



ORIGINAL ARTICLE

Knowledge and awareness assessment of cross-contamination of dental floss containers in King Saud University dental hospital clinics

Hamad Albagieh^{a,*}, May Alsenani^a, Mohammed Alshehri^b, Hadi Alamri^c,
Nada Alghamdi^d, Rahaf Alawaji^d, Lulwah Almutib^d

^a Oral Medicine and Diagnostic Sciences Department, College of Dentistry, King Saud University, Riyadh, Saudi Arabia

^b Dental Department, King Khaled University Hospital, King Saud University Medical City, Riyadh, Saudi Arabia

^c Conservative Dental Sciences, College of Dentistry, Prince Sattam bin Abdulaziz University, Alkharj, Saudi Arabia

^d College of Dentistry, King Saud University, Riyadh, Saudi Arabia

Received 14 December 2022; revised 25 December 2022; accepted 26 December 2022

Available online 29 December 2022

KEYWORDS

Infection control;
Dental floss container;
Cross-contamination

Abstract *Introduction:* Infection control procedures are implemented in dental clinics to reduce the risk of cross-contamination; saliva, blood, or airborne droplets containing infective agents are example of direct contamination, while indirect exposure via contact with contaminated surfaces and dental equipments such as dental chair, tray, faucet, air syringe, suction tip, gutta percha, paper points, retraction cords, and dental floss containers. Dental floss is known to be an integral part of most dental procedures.

Objectives: The objective of this study was to assess the knowledge and awareness regarding cross-contamination of dental floss containers among a selected population of dental assistants in dental clinics at King Saud University (KSU).

Material and Methods: A swab was taken from 60 dental floss containers selected by simple random sampling among 60 different dental clinics at KSU and culture test was done using a charcoal transport swab to identify the type of bacteria that might be present on the dental floss containers. Also a Google forms questionnaire which consisted of 20 multiple choice questions, including demographic questions on gender, nationality, and professional experience, followed by questions to evaluate different infection control concepts and practices.

* Corresponding author at: College of Dentistry, Building 23, 2nd Floor, Office# 2B 19, Saudi Arabia.

E-mail addresses: Halbageah@ksu.edu.sa (H. Albagieh), malsenani@ksu.edu.sa (M. Alsenani).

Peer review under responsibility of King Saud University. Production and hosting by Elsevier.



Production and hosting by Elsevier

Results: This study included 70 dental assistants, most of whom were female (94.3 %). A significant number (41.4 %) of the dental assistants have never heard of OSHA course, and most of them (77.1 %) have never taken an OSHA course. Some participants who attended > 2 infection control courses (37.8 %) did not disagree that it is a waste of material to use new gloves to clean each clinic. Regarding the laboratory results for the collected samples, the highest frequency was noted for *Staphylococcus hominis* (27.8 %).

Conclusion: The present study concluded that there is still further need for implementation of infection control programs and raising more awareness regarding this subject.

© 2022 The Authors. Production and hosting by Elsevier B.V. on behalf of King Saud University. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

1. Introduction

One of the most critical issues in the global healthcare services is infection. Infection control procedures are implemented in dental clinics to reduce the risk of cross-contamination, which available evidence suggests that it is one of the most highly infectious areas (Dagher et al., 2017). The examples are direct contact with saliva, blood, or airborne droplets containing infective agents, or indirect exposure via contact with contaminated surfaces and dental equipments (Kohn et al., 2003) (Gerberding et al., 2003). The pathways of contamination can be bidirectional, meaning that an infectious microorganism could be transferred from the patient to members of the dental team, and vice versa (Laheij et al., 2012). When appropriate precautions are taken, the risk of cross-contamination in the dental clinic can be significantly decreased. It is the responsibility of both the dentist and the assistant to maintain the patient's safety, as well as their own.

Cross-transmission in dentistry is under-reported in the literature (Laheij et al., 2012). Prospective research in this area is needed to determine the real risks of cross-infection in dentistry. The adoption of effective hygiene procedures in dental practice needs to be assessed, as the current debate seems to validate the view that dental assistants in private or educational clinics have less chance to appropriately apply infection control procedures. Examples of objects inside the dental office that could transfer diseases if not properly sterilized are the dental chair, tray, faucet, air syringe, suction tip, gutta percha, paper points, retraction cords, burs, and hand pieces. One of the things that is often overlooked is reaching out to instruments inside the drawers while wearing gloves during a procedure, such as cotton pellets, rubber dam, and the dental floss container.

Dental floss is known to be an integral part of most dental procedures because it serves many purposes. It can aid in checking the contact between the teeth, inverting the rubber dam interproximally, checking the smoothness of proximal restorations, securing objects placed inside the oral cavity, such as clamps and mouth props, and preventing the aspiration or swallowing of objects, as well as aiding in their retrieval from the oral cavity (Malamed et al., 2014).

The aim of this study was to assess the knowledge and awareness regarding cross-contamination of dental floss containers among a selected population of dental assistants in dental clinics at King Saud University (KSU).

2. Materials and methods

This study examined 60 dental floss containers selected by simple random sampling among 60 different dental clinics at KSU: 30 clinics from Girls University Campus (10 student clinics, 10 post graduates clinics, and 10 specialist clinics) and 30 clinics from Boys University Campus (10 student clinics, 10 post graduates clinics, and 10 specialist clinics). A swab was taken and culture test done using a charcoal transport swab to identify the type of bacteria that might be present on the dental floss containers.

The study was approved by the Institutional Review Board (IRB) at the College of Dentistry, KSU [E-20-4750]. In this in-vitro study, data were obtained from dental assistants using simple random sampling. The objective was to assess knowledge and awareness regarding dental cross-contamination. For data collection, a self-constructed Google forms questionnaire which consisted of 20 multiple choice questions, including demographic questions on gender, nationality, and professional experience, followed by questions to evaluate different infection control concepts and practices was randomly e-mailed to the dental assistants of KSU as a link.

For the collected laboratory samples, Brain Heart Infusion Agar (BHI Agar) (Condalab), as well as Sigma-Aldrich Gram staining kit were used. BHI medium was made by measuring 52 g in 1L of distilled water, mixed until dissolved, and sterilized in an autoclave at 121 °C for 15 min. Dental floss swab specimens were collected thoroughly from the inside to the outside using cotton swabs pre-moistened with sterile normal saline according to ISO/DIS 14698-1 (Meunier et al., 2005). Collection was performed in the morning before the clinic started, and samples were transported in a cooler kept at 5 ± 3 °C for analysis at the College of Dentistry Research Center (CDRC) under the registration number [NO.FR 0576]. After the delivery of samples to the laboratory, each swab was inoculated on sterile solid medium (BHI) and incubated at 37 ± 1 °C for 24–48 h. After growth was noted, the swabs were further subcultured in BHI agar and incubated under the same environmental conditions. Characteristically distinct colonies were isolated and purified by subculturing in fresh media and incubated at 37 ± 1 °C for 18–24 h to obtain pure culture isolates according to the recommendations of Meunier et al. (Meunier et al., 2005). Gram staining was performed to distinguish the Gram-positive isolates ($n = 17$) from the Gram-negative isolates ($n = 3$). The Gram-negative and Gram-positive isolates were subjected to the fully automated VITEK®2 (bioMérieux, Inc., Hazelwood, MO) method of identification.

Turbidity was achieved equivalent to that of a McFarland 0.5 standard (range, 0.5 to 0.63) as measured by the DensiChek

(bioMérieux) turbidity meter. The VITEK 2 automatically filled, sealed, and incubated the individual test cards with the prepared culture suspension. The final profile results were compared to the database, generating an identification of the unknown organism. The final identifications listed as “excellent”, “very good”, “good”, “acceptable”, or “low discrimination” were considered correct. The standardized 0.5 McFarland inoculum suspension was placed in a VITEK 2 cassette along with a sterile polystyrene test tube for each organism. The loaded cassettes were then placed in the VITEK 2 and the respective bacterial suspensions diluted appropriately, after which the cards were filled, incubated, and read automatically. The incubation time of each bacterial colony varied based on the rate of growth.

Both investigations were conducted using the chi-squared test to compare responses based on experience, number of courses attended in the last 5 years, and Occupational Safety & Health Academy (OSHA) course attendance. Microsoft Excel 2019 was used to generate representative figures. Significance was set at $p \leq 0.05$. Statistical analysis were performed in SPSS 18.0 (Statistical Package for Scientific Studies, SPSS, Inc., Chicago, IL, USA) for Windows.

3. Results

The study included 70 dental assistants, most of whom were female (94.3 %). A significant number (41.4 %) of the dental assistants have never heard of OSHA course, and most of them (77.1 %) have never taken an OSHA course (Table 1).

Some participants who attended > 2 infection control courses in the last 5 years (37.8 %) did not disagree that it is a waste of material to use new gloves to clean each clinic (Table 2).

Many participants (88.6 %) did not agree with the statement, “I don’t change gloves while distributing instruments for each clinic which i’m assigned to”. Moreover, almost all participants (95.7 %) agreed to the statement, “Dental University Hospital should provide annual infection control courses” (Table 3).

Regarding the laboratory results for the collected samples, the highest frequency was noted for *Staphylococcus hominis* (27.8 %), followed by *Sphingomonas paucimobilis*, *Staphylococcus epidermis*, and *Staphylococcus aureus* (11.1 %). *Pantoea* spp., *Kocuria kristinae*, *Kocuria rosea*, *Allolococcus otitis*, *Streptococcus pseudoporcinus*, *Micrococcus luteus*, and *Rothia dentocariosa* each had a frequency of 5.56 % (Fig. 1).

4. Discussion

Few studies have discussed cross-contamination in dental clinics. Most previous work has discussed dental unit waterlines (Szymańska et al., 2008; Wu et al., 2022) and did not report on cross-contamination of dental floss containers. Accordingly, the knowledge and awareness relating to this topic is scarce. This could be attributed to underestimation and limited awareness of cross-contamination in dental clinics.

A significant number of the dental assistants have never heard of OSHA course, and most of them have never taken an OSHA course, this unfamiliarity with OSHA could be a contributing risk to cross-contamination. Numerous studies have demonstrated the necessity for infection control education that focuses exclusively on Dental Health Care Personnel (DHCP) (Reske et al., 2022), which comes in agreement with our study where almost all participants in this study agreed to the statement, “Dental University Hospital should provide annual infection control courses”, which shows their willingness to attend courses to further educate themselves and update their knowledge on infection control practices, which is consistent with the study done by Reske et al. (Reske et al., 2022). Nevertheless, some participants who attended > 2 infection control courses in the last 5 years did not disagree that it is a waste of material to use new gloves to clean each clinic, which leads to the conclusion that although they had relatively recent attendance to infection control courses, yet they still cannot decisively judge when to change their gloves or not. It is well established that it is necessary and could have a significantly advantageous effect on DHCP to provide professional advice, training interventions, and educational resources tailored specifically to dentistry (Reske et al., 2022).

The laboratory results showed the presence of several bacterial colonies, which indicated the contamination of dental floss containers. The most prevalent bacteria found was *Staphylococcus hominis*, which is frequently isolated from human skin (Severn et al., 2022). This could be a consequence of either not wearing gloves, or the contamination of the gloves themselves.

The major limitation of this study is that the study was solely carried out in KSU Medical Center. However, this is the first study from Saudi Arabia to assess the knowledge and awareness of dental assistants regarding dental floss containers’ contamination. Therefore, further studies are required to enhance distribution to include more dental assistants and more governmental and private dental clinics.

Table 1 Professional experience.

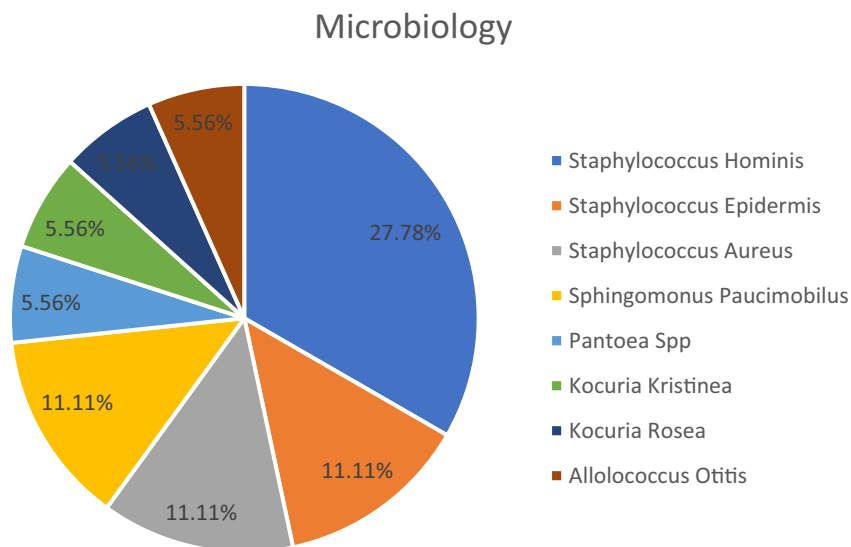
Question	Response			
No. of courses attended in the last 5 years	1 course	2 courses	> 2 courses	None
	5.7 %	10.0 %	82.9 %	1.4 %
Willing to take any infection control courses in future	No		Yes	
	4.3 %		95.7 %	
Heard about Occupational Safety & Health Academy	No		Yes	
	41.4 %		58.6 %	
Ever taken an OSHA course	No		Yes	
	77.1 %		22.9 %	

Table 2 Comparison of responses to the questionnaire regarding different infection control concepts and practices according to number of infection control courses attended in last 5 years.

			Infection control courses attended in last 5 years				P-value*
			1	2	> 2	None	
It's a waste of material to use new gloves to clean each clinic.	Strongly agree	Count	0	0	2	1	0.006
		%	0.0 %	0.0 %	3.4 %	100.0 %	
	Agree	Count	0	0	2	0	
		%	0.0 %	0.0 %	3.4 %	0.0 %	
	Neither agree nor disagree	Count	0	4	18	0	
		%	0.0 %	57.1 %	31.0 %	0.0 %	
	Disagree	Count	3	2	23	0	
		%	75.0 %	28.6 %	39.7 %	0.0 %	
	Strongly disagree	Count	1	1	13	0	
		%	25.0 %	14.3 %	22.4 %	0.0 %	

* Statistically significant at $p < 0.05$.**Table 3** Total response to the questionnaire regarding different infection control concepts and practices.

Question	Response				
	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
[It's a waste of material to use new gloves to clean each clinic.]	4.3 %	2.9 %	31.4 %	40.0 %	21.4 %
[I think it's a waste of material to change gloves/gown between student's clinics if NOT soiled.]	7.1 %	8.6 %	35.7 %	32.9 %	15.7 %
[I don't change gloves while distributing instruments for each clinic which i'm assigned to.]	4.3 %	7.1 %	44.3 %	30.0 %	14.3 %
[While i'm helping student A, student B needs help, so I only change the gloves]	30.0 %	41.4 %	14.3 %	10.0 %	4.3 %
[Dental University Hospital should provide annual infection control courses]	75.7 %	20.0 %	2.9 %	1.4 %	—

**Fig. 1** Pie chart illustrating the frequencies of different species of bacteria in the studied specimens.

5. Conclusion

The present study concluded that there is a lack of awareness of cross-contamination in dental clinics, which implicates that there is further need for implementation of infection control programs and raising more awareness regarding this topic. Moreover, dental assistants have expressed acceptance and willingness to further educate themselves by attending infection control courses. It was also found that there is an under-reporting of this topic in the literature indicating that it needs to be addressed more.

Ethical approval

This article does not include any studies involving human participants or animals performed by the author.

An exemption letter was provided by the Institutional Review Board (IRB) (No. E-20-4750).

Funding

This research did not receive any specific grant from funding agencies in the public commercial or not for profit sectors.

CRediT authorship contribution statement

Hamad Albagieh: Conceptualization, Project administration, Resources, Supervision, Validation. **May Alsenani:** Investigation, Writing – original draft, Writing – review & editing, Project administration, Supervision, Resources, Validation, Visualization, Methodology. **Mohammed Alshehri:** . **Hadi Alamri:** . **Nada Alghamdi:** Investigation, Writing – original draft, Writing – review & editing, Project administration, Supervision, Resources, Validation, Visualization, Methodology. **Rahaf Alawaji:** Investigation, Writing – original draft, Writing – review & editing, Project administration, Supervision, Resources, Validation, Visualization, Methodology. **Lulwah Almutib:** Investigation, Writing – original draft, Writing – review & editing, Project administration, Supervision, Resources, Validation, Visualization, Methodology.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

- Dagher, J., Sfeir, C., Abdallah, A., Majzoub, Z., 2017. Infection Control Measures in Private Dental Clinics in Lebanon. *International Journal of Dentistry* 2017. <https://doi.org/10.1155/2017/5057248>.
- Gerberding, J. L., Director Dixie Snider, M. E., Chu, S. Y., Thacker, S. B., Ward, J. W., Hewitt, S. M., Kay Smith-Akin, C., Douglas Weatherwax, Me. W., Bright, K. L., Quang Doan, M. M., & Erica Shaver, M. R. 2003. Dental Health-Care Settings-2003. In *MMWR* (Vol. 52, Issue 17). <http://www.ada.org>.
- Kohn, W. G., Collins, A. S., Cleveland, J. L., Harte, J. A., Eklund, K. J., Malvitz, D. M., & Centers for Disease Control and Prevention (CDC) 2003. Guidelines for infection control in dental health-care settings–2003. *MMWR. Recommendations and reports : Morbidity and mortality weekly report. Recommendations and reports*, 52 (RR-17), 1–61.
- Laheij, A. M. G. A., Kistler, J. O., Belibasakis, G. N., Välimaa, H., & de Soet, J. J. 2012. Healthcare-associated viral and bacterial infections in dentistry. In *Journal of Oral Microbiology* (Vol. 4, Issue 2012). <https://doi.org/10.3402/jom.v4i0.17659>.
- Malamed, S.F., Orr, D.L., 2014. *Medical Emergencies in the Dental Office: Seventh Edition. Medical Emergencies in the Dental Office. Seventh Edition*, pp. 1–550.
- Meunier, O., Hernandez, C., Piroird, M., Heilig, R., Steinbach, D., Freyd, A., 2005. Prélèvements bactériologiques des surfaces: importance de l'étape d'enrichissement et du choix des milieux de culture [Bacteriological sampling of surfaces: importance of the step of enrichment and the choice of the culture media]. *Annales de biologie clinique* 63 (5), 481–486.
- Reske, K. A., Park, D., Bach, T. H., Stewart, H. B., Vogt, L. C., Arter, O. G., Stoeckel, D., Steinkamp, H. M., Liang, S. Y., Durkin, M. J., & Kwon, J. H. 2022. Assessment of dental health care personnel protocol deviations and self-contamination during personal protective equipment donning and doffing. *Journal of the American Dental Association* (1939), 153(11), 1070-1077.e1. <https://doi.org/10.1016/j.adaj.2022.08.004>.
- Severn, M.M., Williams, M.R., Shahbandi, A., Bunch, Z.L., Lyon, L. M., Nguyen, A., Zaramela, L.S., Todd, D.A., Zengler, K., Cech, N. B., Gallo, R.L., Horswill, A.R., 2022. The Ubiquitous Human Skin Commensal *Staphylococcus hominis* Protects against Opportunistic Pathogens. *MBio* 13 (3). <https://doi.org/10.1128/mbio.00930-22>.
- Szymańska, J., Sitkowska, J., Dutkiewicz, J., 2008. Microbial contamination of dental unit waterlines. *Annals of Agricultural and Environmental Medicine : AAEM* 15 (2), 173–179.
- Wu, M., Shi, Z., Yu, X., Xu, Y., Jin, X., Zhang, L., Fu, B., 2022. Disinfection methods of dental unit waterlines contamination: a systematic review. *Journal of Medical Microbiology* 71 (6). <https://doi.org/10.1099/jmm.0.001540>.