Introduction

In hospitals and dental clinics, the major risk of infection for healthcare workers and dental professionals is the transmission from patients, through contaminated instruments or pieces of equipment and the hospital surroundings.[1,2] In hospital-acquired infections, surgical site infections (SSIs) and dental clinics play a role in more than 20% of infections.[3,4] It is by the Centre for Disease Control and Prevention that 2.7% of surgical procedures are complicated by patient working areas because of the presence of various infections.[5] With over 6 billion microbes/ml of saliva colonizing in every individual's oral cavity, the dental clinic is an axis of microbial pursuit. To maintain international guidelines and precautions for infection control, various protective measures have been taken to control the contamination of the dental clinics and to protect the patient and the dental personal. The significant part of infection control is the clinician’s mouth mask which acts as a strike to microorganisms from the touch of possibly contaminated hands to the contaminated aerosols due to routine ultrasonic scaling and high-speed handpieces.[6,7]

Spooner JL in 1967 in his review mentioned that Weaver and Capps were the first who described in 1915 that face masks are effective against contagious disease as well as cross infections.[8] In the dental clinics, the dentist mouth mask, major protective

Abstract

Context: Dental personals are more prone to acquire infections through saliva and aerosols. Surgical masks (SMs) are used by dental professionals to reduce microorganism shedding from the mouth, nose, and face of the patient. Aims: This aim of the study is to assess the bacterial and fungal presence and their prevalence over the contaminated surgical mask in dental practice. Settings and Design: This study was conducted with sample size 240 used surgical masks collected from 130 dental personnel. Subjects and Methods: A cross-sectional questionnaire survey was conducted with analysis involved inoculation of external and internal surfaces in an enrichment media for isolation of bacteria and fungi. Group of isolated bacteria and fungi were preliminarily identified by morphology and using Gram's stain and lacto-phenol cotton blue mediums. Data were analyzed using paired t-test; the significant level of $P < 0.050$. Results: Microbiological analysis of samples revealed bacteria Staphylococci 26.35% as a predominant species followed by Pseudomonas 17.82% and Streptococci 15.50%. Aspergillus fungal species was also present in 6.97%. Mean ± SD of bacterial and fungal contamination on inside/outside area of the used masks was 48 ± 26 and 180 ± 110 cfu/ml/piece and 14 ± 6 and 32 ± 13 cfu/ml/piece, respectively, $P < 0.001$. The used surgical masks from dental department personnel working outpatient dental department had relatively higher bacterial and fungal contamination than the other dental departments. Conclusions: To reduce a load of microorganism contamination in the clinical environment, more awareness campaigns should be implemented in daily routine and air quality of dental departments should be improved with necessary protective measures.

Keywords: Dental department, dental personal, microbial contamination, surgical mask

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equipment comes in direct closeness to the patient and is an area of significant concentration of the aerosol but the literature available showed that the surgical mouth mask might not be sufficient to protect the person from air-borne pathogens and might also be the origin of various air-borne and droplet infection.⁹,¹⁰ Hence, the present study was conducted to assess the bacterial and fungal presence and their prevalence over the contaminated surgical mask in dental practice.

Subjects and Methods

This study was conducted to assess the bacterial and fungal contamination and their prevalence on 240 used surgical face masks (face mask earloop triple-layered non-woven polypropylene) from 130 dental personnel during the 2 months period from September to November 2019. The participants of the study were of both genders aged 20 to 40 years, and have voluntarily participated and gave the signed consent form. The study was conducted with the ethical approval of the ethical committee. A cross-sectional survey was conducted using a self-administered questionnaire, consisting of seven questions used to assess the knowledge and practice of participants regarding the use of mouth mask.

The 130 dental clinic participants were working from different departments such as: Department of oral medicine and radiology, department of oral and maxillofacial surgery, department of pedodontics, department of endodontics, department of periodontics, and dental emergency room of the college. Their used surgical masks maximum of 30 min duration, which were 240 in total, were collected in sterile zip lock pouches to culture and analysis of the bacterial and fungal counts on the inside and outside surface of the mouth masks. Inside and outside surface of the mouth masks were separated by sterile technique and put in a sterile container consisting of trypticase soy broth for 25 min. A spread plate method was used for determining total bacterial and fungal counts. General bacteria of the specimen are cultivated in a plate count agar (PCA) and general fungi of the specimen are cultivated in a Sabouraud 4% dextrose agar (SDA). The plates were incubated at 37°C for 48 h to get the bacterial counts, and incubated at room temperature for 7 days for fungal counts. The observation was done daily for 10 days. With the method given by Larone 1995, preliminarily identification of microorganism's species present was done by Gram's stain and microscopic morphology (lactophenol cotton blue) of the isolated bacteria and fungi was performed.¹¹ After incubation, the bacterial and fungal colonies were counted and calculated to express as colony-forming unit/m³ (cfu/m³) by a formula as follows:

\[
\text{Total counts (colony-forming unit/m³ or cfu/m³)} = \frac{\text{Total colonies} \times 1000}{250}
\]

Collected data of the study were analyzed using Statistical Package for Social Sciences (SPSS) software version 17 using descriptive frequency method. Results are represented as frequency and percentage to estimate the prevalence of antimicrobial agents present in the samples as well the responses of participants. Mean and standard deviation (SD) for describing bacterial and fungal counts were analyzed using the paired t-test and to compare between the mean of microbial contamination on the outside and inside areas of used masks.

Results

A total of 240 used surgical masks were collected in the present study from 130 dental professionals from various departments to assess the bacterial and fungal contamination. Out of 130 participants, 73 were males and 57 were females. Questionnaire variables analysis revealed that 66.9% of participants wear their mouth-masks while working at chair-side and about 33% wear them all the time. 67.6% of the study participants keep their mouth equipment comes in direct closeness to the patient and is an area of significant concentration of the aerosol but the literature available showed that the surgical mouth mask might not be sufficient to protect the person from air-borne pathogens and might also be the origin of various air-borne and droplet infection.⁹,¹⁰ Hence, the present study was conducted to assess the bacterial and fungal presence and their prevalence over the contaminated surgical mask in dental practice.

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| Table 1: Participants response based on questionnaire |
|-----------------------------------------------------|
| **Variables**                                       | **Results** |
| Gender (n=130)                                      | Male        |
|                                                   | Female      |
| Time period of wearing mouth mask                  | Only Chairside |
|                                                   | Whole working time in clinics |
| Frequency of changing mouth mask                   | For every patient |
|                                                   | Once daily  |
| Practice of exchanging mouth mask with friends     | Yes         |
|                                                   | No          |
| Storage of mouth mask                              | Working apron pockets |
|                                                   | Books       |
|                                                   | Instrument tray |
| Working on the case without mouth mask             | Yes         |
|                                                   | No          |
| Awareness regarding used mouth mask causing cross-contamination if touched once | Yes |
|                                                   | No          |
| Disposal of mouth mask with household waste        | Yes         |
|                                                   | No          |

| Results n (%) |
|---------------|
| Male 73 (56.1) |
| Female 57 (43.8) |
| Only Chairside 87 (66.9) |
| Whole working time in clinics 43 (33) |
| For every patient 89 (68.4) |
| Once daily 41 (31.5) |
| Yes 35 (26.9) |
| No 95 (73) |
| Working apron pockets 25 (19.2) |
| Books 17 (13) |
| Instrument tray 88 (67.6) |
| Yes 55 (42.3) |
| No 75 (57.6) |
| Working on the case without mouth mask |
| Yes 111 (85.3) |
| No 19 (14.6) |
| Awareness regarding used mouth mask causing cross-contamination if touched once |
| Yes 21 (16.1) |
| No 109 (83.8) |
masks in the instrument trays, while 19.2% in their clinic working apron pockets. 85.3% participant responded that mouth-mask can cause cross-contamination when touched. In the present study, 42.3% participant attempted cases without a mouth mask and about 26.9% stated that they have exchanged their mouth-masks with others. 16.1% of participants stated that a mouth-mask can be disposed along with the normal household waste [Table 1].

All bacterial and fungal species were identified in samples by their morphological appearance and biochemical reaction characteristics. Table 2 results revealed that out of 240 samples collected, bacterial species was predominated by *Staphylococci* species 26.35% followed by *Pseudomonas* 17.82% and *Streptococci* 15.50%. *Aspergillus* fungal species was also present in 6.97%.

In the present study, results stated that the mean ± SD of bacterial contamination on the inside area of the used masks was 48 ± 26 cfu/ml/piece and 180 ± 110 cfu/ml/piece from the outside area. It was significantly different, P < 0.001. The used surgical masks from dental department personnel working outpatient dental department had relatively higher bacterial contamination than the other dental departments. [Table 3] For fungal contamination, mean ± SD on the outside area of the used masks was significantly higher than the inside area 14 ± 6 and 32 ± 13 cfu/ml/piece, P < 0.001. The used surgical masks from dental personnel working in the outpatient dental department had relatively higher fungal contamination than the other dental departments [Table 4].

### Discussion

In dental clinics, it has been assumed that bloodborne pathogens such as hepatitis B virus and hepatitis C virus can be transmitted through the inhalation of blood products in the aerosol, which obtain their main entry inside the body via the microabrasion in the mucosa of the airway.[13] In 1969 Micik, proposed the term “aerosol” and “splatter” in the dental clinics, which has a capacity to produce numerous health risks, among which tuberculosis and severe acute respiratory syndrome are considered fatal.[13,14]

In the present study, a cross-sectional questionnaire revealed that the study participants were not properly aware of the proper usage of mouth mask in clinical practice. Most of the participants have claimed to change mouth mask after every case but storage habit was not adequate and keeping mouth mask in instrument trays and working apron pockets causes external contamination, the main reason for a microbial load on the outer surface of a mouth mask. Studies done by Banu *et al.* and Vargese *et al.* stated that white coat pockets harbor various bacteria which can lead to infections in the clinical working area.[13,14] Monalisa *et al.* in their study found that 47% of participants reported keeping their mouth mask in instrument trays while 44% store mouth mask in apron pockets, which was consistent with the present study.[17]

In dental clinics, the usage of ultrasonic scaler tips which produces 300 colony forming units/cubic feet of bacteria and burs of high-speed handpieces are considered as the main source of aerosol production.[13,14] Marceswari *et al.* stated that microorganisms which are commonly present in the dental clinic working contaminated surfaces may include Gram-positive *Streptococcus* spp., *Staphylococcus* spp., and Gram-negative *Pseudomonas* spp., *E. coli*, and *Aspergillus* spp.[7] Most of the micro-organisms isolated from the used surgical mouth mask were potentially pathogenic and Gram-positive bacteria were isolated in majority of number from the present study which remains consistent with the study done by Pospere *et al.* where total bacteria from the dental professional face mask and from the contaminated surfaces in the dental clinics had 42% of *Streptococcus* species, 41% of *Staphylococcus*, and 17% of Gram-negative bacteria.[19]

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**Table 2: Number and percentage of prevalence of microorganisms**

| Organism indentified   | Number | %     |
|------------------------|--------|-------|
| *Pseudomonas*          | 46     | 17.82 |
| Klebsiella             | 28     | 10.85 |
| Acinetobacter          | 22     | 8.52  |
| *E. coli*              | 36     | 13.95 |
| Staphylococci          | 68     | 26.35 |
| Betahemolytic Streptocci | 40   | 15.50 |
| Aspergillus species    | 18     | 6.97  |
| Total                  | 258    | 100   |

| Studied Dept to collect sample | Mean ± SD of bacterial contamination (cfu/ml/piece) |  |
|-------------------------------|--------------------------------------------------|--
|                                | Inside mask                                       | Outside mask |
| Oral and maxillofacial surgery | 93 ± 6                                           | 232 ± 137    |
| Dept of periodontics (n=65)   | 39 ± 13                                          | 231 ± 134    |
| Dept of endodontics (n=45)    | 30 ± 13                                          | 149 ± 87     |
| Dental emergency room (n=35)  | 39 ± 20                                          | 164 ± 95     |
| Total (n=240)                 | 48 ± 26*                                         | 180 ± 110*   |

*Statistically significant difference by paired t test, P<0.001

**Table 3: Bacterial contamination on used surgical masks by studied dental depts.: Inside and outside areas of the used masks (n=240)**

| Studied Dept to collect sample | Mean ± SD of fungal contamination (cfu/ml/piece) |  |
|-------------------------------|--------------------------------------------------|--
|                                | Inside mask                                       | Outside mask |
| Oral and maxillofacial surgery | 16 ± 7                                           | 37 ± 13      |
| Dept of periodontics (n=65)   | 11 ± 6                                           | 34 ± 13      |
| Dept of endodontics (n=45)    | 15 ± 9                                           | 25 ± 16      |
| Dental emergency room (n=35)  | 14 ± 5                                           | 32 ± 13      |
| Total (n=240)                 | 14 ± 6*                                          | 32 ± 13*     |

*Statistically significant difference by paired t test, P<0.001
The present study was performed for the assessment of bacterial and fungal contamination on the used surgical masks among dental professionals. The disposable surgical mouth masks were at first developed to strain aerosols containing microorganisms discharged from the mouth and nose, and probably to shield the human respiratory system from fine airborne particles that are known to be linked with various respiratory disorders. Normally surgical mouth mask is developed to prevent microorganisms from the nose and oral cavity of the dental operator from spreading to others. However, surgical mouth mask is not well designed to filter particles of some infectious agents, especially *M. tuberculosis*. In the present study, bacteria and fungi were significantly more in number on the outer surface of contaminated used surgical mask which was found similar to study done by Lukksamijarulkul et al. with the presence of bacteria and fungi on outer surface of mask 166 ± 199 cfu/ml/piece and 34 ± 18 cfu/ml/piece, *P < 0.001* respectively. In 1998 Kretzer and Larson stated that some used mask behaviors probably increased the microbial contamination on the masks. Therefore, it is suggested that surgical masks could filter most of microorganism from the environment of dental clinics. Lukksamijarulkul et al. in their study found that the majority of isolates are *Staphylococcus aureus* (41%) and *Pseudomonas* species (38%) similar to the present study, and the most isolated fungi were *Apergillus* species (44%) and *Penicilium* species (25%) from the isolated incubated colonies, while in our study, only *Apergillus* spp. was present as fungal colony.

**Conclusion**

Dental clinics are places with a high concentration of various infectious microorganisms, present on the surgical mouth masks used by dental professionals. Moreover, as the saying goes: “Do not think any virtue trivial, and so neglect it; do not think any vice trivial, and so practice it.” Complete elimination of the risk raised by the aerosol is difficult but it can be minimized by using sterile water or sterile saline in dental water lines, draining and flushing water for a sufficient period of time before beginning the dental clinical work, performing periodic chemical treatment of dental chair water lines, and good housekeeping should be implemented. Moreover, dental professionals should change the mask after each dental operatory procedures, especially those beyond 2 h. Double-layered surgical mask or 95% efficiency for aerosol particles of 3.0 to 5.0 µm in diameter should be provided to patients as well to prevent cross-contamination.

**Declaration of patient consent**

The authors certify that they have obtained all appropriate participant consent forms. In the form, the participants have given their consent for their images and other clinical information to be reported in the journal. The participants understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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**Conflicts of interest**

There are no conflicts of interest.

**References**

1. Delclos GL, Gimeno D, Arif AA, Burau KD, Carson A, Lusk C, et al. Occupational risk factors and asthma among health care professionals. Am J Respir Crit Care Med 2007;175:667-75.
2. Luksamijarulkul P, Aiempradit N, Vatanasomboon P. Microbial contamination on used surgical masks Among hospital personnel and microbial air quality in their working wards: A hospital in Bangkok. Oman Med J 2014;29:346-50.
3. de Lissovoy G, Kraeman K, Hutchins V, Murphy D, Song D, Vaughn BB. Surgical site infection: Incidence and impact on hospital utilization and treatment costs. Am J Infect Control 2009;37:387.
4. Kirkland Kathryn B, Trivette Sharon L, Wilkinson William E, Sexton Daniel J. The impact of surgical-site infections in the 1990s: Attributable mortality, excess length of hospitalization, and extra costs. Infect Control Hosp Epidemiol 2014;20:725.
5. Zhiqing L, Yongyun C, Wenxiang C, Mengning Y, Yuanqing M, Zhenan Z, et al. Surgical masks as source of bacterial contamination during operative procedures. J Orthop Translat 2018;14:57-62.
6. D’dharan SR, Arjunkumar R. Decreasing aerosol contamination and prevention of cross infection due to ultrasonic scaling. Int J Adv Res 2014;2:903-7.
7. Mareeswari GM, Joy ET, Kiran MS, David CM, Sherubin JE, Manchil Dhas PR. Prevalence of microbial colonization in the mouth mask used by the dental professionals. J Med Radiol Pathol Surg 2016;2:7-10.
8. Spooner JL. History of surgical mouth masks. AORN J 1967;5:76-80.
9. Willeke K, Qian Y, Donnelly J, Grinshpun S, Ulevicius V. Penetration of airborne microorganisms through a surgical mask and a dust/mist respirator. Am Ind Hyg Assoc J 1996;57:348-55.
10. Fennelly KP. Personal respiratory protection against Mycobacterium tuberculosis. Clin Chest Med 1997;18:1-17.
11. Larone DH. Medically Important Fungi: A Guide to Identification. 4th ed. Washington DC: American Society of Microbiology Press; 2002.
12. Kaur R, Singh I, Singh G, Mahajan A. Aerosols a menace for the dental healthcareers. J Pharm Biomed Sci 2013;30:558-63.
13. Micik RE, Miller RL, Mazzarella MA, Ryge G. Studies on dental aerobiology. I. Bacterial aerosols generated during dental procedures. J Dent Res 1969;48:49-56.
14. Toroglu MS, Bayramoglu O, Yarkin F, Tuli A. Possibility of blood and hepatitis B contamination through aerosols generated during debonding procedures. Angle Orthod 2003;73:571-8.
15. Banu A, Anand M, Nagi N. White coats as a vehicle for bacterial dissemination. J Clin Diagn Res 2012; 6:1381-84.
16. Vargese D, Patel H. Hand Washing. Stethoscopes and white coats are sources of nosocomial infection. BMJ 1999;319:519.
17. Monalisa, Aruna CN, Padma KB, Manjunath K, Hemavathy E, Varsha D. Microbial contamination of the mouth masks used by post-graduate students in a private dental institution: An In-Vitro Study. IOSR J Dent Med Sci 2017;16:61-7.
18. Swaminathan Y, Thomas JT. "Aerosol" - A prospective contaminant of dental environment. JDMS 2013;11:45-50.
19. Pospero E, Savini S, Annino I. Microbial aerosol contamination of dental healthcare workers' faces and other surfaces in dental practice. Infect Control Hosp Epidemiol 2003;24:139-41.
20. Kretzer EK, Larson EL. Behavioral interventions to improve infection control practices. Am J Infect Control 1998;26:245-53.
21. Dintakurti SK, Sudheep N. Aerosols: A concern for dentist. Int J Dent Adv 2010;2:100-2.
22. Seitz TA. NIOSH indoor air quality investigations 1971-1988. In: Weekes DM, Gammage RB, editors. Proceedings of the Indoor Air Quality, International Symposium: May 23, 1989. Cincinnati, OH: National Institute for Occupational Safety and Health; 1989. p. 163-71.
23. World Health Organization. Indoor air quality: Biological contaminants. Report on a WHO meeting. WHO Reg Publ Eur Ser 1990;31:1-67.
24. Kodama AM, McGee RL. Airborne microbial contaminants in indoor environments. Naturally ventilated and air-conditioned homes. Arch Environ Health 1986;41:306-11.
25. Radonovich LJ Jr, Simberkoff MS, Bessesen MT, Brown AC, Cummings DAT, Gaydos CA, et al. N95 Respirators vs Medical Masks for Preventing Influenza Among Health Care Personnel: A Randomized Clinical Trial. JAMA 2019;322:824-33.