Medical Science

pISSN 2321–7359; eISSN 2321–7367

Contamination level of unused gloves in King Saud University dental clinics

Mohammad Helmi[1]✉, **Hamad N Albagieh**[2], **Rasha S Alrasheed**[3], **Reem M Aldosary**[3], **Tala M Alsulaim**[3]

To Cite:
Helmi M, Albagieh HN, Alrasheed RS, Aldosary RM, Alsulaim TM. Contamination level of unused gloves in King Saud University dental clinics. Medical Science, 2022, 26, ms28e2047.
doi: https://doi.org/10.54905/disssi/v26i119/ms28e2047

Author Affiliation:
[1]Periodontics and Community Dentistry Department, College of Dentistry, King Saud University, Riyadh, Saudi Arabia; ORCiD0000-0003-3125-1091
[2]Oral Medicine and Diagnostic Science Department, College of Dentistry, King Saud University, Riyadh, Saudi Arabia
[3]Dental Intern, College of Dentistry, King Saud University, Riyadh, Saudi Arabia

Contact Information

Mohammad Helmi	mhelmi@ksu.edu.sa
Hamad N Albagieh	halbageah@ksu.edu.sa
Rasha S Alrasheed	rashas.alrasheed@gmail.com
Reem M Aldosary	ReemAldosary@gmail.com
Tala M Alsulaim	Talaalsu@gmail.com

✉**Corresponding author**
Periodontics and Community Dentistry Department, College of Dentistry, King Saud University,
Riyadh, Saudi Arabia
Email: mhelmi@ksu.edu.sa

Peer-Review History
Received: 10 December 2021
Reviewed & Revised: 10/December/2021 to 11/January/2022
Accepted: 13 January 2022
Published: 14 January 2022

Peer-review Method
External peer-review was done through double-blind method.

URL: https://www.discoveryjournals.org/medicalscience

This work is licensed under a Creative Commons Attribution 4.0 International License.

ABSTRACT

Objective: The present study aims to measure the contamination level of gloves contained in an open box during dental procedures in the clinics of King Saud University, Dental Hospital, Riyadh, Saudi Arabia. *Methods:* a prospective in-vitro study for evaluating the contamination level of unused non-sterile latex gloves in dental clinics. Distance between the glove box and the dental chair was measured and grouped into two categories. The boxes were numbered and swabbed before opening. Two additional swabs were collected from the unused gloves at the beginning and end of each clinical session. The sample was then evaluated to identify type of bacteria and number of colonies. *Results:* 57.5% of contaminated second gloves were within 135cm distance while 70.83% of non-contaminated second gloves were located further than 135cm of the dental chair. For any given second glove placed more than 135cm, there is a decrease of 1.34cfu/ml compared to second gloves placed within 135cm. *Conclusion:* the study findings necessitate the importance of placing exposed glove boxes no less than 135cm from the source of aerosols to reduce the risk contaminating unused gloves.

Keywords: microbiology, dental, infection control, aerosols, contamination

1. INTRODUCTION

Microorganisms contaminating objects and surfaces are responsible for causing various types of infections (Fauci and Morens, 2012; Scott and Bloomfield, 1990). Many of these infections are transmissible through different modes including contact with contaminated objects (Antonovics et al., 2017; Fauci and Morens, 2012; Scott and Bloomfield, 1990). Overall, the rate of communicable diseases in Saudi Arabia is decreasing due to the major advances in healthcare services. However, there is a current emergence of new infections that are requiring greater efforts for preventing these infections (Memish et al., 2014). Hospitals and clinical settings are particularly considered a more favorable environment for infection transmission. Furthermore, pathogens could live on contaminated surfaces and instruments for up to months in the absence of infection control measures (Kramer et al., 2006). This is especially true in dental clinics, in which aerosols are products of air-driven devices and ultrasonic scalers that are routinely used in dentistry

DISCOVERY SCIENTIFIC SOCIETY
Copyright © 2022 Discovery Scientific Society.

(Castiglia et al., 2008; King et al., 1997). Microbial aerosols are usually less than 50um in diameter suspended in the air during many dental procedures, particularly dental scaling (Micik et al., 1969; Bennett et al., 2000). Thus, aerosol contamination is a major source of infection not only to patients but also to dental staff members (Micik et al., 1969). These droplets can contain saliva, blood, restorative materials or dental plaque (Bennett et al., 2000).

Respiratory diseases such as tuberculosis and Methicillin-resistant Staphylococcus aureus (MRSA) are common examples of diseases that can be transmitted through these mediums (Harrel and Molinari, 2004; Bentley et al., 1994). It has been found that those aerosols can travel in an upward vertical way and form a cloud of small droplets that extends to the operator. Moreover, fine aerosolcan reach surfaces more than ahalf-meter (60cm) away from the procedure (Bentley et al., 1994). The use of an antiseptic mouth rinse before dental procedures has been reported to reduce the number of microorganisms in the spreading aerosols and hence decrease their ability to cause infections (Marui et al., 2019). Other precautions recommended by the "Centers for Diseases Control" (CDC) include the use of disinfectants and avoiding direct contact through the use of masks and gloves. These recommendations, if properly implemented, can effectively reduce the spread of infectious diseases (Kohn et al., 2003). It is worth noting that glove boxes are kept open in some dental clinics, thereby being exposed to the environment that is usually contaminated with air-prone aerosols (Chuang et al., 2014). This can make them vectors spreading infectious microorganisms from one patient to another rather than a protective measure (Hughes et al., 2013).

Previous studies have investigated the contamination rates of unused non-sterile gloves contained in an open box in different hospital settings (Ferreira et al., 2011; Hall et al., 2014; Diaz et al., 2008). It was documented that unused non-sterile gloves exposed to the hospital environment are contaminated and have a serious role in transmitting infections. Moreover, recommendations such as modifying glove withdrawal techniques and improving hand hygiene were suggested (Hughes et al., 2013). However, in another study when aseptic and typical glove withdrawal techniques were compared, it was found that there is no statistical significance in the difference of microbial quantity implying that their exposure to the environment is the main source of contamination (Ferreira et al., 2011).

Despite that, evaluating the effectiveness of infection control measures although not mandatory, but yet, would still help in improving them (Bracher et al., 2019). Little information is available in the literature regarding the contamination level of open box gloves in a dental environment. Due to the nature of the dental procedures, gloves in an exposed box may be at greater risk of contamination (Chuang et al., 2014). Therefore, this study aims to investigate the level of microbial contamination of unused boxed examination gloves in the clinics of King Saud University dental hospital in Riyadh, Kingdom of Saudi Arabia.

2. MATERIALS AND METHODS

The study was conducted during the academic year 2020-2021 starting in July 2020 and concluded during September 2021. This is a prospective in-vitro study for evaluating the contamination level of unused non-sterile latex gloves (Topamm, Malaysia) in the dental clinics at King Saud University Dental Hospital, Riyadh, Kingdom of Saudi Arabia. Institutional Review Board and Ethical clearance were obtained from the institutional ethical committee at College of Medicine, King Saud University No. (E-20-4925). A sample size of 128 gloves (64 pairs) was swabbed in this study prior and after glove exposure to dental setting. This sample size was chosen conveniently and with covid-19 clinical and laboratory restrictions. At that time period in the dental clinics of Kind Saud University, the sample size was limited to 64 pairs. Additionally, the external surface of each of the 64 glove boxes was swabbed to verify if it had any prior contamination due to shipping or storage.

The distance between the glove box and dental chair was measured and grouped into two categories: more than 135 cm and equal or less than 135 cm. All boxes were placed on the same height of 125cm above ground level. The nature and intent of the study were not disclosed to the dental staff to avoid any changes to the standard employed routine. The boxes were numbered and swabbed before opening. The swabbing technique was conducted by using a sterile dry cotton applicator dipped in sterile distilled water and rolled over the intended surface. Two additional swabs were collected from the unused gloves at the beginning and end of each clinical session. Proper hand hygiene was done before taking the gloves to avoid contaminating the gloves prior to swabbing.

All collected swabs were rolled over plates that have brain heart infusion agar (BHI) (HiMedia, India) and were incubated at 37C° for 24-48 hours. Any bacterial growth after the incubation period was considered as contamination. The sample was then evaluated to identify the type of bacteria and the number of colonies. Statistical analyses used in this study include descriptive statistics, Chi square, two-sample t-test, and linear and logistic regression models. P-values less than 0.05 were considered statistically significant. All statistical analyses were conducted using Stata14 statistical package.

3. RESULTS

A total of 64 glove boxes were used in this study, in which 3 swabs were taken from each sample. These include swabbing the outer surface of the box, the first glove when opening the box, and the exposed glove after the procedure. 46.88% of samples were placed within 135 cm distance of the dental unit while 53.12% were placed further than 135 cm distance of the unit. The average levels of contamination measured at each swab are shown in Table 1.

Table 1 The average levels of contamination measured at each swab for the total sample of 64 boxes and 128 gloves.

	Box outer surface	First glove	Second glove (After procedure)
N of samples with no growth (%)	17 (26.6%)	28 (43.8%)	24 (37.5%)
N of samples with bacterial/fungal growth (%)	47 (73.4%)	36 (56.2%)	40 (62.5%)
Average CFU\ml	3.19 cfu\ml	2.60 cfu\ml	3.01 cfu\ml

While the first glove contamination had no association with distance, the contamination level varied for the second glove that was placed within 135 cm from the dental chair compared to those that were placed further away than 135 cm. 57.5% of contaminated second gloves were placed within 135 cm distance while 70.83% of non-contaminated second gloves were placed further than 135 cm of the dental chair ($\chi^2(1, N= 64) =4.83$, p-value=0.028). Both linear regression model and two-sample t-test showed a significant association between the distance and average cfu/ml for the second glove. For any given second glove placed more than 135 cm, there is a decrease of 1.34 cfu/ml compared to second gloves placed within 135 cm from the dental chair (p-value=0.04). Logistic regression indicating 70% decreased odds for second gloves to be contaminated when placed further than 135 cm compared with second gloves when placed within 135 cm (p-value=0.031). The average levels of contamination measured for each glove by distance are shown in Table 2.

Table 2 The average levels of contamination measured at each swab for the total sample of 128 gloves (64 pairs) by distance.

	First glove		Second glove (After procedure)*	
Distance	<135 cm	>135 cm	<135 cm	>135 cm
N of samples with no growth (%)	13 (46.4%)	15 (53.6%)	7 (29.2%)	17 (70.8%)
N of samples with bacterial/fungal growth (%)	17 (47.2%)	19 (52.8%)	23 (57.5%)	17 (42.5%)
Average CFU\ml Difference	Ref	-0.1cfu\ml	Ref	-1.34cfu\ml**
***p-value<0.05 for chi square test of independence **p-value<0.05 for two-sample t-test**				

The bar chart in Figure 1 shows a comparison between first and second gloves average contamination level by distance. The bar chart in Figure 2 demonstrates the number of after procedure glove samples for each range of colony-forming units collected within different distances of the dental unit. 12 out of 64 boxes sampled had fungal growth which accounts for 18.25%, while only 5 out 128 gloves had fungal contamination. Fungal organisms identified and weremainly Aspergillus Fumigated and Rhizopus. Types of microorganisms found are illustrated in Figure 3.

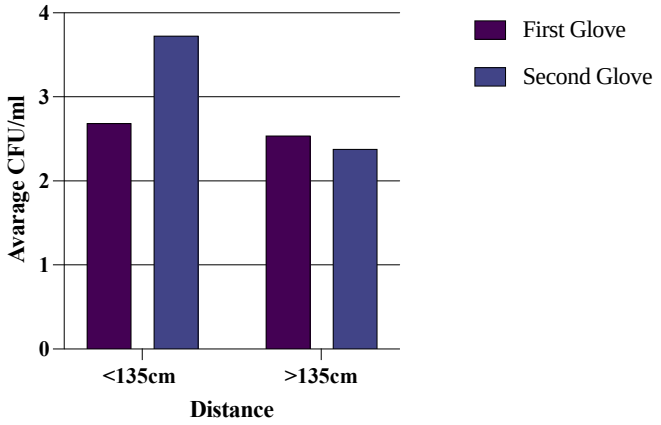

Figure 1 A comparison between first and second gloves average contamination level by distance. Average CFU/ml in varying distances of first glove is similar (2.7CFU/ml, 2.5CFU/ml) compared to differences noted in the second gloves in which distances less than 135cm had more average CFU\ml (3.7CFU/ml, 2.3CFU/ml).

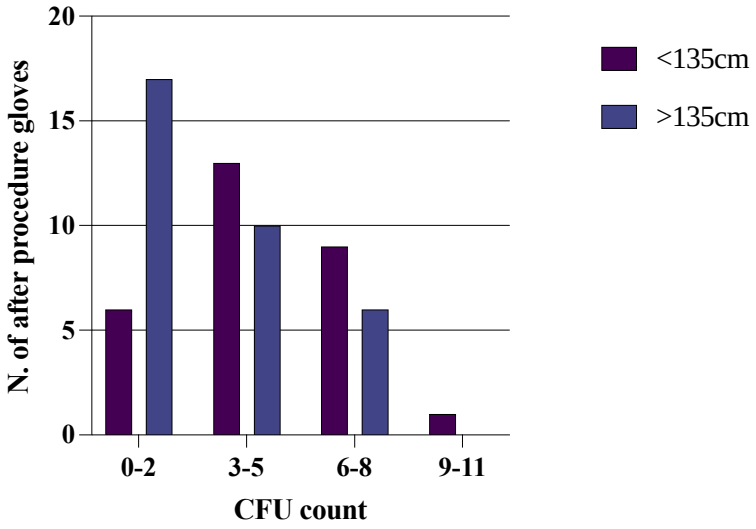

Figure 2 Contamination burden of after procedure gloves sampled. Bar chart demonstrating the number of after procedure glove samples for each range of colony forming units collected within different distances of dental unit.

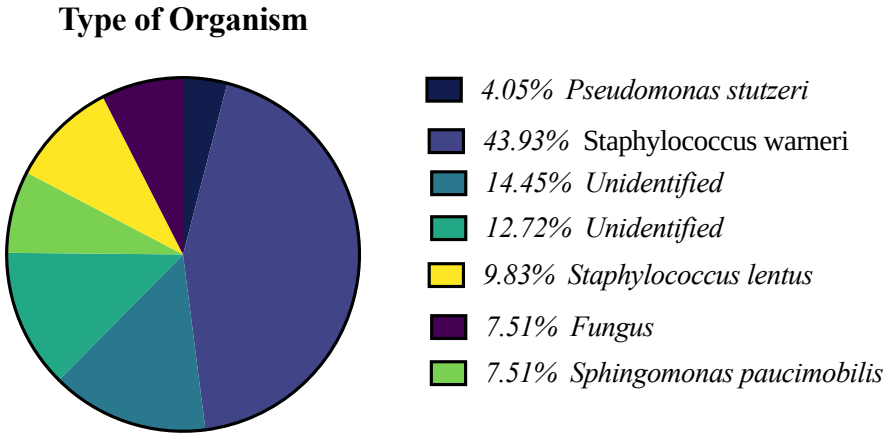

Figure 3 Pie chart on types of microorganisms found in all swabbed samples

4. DISCUSSION

Aerosols contamination in dental clinics is a result of using high-speed hand-driven devices. Most of these instruments are used heavily in restorative dentistry and hygienist clinics. It was reported that ultra-sonic scalers used for dental scaling produce the highest amount of aerosol compared to other instruments (Bennett et al., 2000; Harrel and Molinari, 2004). In this study, clinics that have been selected used either ultra-sonic scalers or high-speed hand pieces. According to the results, 73% of the boxes were contaminated before use or exposure; this contamination could have arisen in the manufacturing, shipping or storage process of these boxes (Berthelot et al., 2006). Accordingly, the contamination of the boxes has affected the first glove sample immediately after opening the box without being exposed to any dental working environment, this also confirms that the contamination is mostly due to manufacturing contamination (Ferreira et al., 2011; Berthelot et al., 2006). Additionally, this could also result from handling techniques despite proper hand hygiene before sampling. The testing of the first glove was made to act as a baseline before subjecting the box to the dental environment.

It was noted that the distance at which the gloves were placed had a significant association with average CFU\ml. A recent study found that 1.5m and beyond had no association or increase in bacterial contamination (Zemouri et al., 2020). Moreover, another study have reported that any object within <100cm from dental scaler had a risk of contamination (Chuang et al., 2014). This finding necessitates the importance of placing the glove box, if not covered, at a distance more than 135 cm from the patients' head. The obtained microorganisms were analyzed and were categorized into fungal or bacterial microorganisms. Both fungal and bacterial microorganisms can cause devastating effects on patients especially immunosuppressed or medically compromised. Fungal contamination was mostly noted in either the box outer surface or on the first glove. Upon examination they consisted mainly of *Aspergillus Fumigatus* and *Rhizopus*. According to the British society for immunology, *Aspergillus Fumigatus* can cause an array of diseases when inhaled including chronic lung diseases (chronic pulmonary aspergillosis). Regarding Rhizopus, it canlead to rare diseases such as *Rhinocerebral Mucormycosis*. These two organisms are well known to be naturally appearing in nature but it can also be seen as an occupational risk for the patients or the staff. A similar study reported similar fungal contamination when sampling private dental clinics in Riyadh (Almutairi et al., 2019).

Regarding bacterial contamination, all species mentioned in Figure 3 are widely found in nature especially water and soil, but they can act as an occasional human pathogen. Staph, species detected were *Staphylococcus warneri* and *staphylococcus lentus,* both have been reported to cause serious infections (Kamath et al., 1992; Naik et al., 2015). *Sphingomonas paucimobilis* was also present in 8% of the sample and is known to be infectious in immunocompromised patients (Bennett et al., 2014). On the other hand, *pseudomonas stutzeri* rarely leads to serious community or nosocomial acquired infections, but in cases where it affects patients, they usually have a serious underlying disease but generally respond to treatment with antibiotics (Noble and Overman, 1994). These bacteria types were seen in other studies which indicate their abundance in the environment (Kimmerle et al., 2012; Zemouri et al., 2020).

A limitation of this study is that only bacterial and fungal contaminations were measured, viruses were not. Viruses are much smaller and could travel greater distances and in light of the COVID-19 virus, there is a high possibility of transmission through droplets to a higher distance than what is measured in this study. Taking in hand the new recommendation by the"Centers for Disease Control" (CDC), proper room ventilation is advised. In addition, keeping gloves boxes unexposed to the dental environment could potentially reduce the risk of gloves contamination. Moreover, there was a lack of randomization in clinic allocation; clinics used in the study were chosen according to their availability at that time. The inability to maintain a sterile clinical environment also needs mentioning in this regard. Future randomized trials investigating both bacterial and viral contamination including dental clinics operating different specialties are needed in the future.

Clinical Relevance

Scientific rationale of the study: aerosols contamination in dental clinics is a result of using high-speed hand-driven devices; most of these instruments are heavily used in restorative dentistry and hygienist clinics. We wanted to measure the level of contamination of unused gloves in dental clinics due to aerosols generating dental procedures. Principal findings: the study findings necessitate the importance of placing the exposed glove box at a further distance than 135cm from the source of aerosols to reduce the risk of contamination. Practical implications: hospitals and dental clinics have to assure strict protocols and guidelines for placing glove boxes inside dental clinics as well as for handling and storing gloves as newly collected boxes from stores or gloves from newly opened boxes might get contaminated prior to dental procedures.

5. CONCLUSION

A total of 64 glove boxes and 128 gloves were sampled from dental clinics at King Saud University Dental Hospital. 57.5% of contaminated second gloves were placed within 135cm distance while 70.83% of non-contaminated second gloves were placed further than 135cm of the dental chair. For any given second glove placed more than 135cm, there is a decrease of 1.34cfu/ml compared to second gloves placed within 135cm. 70% decreased odds for second gloves to be contaminated was found when placed further than 135 cm compared with second gloves when placed within 135 cm.

Acknowledgment

We would like to acknowledge Dr. Nassr Almeflehi for the great contribution in explaining the statistical model used in this study. We would also like to acknowledge the support we have had in this study from the College of Dentistry, King Saud University for providing us with the material and supply for this study.

Authors Contributions

Conceptualization: Mohammad Helmi, Hamad Albagieh, Rasha Alrasheed, Reem Aldosary, Tala Alsulaim; Methodology: Mohammad Helmi, Rasha Alrasheed, Reem Aldosary, Tala Alsulaim; Formal analysis: Mohammad Helmi; Investigation: Rasha Alrasheed, Reem Aldosary, Tala Alsulaim; Writing: Rasha Alrasheed, Reem Aldosary, Tala Alsulaim; Supervision: Mohammad Helmi

Funding

Upon the approval of the College of Dentistry Research Center (IR 0358), the study was conducted using College of Dentistry, King Saud University material, supply, and facilities. This study has not received any external funding.

Ethical Approval

Institutional Review Board and Ethical clearance were obtained from the institutional ethical committee at College of Medicine, King Saud University No (E-20-4925).

Conflict of interests

The authors declare that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

REFERENCES AND NOTES

1. Almutairi SN, Aldusari RS, Binhuwaishel HA, Alshammary H, Eltom SM, Ankliss H. Fungal Contamination and Disinfection of Dental Chairs Among Private Dental Clinics in Riyadh, Saudi Arabia. EC Dent Sci 2019; 18(12):1-8.
2. Antonovics J, Wilson AJ, Forbes MR, Hauffe HC, Kallio ER, Leggett HC, Longdon B, Okamura B, Sait SM, and Webster JP. The evolution of transmission mode. Philos Trans R Soc B Biol Sci 2017; 372(1719):20160083.
3. Attapattu MC. Acute rhinocerebral mucormycosis caused by Rhizopus arrhizus from Sri Lanka. J Trop Med Hyg 1995; 98(5):355-358.
4. Bennett AM, Fulford MR, Walker JT, Bradshaw DJ, Martin M V, Marsh PD. Microbial aerosols in general dental practice. Br Dent J 2000; 189(12):664-667.
5. Bennett JE, Dolin R, Blaser MJ. Mandell, Douglas, and Bennett's Principles and Practice of Infectious Diseases: 2-Volume Set. Elsevier Health Sciences 2014.
6. Bentley CD, Burkhart NW, Crawford JJ. Evaluating spatter and aerosol contamination during dental procedures. J Am Dent Assoc 1994; 125(5):579-584.
7. Berthelot P, Dietemann J, Fascia P, Ros A, Mallaval FO, Lucht F, Pozzetto B, and Grattard F. Bacterial contamination of nonsterile disposable gloves before use. Am J Infect Control 2006; 34(3):128-130.
8. Bracher L, Kulik EM, Waltimo T, Türp JC. Surface microbial contamination in a dental department. A 10-year retrospective analysis. Swiss Dent J 2019; 129(1):14-21.
9. Castiglia P, Liguori G, Montagna MT, Napoli C, Pasquarella C, Bergomi M, Fabiani L, Monarca S, and Petti S. Italian multicenter study on infection hazards during dental practice: control of environmental microbial contamination in public dental surgeries. BMC Public Health 2008; 8(1):1-7.
10. Chuang C-Y, Cheng H-C, Yang S, Fang W, Hung P-C, Chuang S-Y. Investigation of the spreading characteristics of

bacterial aerosol contamination during dental scaling treatment. J Dent Sci 2014; 9(3):294-296.
11. Diaz MH, Silkaitis C, Malczynski M, Noskin GA, Warren JR, Zembower T. Contamination of examination gloves in patient rooms and implications for transmission of antimicrobial-resistant microorganisms. Infect Control Hosp Epidemiol 2008; 29(1):63-65.
12. Drummond RA, Brown GD. The role of Dectin-1 in the host defence against fungal infections. Curr Opin Microbiol 2011; 14(4):392-399.
13. Fauci AS, Morens DM. The perpetual challenge of infectious diseases. N Engl J Med 2012; 366(5):454-461. doi:10.1056/NEJMra1108296.
14. Ferreira AM, Andrade D de, Haas VJ. Microbial contamination of procedure gloves after opening the container and during exposure in the environment. Rev da Esc Enferm da USP 2011; 45:745-750.
15. Hall M, Trivedi U, Rumbaugh K, Dissanaike S. Contamination of Unused, Nonsterile Gloves in the Critical Care Setting: A Comparison of Bacterial Glove Contamination in Medical, Surgical and Burn Intensive Care Units. Southwest Respir Crit Care Chronicles 2014; 2(5):3-10.
16. Harrel SK, Molinari J. Aerosols and splatter in dentistry: a brief review of the literature and infection control implications. J Am Dent Assoc 2004; 135(4):429-437.
17. Hughes KA, Cornwall J, Theis J-C, Brooks HJL. Bacterial contamination of unused, disposable non-sterile gloves on a hospital orthopaedic ward. Australas Med J 2013; 6(6):331.
18. Kamath U, Singer C, Isenberg HD. Clinical significance of Staphylococcus warneri bacteremia. J Clin Microbiol 1992; 30(2):261-264.
19. Kimmerle H, Wiedmann-Al-Ahmad M, Pelz K, Wittmer A, Hellwig E, Al-Ahmad A. Airborne microbes in different dental environments in comparison to a public area. Arch Oral Biol 2012; 57(6):689-696.
20. King TB, Muzzin KB, Berry CW, Anders LM. The effectiveness of an aerosol reduction device for ultrasonic sealers. J Periodontol 1997; 68(1):45-49.
21. Kohn WG, Collins AS, Cleveland JL, Harte JA, Eklund KJ, Malvitz DM. Guidelines for infection control in dental health-care settings-2003. MMWR Recomm Rep 2003; 52:1-61.
22. Kramer A, Schwebke I, Kampf G. How long do nosocomial pathogens persist on inanimate surfaces? A systematic review. BMC Infect Dis 2006; 6(1):1-8.
23. Marui VC, Souto MLS, Rovai ES, Romito GA, Chambrone L, Pannuti CM. Efficacy of preprocedural mouthrinses in the reduction of microorganisms in aerosol: A systematic review. J Am Dent Assoc 2019; 150(12):1015-1026.
24. Memish ZA, Jaber S, Mokdad AH, AlMazroa MA, Murray CJL, Al Rabeeah AA, and Saudi Burden of Disease Collaborators. Peer reviewed: Burden of disease, injuries, and risk factors in the Kingdom of Saudi Arabia, 1990–2010. Prev Chronic Dis 2014; 11.
25. Micik RE, Miller RL, Mazzarella MA, Ryge G. Studies on dental aerobiology: I. Bacterial aerosols generated during dental procedures. J Dent Res 1969; 48(1):49-56.
26. Naik S, Bouladoux N, Linehan JL, Han SJ, Harrison OJ, Wilhelm C, Conlan S, Himmelfarb S, Byrd AL, and Deming C. Commensal–dendritic-cell interaction specifies a unique protective skin immune signature. Nature 2015; 520(7545):104-108.
27. Noble RC, Overman SB. Pseudomonas stutzeri infection a review of hospital isolates and a review of the literature. Diagn Microbiol Infect Dis 1994; 19(1):51-56.
28. Scott E, Bloomfield SF. The survival and transfer of microbial contamination via cloths, hands and utensils. J Appl Bacteriol 1990; 68(3):271-278. doi:10.1111/j.1365-2672.1990.tb02574.x.
29. Zemouri C, Volgenant CMC, Buijs MJ, Crielaard W, Rosema NAM, Brandt BW, Laheij AMGA, and De Soet JJ. Dental aerosols: microbial composition and spatial distribution. J Oral Microbiol 2020; 12(1):1762040.