinics.

Unlike UVC, inactivation of microbes requires a significantly higher radiation exposure, but the advantage of aBL is that it is not toxic to mammalian tissues even with strong radiation exposure. Therefore, it is possible that aBL may be present even during procedures in dental clinics to limit contamination of surfaces and air.

The literature on the effectiveness of aBL against viruses is limited, and to date there is no evidence that aBL will be effective in inactivating SARS-CoV-2. However, a recent study found that SARS-CoV-2 requires porphyrins, which it receives from hemoglobin, which leads to disruption of heme metabolism. This hypothesis has been called into question by in silico analyses, and therefore experimental evidence is still required to confirm it. However, if SARS-CoV-2 does lead to the accumulation of porphyrins in the host body, it is possible that aBL can inactivate SARS-CoV-2. However, with regard to decontamination from surfaces, since there will be no interaction with host cells, it is difficult to predict the potential effectiveness of aBL against SARS-CoV-2 on surfaces or in aerosols.

Despite the proven effectiveness of UV radiation to fight pathogens, the safety of UV radiation still deserves attention, since its use can cause undesirable side effects, including skin damage and eye diseases. Thus, recommendations on the safety of UV-based approaches are needed to ensure its general use for the control or prevention of SARS-CoV-2 and other infections.[9]

Low-power lasers are widely used in dentistry to modulate the inflammatory process, analgesic effect and accelerate the healing process of soft and hard tissues of the oral cavity. It is also used in the treatment of a number of pathologies without causing a thermal reaction and mutagenic effects. The mechanisms of low-intensity lasers are based on photobiomodulation of intracellular compounds.

Photobiomodulation is described as a simple, effective and inexpensive method of treating acute and chronic pain. Light of a certain wavelength penetrates into tissues and is absorbed by mitochondrial photoreceptors, which activate chemical reactions that lead to increased adenosine triphosphoric acid synthesis, promoting tissue regeneration, for example, in the nerves of the skin, muscles, bones and peripheral nerves.

Photobiomodulation, provided by the use of low-intensity lasers, can be used in various clinical conditions of the oral cavity, including anesthesia in orthodontics, mitigation of aphthous ulceration, treatment of dentin hypersensitivity, as well as prevention and mitigation of the consequences of cancer with radio and chemotherapy, oral mucositis associated with therapy, is among others. In addition, low-level lasers can affect muscle relaxation and adaptation of the temporomandibular joint to improve the quality of life during orthodontic/orthopedic treatment and for immediate relief in a stressful situation of muscle contraction or even headaches due to malocclusion, lymphatic drainage to accelerate recovery processes, as well as to reduce episodes of pain in the cases of trigeminal neuralgia and restorations made of composite materials.

Photobiomodulation usually uses low-intensity light exposure (energy density in the range of 1-100 MW/cm2) for several minutes in this way, taking into account many possibilities, including during a pandemic outbreak.

It has been reported that patients with a positive result for COVID-19 may have oral lesions, such as aphthous ulcers, erythema and herpes. In the same study, it was reported that more than 78% of patients infected with COVID-19 had any oral lesions. In this context, combined phototherapy approaches were used to treat oral lesions associated with COVID-19. The use of photobiomodulation is claimed even in severe cases of acute respiratory distress syndrome in patients infected with COVID-19. Clinical results associated with the use of photobiomodulation showed successful healing of oral lesions in a few days. These benefits seem to be related to the ability of photobiomodulation to reduce or inhibit important substances involved in pain and inflammatory processes, which leads to accelerated healing and improved quality of life of patients.

Researchers report that photobiomodulation can significantly reduce the production of pro-inflammatory cytokines and some interleukins, reducing inflammatory processes, regenerating damaged tissues and balancing the immune system.

Moreover, during the outbreak of the pandemic, people with a positive diagnosis or suspected COVID-19 experienced severe psychological pressure. In addition, people who are quarantined, performing social isolation, restricted in travel, worried about infection, afraid of death, having no information and having lost everyday social connections, may experience a high level of anxiety and depression in the future. Since psychological factors are associated with the development of disorders, including temporomandibular disorders, low-power lasers can help control and minimize symptoms of temporomandibular disorders, especially during a pandemic outbreak.[10]

High-level lasers are used to quickly and effectively eliminate complications on soft tissues during bloodless and atraumatic surgical interventions. The main indication for high-level lasers in soft tissues is based on operations such as gingivectomy, ulectomy, frenectomy and fibrotomy. The advantages of using high-level lasers for oral soft tissue surgery include better hemostasis, reduced postoperative pain and infection rate, minimal tissue reduction, low need for sutures or lack thereof, short surgical stages, reduced injuries, swelling and scarring, in addition to reducing the need for local anesthetics. Since powerful lasers act by increasing the temperature, their use also has the advantage of disinfecting the irradiated area. Thus, there is a high probability that the process of tissue repair proceeds without the presence of infection in the surgical wound.

Lasers used to affect hard tissues act through ablation, a mechanism in which laser energy is absorbed by water and the hydroxyl group in hydroxyapatite, causing rapid heating and swelling, resulting in high internal pressure, which leads to the removal of the substrate by micro-explosions. The preparation of the cavity with a high-level laser allows you to preserve the tooth structure as much as possible, reduce the need for anesthesia with additional characteristics that make enamel, dentin and cement more resistant to the acidic effects of bacteria.

One of the published reviews showed that the use of a high-level laser is considered minimally invasive and demonstrates superior advantages over a conventional scalpel, such as reducing bleeding, inflammation, and the postoperative period - surgical pain and less chance of scarring. These reports are in line with recommendations to minimize the risk of SARS-CoV-2 cross-infection, as high-level lasers allow dentists to quickly perform procedures that require shorter surgery time, as well as fewer follow-up examinations and patient visits. In addition, high-level lasers can work with reduced water splashing, reducing aerosol formation, which can help avoid or minimize cross-infection in dental settings.

Antimicrobial photodynamic therapy (aFDT) mainly consists in the interaction between the three components, which leads to photophysical and chemical reactions responsible for the production of reactive oxygen species (ROS) with a high oxidative capacity of cellular components, causing cell damage.[11]

The use of aFDT as an alternative method of disinfection of the oral cavity, treatment of pneumonia and/or respiratory tract infections, as well as against enveloped viruses such as SARS-CoV-2, has proven its effectiveness. In addition, aFDT can be an effective method against SARS-CoV-2 due to the formation of reactive oxygen species (ROS), which can damage viruses and prevent the penetration of microorganisms into the body.

Thus, in order to promote the safety of all dentists, combining other protocols with aFDT can be a useful method of preventing COVID-19 infection in a dental facility.

CONCLUSION

The outbreak of SARS-CoV-2 forcibly changed dental practice and biosafety measures due to the high risk of infection by oral health practitioners. Aerosol-forming procedures are commonly used in dental practice and can be an important route of transmission and spread of the virus. In this context, it was stated that light-based approaches reduce the number of microorganisms, disinfect surfaces, air, tissues, as well as the formation of aerosols and the spread of viruses. At the same time, such approaches are mainly minimally invasive, time-saving and alternative methods that can help dentists fight or avoid infection with SARS-CoV-2 and ensure the safe provision of dental care to patients.

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