Central Asian Research Journal For Interdisciplinary Studies (CARJIS). ISSN (online): 2181-2454
Volume 4 | Special Issue | September, 2025 | SJIF: 5,965 | UIF: 7,6 | ISRA: JIF 1.947 | Google Scholar |
https://carjis.afu.uz/

UDK:-614.48:616.31:001.891

THE SUITABILITY OF APPLYING METHODS TO DECREASE A BIOAEROSOL CLOUD'S DISTRIBUTION AT A DENTIST (review article)

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Abstract:

The transmission of germs in dental settings has now been the subject of numerous research publications. The patient's oral cavity, which is home to a variety of bacteria and fungus, is where a dentist performs their direct job. A specific quantity of bacteria settles on the surface of dental office equipment, and microbial aerosol builds up around the patient and dentist during professional oral hygiene, caries treatment, and other dental treatments. Medical personnel's health is at risk from this type of bacterial, protozoan, and fungal seeding since it may result in the emergence of an infectious process. This is particularly important in light of the COVID-19 pandemic at the moment. Wearing personal protective equipment, like as masks, gloves, screens, and helmets, is essential because it lowers the risk of infection for both the patient and the physician. Several research have been conducted to lessen the transmission of harmful bacteria. One of these studies focused on patients using antiseptic rinses prior to dental procedures, which lowers the quantity of microorganisms in the patient's oral cavity. Moreover, bactericidal lamps are required in the doctor's office to purify the air; ventilation is a vital defense against the growth of bacteria. The bioaerosol cloud is less likely to spread when a vacuum cleaner, saliva ejector, and other intraoral suction tools are used.

Keywords: personal protective equipment, bioaerosol cloud, and antiseptic rinses.

Аннотация

В настоящее время опубликовано множество научных работ, посвященных распространению микроорганизмов в стоматологических учреждениях. Непосредственная работа стоматолога проводится в ротовой полости пациента, которая является домом для различных видов бактерий и грибов. Во время профессиональной гигиены полости рта, лечения кариеса и других стоматологических процедур вокруг пациента и стоматолога накапливается микробный аэрозоль, и определенное количество микроорганизмов оседает на поверхности оборудования стоматологического кабинета. Такое обсеменение бактериями, простейшими и грибами угрожает здоровью медицинского персонала, поскольку может привести к возникновению инфекционного процесса. Это особенно актуально в настоящее время в связи с пандемией COVID-19. Крайне важно использовать средства индивидуальной защиты, такие как маски, перчатки, защитные экраны и шапочки, поскольку это снижает риск заражения различными инфекциями как для пациента, так и для врача. Было проведено несколько исследований, направленных на уменьшение передачи вредных бактерий. Одно из таких исследований было посвящено использованию пациентами антисептических ополаскивателей перед стоматологическими манипуляциями, что снижает количество микроорганизмов в полости рта пациента. Кроме того, в кабинете врача необходимы бактерицидные лампы для очистки воздуха; проветривание является жизненно важным средством защиты от скопления микроорганизмов. Распространение

биоаэрозольного облака уменьшается при использовании пылесоса, слюноотсоса и других внутриротовых аспирационных устройств.
Ключевые слова: средства индивидуальной защиты, биоаэрозольное облако, антисептические ополаскиватели. индивидуальной защиты, биоаэрозольное облако, антисептические ополаскиватели.

Annatatsiya:

Hozirgi kunda stomatologik sharoitlarda mikroorganizmlarning tarqalishi bo'yicha ko'plab ilmiy ishlar nashr etilgan. Stomatologning bevosita ishi bemorni og'iz bo'shlig'ida amalga oshiriladi, bu yerda turli xil bakteriyalar va zamburug'lar mavjud. Professional og'iz gigiyenasi, kariesni davolash va boshqa stomatologik muolajalar paytida shifokor va bemor atrofida mikrobial aerozol to'planadi, ma'lum miqdordagi mikroorganizmlar stomatologik kabinet buyumlari yuzasiga tushadi. Bakteriyalar, sodda hayvonlar va zamburug'larning bunday tarqalishi tibbiyot xodimlarining sog'lig'iga xavf tug'diradi, chunki bu yuqumli jarayonning rivojlanishiga olib kelishi mumkin. Bu ayniqsa hozirgi paytda COVID-19 pandemiyasi sababli juda muhimdir. Shaxsiy himoya vositalari – niqoblar, qo'lqoplar, ekranlar va bosh kiyimlardan foydalanish zarur, bu ham bemor, ham shifokor uchun turli xil infeksiyalarni yuqtirish xavfini kamaytiradi. Patogen mikroorganizmlarning tarqalishini kamaytirish bo'yicha ko'plab tadqiqotlar o'tkazilgan, ulardan biri stomatologik muolajalardan oldin bemorlar tomonidan antiseptik chayish vositalaridan foydalanishga qaratilgan bo'lib, bu bemorning og'iz bo'shlig'idagi mikroorganizmlar sonini kamaytiradi. Shuningdek, havo tozalash uchun shifokor kabinetida bakteritsid lampalar bo'lishi kerak; xonani shamollatish xonada to'planib qoladigan mikroorganizmlardan himoya qilishning zarur usuli hisoblanadi. Changyutgich, so'lak otqazgich va boshqa intraoral so'rish moslamalaridan foydalanish bioaerozol buluti tarqalishini kamaytiradi.
Kalit so'zlar: shaxsiy himoya vositalari, bioaerozol buluti, antiseptik chayish vositalari.

Introduction. According to the research, managing the spread of bioaerosol clouds in dental settings is a complex task that calls for knowledge of aerosol properties, airflow dynamics, and efficient mitigation techniques. The importance of airflow distribution in affecting the spread of bioaerosol in dental clinics is shown by the spatiotemporal analysis of aerosol dispersion. Optimizing airflow can be a crucial strategy to lessen aerosol dispersion during dental treatments, as airflow patterns have a substantial impact on the dissemination of bioaerosols, according to [1]. Air cleaning devices have been investigated as a way to reduce the concentration of bioaerosols and have shown promise in reducing the presence of aerosols in clinical settings.

Evaluating the efficacy of control strategies requires the measurement and characterization of bioaerosols. [2] discusses the difficulties in measuring bioaerosol fields, such as temporal fluctuation and spatial distribution, and highlights the significance of accurate measurement methods such eddy-covariance techniques. These methods aid in clarifying the spatial distribution of bioaerosols, which is essential for creating focused mitigation plans.

Guidelines for infection control emphasize how crucial ventilation systems—like HVAC—are to reducing the spread of airborne pathogens. In dental clinics, the concentration of infectious aerosols can be decreased using HVAC systems with outside air intake, as mentioned in [3]. This lowers the risk of transmission. A key component of managing bioaerosols is adequate ventilation, when paired with other control strategies.

We are getting better at dynamically monitoring bioaerosol levels thanks to real-time sensing technologies. The review in [4] emphasizes that while the requirement for taxonomic specificity changes according on the situation, real-time bioaerosol detection can guide prompt mitigation measures. Aerosol dispersion can be adaptively managed by incorporating such sensing techniques into control algorithms.

Techniques for sampling and characterization are essential for comprehending the characteristics of bioaerosols and assessing control strategies. Standardized sample criteria are required to precisely measure aerosol concentrations and guide mitigation efforts, as described in [5]. These techniques aid in the creation of focused actions to successfully reduce aerosol clouds.

[6] discusses the seasonal change of bioaerosols and their role in the airborne microbial burden, suggesting that aerosol dispersal is influenced by temporal considerations. Patterns that can guide the timing and deployment of control mechanisms and possibly increase their efficacy are found through statistical analysis like Spearman correlation.

Bioaerosols are naturally produced during aerosol-generating dental treatments, hence certain mitigation strategies are required. High-volume evacuation and other aerosol control devices' effects on particle dispersion are examined in studies such as [7] and [8], which show that these techniques can greatly lessen droplet spatter and aerosol spread during processes. These results provide credence to the use of focused mitigation strategies to reduce bioaerosol clouds.

Finally, both generation reduction and removal procedures are included in technological approaches to bioaerosol control. Effective mitigation depends on knowing the size distribution of bioaerosols and using the right control technologies, like filtering and local exhaust, as covered in [9]. The intricacy of aerosol treatment and the variability of bioaerosol composition highlight the necessity of customized treatments in dental settings

Personal protective equipment (PPE) is the primary line of protection for both patients and doctors against dangerous bacteria [2,9,16]. Wearing a mask, cap, gloves, and glasses reduces the risk of infection and the likelihood of illness. When getting dental work done during a pandemic, these rules must be especially strictly adhered to. In any case, a cloud of bacterially seeded bioaerosol is produced throughout the treatment process, infecting nearby surfaces [3,4,9,24].

The genesis of the Bioaerosol Cloud. The international organization Cochrane conducted over eighty-three research on the formation of aerosols during dental manipulations, specifically while employing ultrasonic instruments and high-speed and low-speed handpieces. A contamination risk gradation for the aforementioned procedures can be established by comparing the amount of droplet splatter produced by each: high for the high-speed handpiece and the ultrasonic device, and moderate for the low-speed handpiece, even though contamination of the patient's body and surrounding surfaces was found during all forms of activity. These studies thus show the continuous formation of an aerosol cloud that reaches the surface of the patient's body and surrounding objects [6,17].

Antiseptic washes. To lessen the quantity of bacteria in the oral cavity, patients can now employ special rinses that are being developed prior to a dental surgery [1,21]. They may contain zinc lactate (Zn), sodium fluoride, cetylpyridinium chloride, or chlorhexidine digluconate [8,13,18]. Up until May 31, 2019, randomized clinical trials from the MEDLINE (PubMed), Embase, Google Scholar, and Latin American and Caribbean medical science literature were reviewed by dental professionals from the University of São Paulo's School of Dentistry. To lower the quantity of Colony-Forming Units (CFU) in the bioaerosol produced by dental operations, they conducted a random-effects meta-analysis. The authors examined 13 randomized clinical trials out of 770 publications that examined the effectiveness of herbal items, cetylpyridinium chloride, essential oils, and chlorhexidine. The CFU count was considerably lowered by mouthrinses containing cetylpyridinium chloride, essential oils, and chlorhexidine, according to the meta-analysis. Comparing the pre-procedural mouthrinse to the control, the average CFU reduction was 64.8%. As a result, antiseptic remedies lower the bioaerosol cloud's microbial population [21, 28].

Surgical Practice Infection Risk. At the Royal College of London, eleven investigations on oral surgery—including extraction—were carried out. Researchers looked at blood and microbiological (bacterial and fungal) contamination at the patient and physician levels. According to these research, there is a general danger that contaminated aerosols, droplets, and splatters will occur during oral procedures, particularly when rotating handpieces are used to extract damaged teeth. A number of factors, including closeness to the surgical site, length of therapy, and the intricacy of tooth extraction, increased the chance of infection and dissemination. Therefore, personal protective equipment is required to safeguard the safety of dentists in surgical dentistry due to the very high risk of infection for medical personnel [7,14].

COVID-19. Because of the COVID-19 pandemic, this issue occupies a prominent (special) position in dental practice. Assessing the distribution of microbial aerosols to patients and dentists during treatment was necessary to lower the risk of infection due to the potential for viral transmission through aerosol particles in saliva produced when using handpieces or ultrasonic scalers. One volunteer participated in a pilot study at the Maurice H. Kornberg School of Dentistry. A dentistry unit served as the experiment's site. The DustTrak 8534, PTrak 8525, and AeroTrak 9306 were the three measurement devices utilized to measure the particle distribution in the air surrounding the dentist chair prior to the investigation. The volunteer was in the dentist chair in a supine posture, wearing safety goggles, a cap, and shoe covers. Personal safety equipment was given to the dentist and assistant. A high-speed handpiece with a diamond bur was used for modeling, which was done in the oral cavity for six minutes without coming into contact with the teeth. After cleaning every volunteer's teeth with an ultrasonic scaler, a fresh set of measurements was taken. A saliva ejector and a vacuum cleaner were used to measure the particles for both aerosol-generating processes. Within two meters of the patient, the dentist, and the assistant, the distribution of particles, including aerosols, was measured. Consequently, four areas—the assistant's, patient's, and dentist's chest areas—were shown to have higher aerosol levels than baseline [9,30]. In order to prevent overheating of the dental and bone tissues during treatment with high-speed handpieces, the teeth must be effectively cooled. This prevents the production of a water-air cloud, which is a mixture of aerosol, droplets, and particles of different sizes [10, 20].

Device for intraoral suction. The California School of Dentistry carried out a clinical investigation with a split-mouth design. In accordance with the inclusion and exclusion criteria, 93 students in all were recruited as participants. During four treatment periods—baseline, high-volume evacuation (HVE), combination (HVE and an intraoral suction device), and post-treatment—aerosol samples were gathered on blood agar plates that were set up in the dental office. Student operators were randomly assigned to use ultrasonic scalers for oral prophylaxis, HVE exclusively during the HVE treatment phase, and an intraoral suction device for the combo therapy period. Following each session, the agar plates were gathered and incubated for 48 hours at 37°C [11, 29]. An automatic colony counter was used to calculate the number of CFUs. Consequently, compared to employing the intraoral suction device alone, the combination of devices resulted in a considerable decrease in CFUs, which in turn reduced the quantity of microbial aerosols [5,23,29].

Conclusions. Therefore, protecting dentists' safety while providing patient care is crucial for the wellbeing of medical staff. Droplet spatter happens, a pathogenic microorganism-containing air cloud forms, and bacteria are seeded into the air and surrounding surfaces while the doctor is working. New intraoral devices and unique pre-procedural rinses have been created to lower the risk of human infection by drastically lowering the amount of bacteria that remain after dental treatments. The most effective method of protecting both the patient's and the doctor's health is through the use of personal protective equipment.

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