Microbial Air Contamination in Dental Clinics with Different Ventilation Systems

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Abstract

The study aimed to compare the Total Viable Aerobic Count (TVACs) before and during dental procedures in two different ventilation systems, the first systems in a Pre-Upgrade Dental Clinic that has separated air conditioners and standing air purifiers, the second systems in a Special Dental Clinic, and a Post-Upgrade Dental Clinic, which have a centralized ventilation and air purifying systems, with the Index of Microbial Air Contamination (IMA). The data was collected the numbers of bacteria and fungi colony in blood agar (BA) and Sabouraud dextrose agar (SDA). The settle plates were placed 50 cm from a patient's head, and 1 metre from the wall. Each sampling was placed 1 hour before and during dental procedures, for three days. The Result, in the Special Dental Clinic, the Pre-Upgrade Dental Clinic and the Post-Upgrade Dental Clinic TVACs before and during dental procedures were 71 and 46, 58 and 45, 93 and 15 CFU/dm2/hr, respectively. The Wilcoxon Sign-Rank test showed a statistically significant difference for each setting ($p<0.001$). Considering three days of data collection, The Kruskal Wallis test indicated that in the Special Dental Clinic (before and during dental procedure) and the Pre-Upgrade Dental Clinic (during procedure), TVACs showed no statistically significant difference. The TVACs showed statistically significant difference in the Pre-Upgrade Dental Clinic (before dental procedure) and the Post-Upgrade Dental Clinic (before and during dental procedure) ($p<0.001$) Conclusion, the IMA indicated "fair" for the Special Dental Clinic and the Pre-Upgrade Dental Clinic before and during dental procedures. In contrast, the Post-Upgrade Dental Clinic indicated "poor" before dental procedure and "good" in during dental procedure. The TVACs of 2 ventilation systems showed less TVAC during dental procedure than before dental procedure, with a statistically significant.

Keywords: *Dental clinics/ Microbial air contamination/ Aerosol/ Dental hospital/ Centralized ventilation system*

Received: *Dec 21, 2023*
Revised: *Mar 27, 2024*
Accepted: *Mar 29, 2024*

Introduction

The coronavirus disease 2019 (COVID-19) originated in the city of Wuhan, Hubei Province, China. The disease, currently known as COVID-19, has since been spreading and jeopardizing public health around the world.[1] The World Health Organization (WHO) declared this outbreak a public health emergency of international concern. As of February 26, 2020, COVID-19 has been identified in 34 nations.[2] The disease had been continuity spreading around the country that effected to Economics, Education, and health policy especially dental practitioners.[3] In dental settings, where the production of droplets and aerosols is notable, there's an increased risk of infections being transmitted between patients and dental professionals.[2] Many dental procedures produce aerosols and droplets that are contaminated with bacteria and blood, such as polishing and air abrasion. These aerosols represent a potential route for disease transmission.) In order to effectively reduce the risk of infection, dental clinics utilize personal protective equipment (PPE) such as gloves, masks, eye protection, and gowns, while also ensuring adequate ventilation and implementing rigorous disinfection procedures among patients.[4,5] However, there are many other techniques that can reduce aerosols, such as using air purifying systems and using exhaust fans.[6]

Therefore, the Faculty of Dentistry, Khon Kaen University, improve the ventilation in dental clinics to reduced risk of infection from the dental procedures. The Special Dental Clinic, where the dentists provide a treatment, has the greatest of both number of patients and utilizing rate.

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According to the data, there were 23,737 patients in 2020. Compared to a Pre -Upgrade Dental Clinic, which the treatments were provided by the dental students, has 3,527 patients per year. And then Pre-Upgrade Dental Clinic was completed development that is called Post-Upgrade Dental Clinic.

International standards provide various methods for evaluation microbial air contamination, including both active and passive sampling techniques. In active monitoring, a microbiological air sampler mechanically pulls a known volume of air through or over a collection device containing either liquid or solid culture media, measuring the quantity of microorganisms present in CFU (colony forming units) per cubic meter of air.[7] On the other hand, passive sampling assesses the rate at which microorganisms settle on surface. This method involves exposing settle plates to air for a defined period of time; results are expressed as Total viable aerobic counts (TVACs)(CFU/plate/time).[8] The passive method is standardized by the Index of Microbial Air Contamination (IMA), correlating with the CFU count on a Petri dish. In a study by Inyawilert et al., it was observed that microbial levels by active sampling in Dental Clinic.[9] Active sampling was employed for data collection, which is complexities due to the need for instrument calibration and cleaning, as well as altering the airflow in the clinic. Consequently, the passive method using settle plates was chosen for its simplicity and independence from engineering factors in sample collection.

This study is aimed at comparing the TVACs, which the data was collected by the passive method before and during dental procedures in two different ventilation systems, with The Index of Microbial Air Contamination (IMA).

Materials and Methods

Study design

This cross-sectional experimental study was conducted in April 2021 and March 2022. The study sites were dental clinics at the Faculty of Dentistry, Khon Kaen University. This is an experimental study no ethics approval was required.

The data was collected in 3 dental clinics, that is The Special Dental clinic**,** Pre-Upgrade Dental Clinic and Post-Upgrade Dental Clinic. The specific time for collecting data was depended on the greatest number of the patient. In Pre and Post-Upgrade Dental Clinics, dental students perform dental procedures, resulting in the highest utilization rate typically occurring around 10:00-11:00 a.m. On the other hand, in the Special Dental Clinic where dentists work, the peak number of patients usually occurs around 5:00-6:00 p.m. in table 1.

The number of Petri dishes was determined by the square root of room area(m^2).[7] The actual samples collected was the resulting square root plus an additional 10%, to allow room for correction in case of samples becoming contaminated during data collection. Following this, the Special Dental Clinic, Pre-Upgrade Dental Clinic and Post-Upgrade Dental Clinic were represented by 17, 21 and 30 samples, respectively (Table 1). The contaminated plate was excluded when it was compromised by water spots on its surface, plate fracture, and contamination with a foreign body on the plate. Therefore, if the plate in a given area be contaminated, all data pertaining to that area shall be excluded from the study's analysis.

Table 1 Dental clinic characteristics and data collection

Dental clinic characteristics	Time of collection		Total of plate in 1 day				Total of plate
			BA (Plates)		SDA (Plates)		in 3 days
	Before dental procedure	During dental procedure	Before	During	Before	During	(plates)
Special Dental Clinic	7.30 – 8.30 A.M.	5.00 – 6.00 P.M.	17	17	17	17	204
Pre-Upgrade Dental Clinic	7.30 – 8.30 A.M.	10.00 – 11.00 A.M.	21	21	21	21	252
Post-Upgrade Dental Clinic	7.30 – 8.30 A.M.	10.00 – 11.00 A.M.	30	30	30	30	360

Data collection

Indoor microbial air contamination was collected through passive air sampling for 60 minutes using open Petri dishes filled with Blood agar (BA) and Sabouraud dextrose agar (SDA) The method follows the standard 1/1/1 scheme (1-hour exposure, 1 meter above the floor, and 1 meter away from the wall). Each Petri dish was placed 50 cm away from a patient's head.[8] The data collection was divided into two procedures: before and during dental procedures. Data sampling was conducted for three days in a week (Monday, Wednesday and Friday), with the amounts of patients and types of dental procedure recorded. Data collection was done on April 2021 for both the Special Dental Clinic and the Pre-Upgrade Dental Clinic and on March 2022 for the Post-Upgrade Dental Clinic.

Data Analysis

The BA and SDA were incubated aerobically at 37 °C for 48 hours. The numbers of colonies were counted after 48 hours of incubation in the Colony Forming Unit (CFU) and then translated into a per-square unit of the dish (0.636 dm^2). The sums of the bacterial and fungal colonies were calculated to arrive at the TVACs, which can be benchmarked against the IMA index ($CFU/dm^2/hr$) to determine air quality[8]. (Table 2) In addition, the utilization rate of dental clinics is determined by the proportion of dental units being used compared to all dental units available in dental clinics.

Table 2 IMA classes and their application

IMA value	$CFU/dm^2/h$	Performance	In place at risk
0 - 5	0 - 9	Very good	Very high
6 - 25	10 - 39	Good	High
26 - 50	40 - 84	Fair	Medium
51 - 75	85 - 124	Poor	-
≥ 76	≥ 125	Very poor	-

The Kruskal-Wallis test was used to determine if the TVACs differed from day to day (3 days) for each of the Clinics, followed by a post-hoc analysis. The Wilcoxon signed-rank test was used to ascertain if the TVACs would be different between before and during dental procedures in each of the Clinics. All statistical analyses were conducted using the IBM SPSS Statistics v.28. Statistics software and a p-value of 0.05.

Results

1. The demographic data of Dental Clinics

The demographic data of Dental Clinics show that in the Special Dental Clinic, there are 13 rooms separated by tall partitions (1 dental unit per room); the total area is 220 m^2. The dental procedures in this Clinic included Endodontics, Prosthodontics, Periodontal and Pediatrics. The Pre-Upgrade Dental Clinic had a total area of 347 m^2, with 32 dental units. The dental procedures involved Endodontics, Prosthodontics, Periodontal and Restorations. The Post-Upgrade Dental Clinic contained 67 dental units in a total area of 690 m^2. The dental procedures in this clinic were Endodontics, Prosthodontics and Restorations (Table 3).

2. Dental procedures and utilization rates

The result shows the Utilization rate and dental procedure of the three dental clinics. The details of the data collected during the dental procedures in 3 days. The most frequent procedures seen in the Special Dental Clinic was Prosthodontics. In the Pre-Upgrade and The Post-Upgrade Dental Clinics, the Restoration procedures were more common than others (Table 4).

3. Total amounts of microbial air contamination and corresponding IMA indices in the 2 different ventilation systems before and during dental procedures

Based on the data collection procedure, no contaminated plates were observed in the Special Dental clinic. One plate was found to be contaminated in the Pre-Upgrade Dental Clinic, leading to the exclusion of 12 data points. A total of 120 plates were analyzed in this clinic. In the Post-Upgrade Dental Clinic, two plates were contaminated, resulting in the exclusion of 24 data points. A total of 168 plates were analyzed in the Post-Upgrade Dental Clinic (Table 5).

Table 3 Demographic data, dental procedures, and spatial information

Clinics	Ventilation systems	Dental procedure	Dental units	Area (m^2)
Special Dental Clinic	Central air condition Central HVAC with HEPA H13 filter	Endodontics Prosthodontics Periodontal Pediatrics	13 (with tall partitions almost reaching the ceiling between them)	220
Pre-Upgrade Dental Clinic	Air purifiers Split air conditions Exhaust fans	Endodontics Prosthodontics Periodontal Restorations	32 (3.3 meters apart from one another & with partitions of 1.5 meter in height)	347
Post-Upgrade Dental Clinic	Central air condition Central HVAC with HEPA H13 filter	Endodontics Prosthodontics Restorations	67 (3.3 meters apart from one another & with partitions of 1.5 meter in height)	720

Table 4 Dental procedures and utilization rates

Clinics	Utilization rate (%)	Dental Procedures (dental units)					
		Endodontics	Restorations	Prosthodontics	Pediatrics	Periodontals	Others
Special Dental Clinic							
Day 1	92.30	1	0	4	2	2	3
Day 2	92.30	1	0	4	3	1	3
Day 3	84.61	1	0	5	1	2	2
Total		3	0	13	6	5	8
Pre-Upgrade Dental Clinic							
Day 1	27.27	1	5	3	0	0	0
Day 2	54.54	4	7	7	0	0	0
Day 3	30.30	3	6	0	0	0	1
Total		8	18	10	0	0	1
Post-Upgrade Dental Clinic							
Day 1	26.08	0	8	4	0	0	0
Day 2	41.30	5	8	6	0	0	0
Day 3	54.34	3	10	8	0	0	3
Total		8	26	18	0	0	3

Table 5 The Results of the comparison of microbial air contamination in 3 dental clinics before and during dental procedure

Clinics	Total amount of plate	Microbial ($CFU/dm^2/hr$)(SD)	IMA Performance	Sig [a]	Sig [b]
Special Dental Clinic					
Before	102	71(52.76)	Fair	<.001	.732
During	102	46(37.42)	Fair		.743
Pre-Upgrade Dental Clinic					
Before	120	58(27.04)	Fair	<.001	<.001
During	120	45(24.54)	Fair		.070
Post-Upgrade Dental Clinic					
Before	168	93(56.78)	Poor	<.001	<.001
During	168	15(9.06)	Good		<.001

a. Comparison between before and during dental procedures using the Wilcoxon Signed-Rank test

b. Comparison across the 3 days of observations and data collection using the Kruskal Wallis test

This study found that the air quality both before and during dental procedures, as indicated by the IMA index was "fair" in the Special Dental Clinic and the Pre-Upgrade Dental Clinic. However, in the Post-Upgrade Dental Clinic based on these TVACs, the IMA scale indicated "poor" air quality before dental procedures and "good" air quality during in the Post-Upgrade Dental Clinic. (Table 5) The presence of bacterial and fungal colonies in three dental clinics was examined both before and during dental procedures, as detailed (Table 6).

Table 6 Results of the comparison of bacterial and fungal colonies in the 3 dental clinics before and during dental procedures

Clinics	Bacteria (CFU/dm^2/hr)(SD)	Fungi (CFU/dm^2/hr)(SD)
Special Dental Clinic		
Before	61.04 (45.87)	10.07 (8.67)
During	36.29 (28.05)	9.6 (10.65)
Pre-Upgrade Dental Clinic		
Before	44.99 (23.16)	13.14 (9.00)
During	36.33 (22.02)	8.58 (5.48)
Post-Upgrade Dental Clinic		
Before	82.24 (57.52)	10.95 (7.95)
During	13.26 (8.95)	1.31 (2.05)

Comparing the TVACs before and during dental procedure the Wilcoxon Sign-Rank test showed a statistically significant difference for each of the ventilation settings ($p<0.001$, significance level of 0.05), as showed in Table 5. The tendency is that the TVACs were less during dental procedures, as the ventilation systems were in operation.

Comparing the TVACs using data collected for three days (Table 5), the Kruskal Wallis test indicated that in the Special Dental Clinic (before and during dental procedure) and the Pre-Upgrade Dental Clinic (during procedure, showed no statistically significant difference. However, TVACs showed statistically significant difference in the Pre-Upgrade Dental Clinic (before dental procedure) and the Post-Upgrade Dental Clinic (before and during dental procedure) ($p<0.001$).

Discussion

This study found that the amounts of airborne microorganisms, when benchmarked against the IMA index introduced by Pasquarella et al.,[8] indicated "Fair" air quality before and during dental procedures in the Special Dental Clinic and the Pre-Upgrade Dental Clinic. "good" air quality during dental procedures in the Post-Upgrade Dental Clinic. This is in line with the research finding by Manarte-Monteiro et al.[10] concluded that during dental procedures, the TVACs was 11.9 CFU/dm^2/hr, which indicated "good" air quality on the IMA scale. Moreover, Jain M et al.[11] collected data for two weeks in four different dental clinics and similarly found that the IMA indices indicated "good" and "fair" air quality for before and during dental procedures, respectively.

Comparing the amounts of bacterial and fungal colonies before and during dental procedures, the result study pointed out that there was less air contamination during dental procedures. Dehghani M et al.[12] compared the amounts of bacteria in a surgery room before and after the room was sanitized and air-conditioned, and they arrived at a similar conclusion. That is, before sanitation and air conditioning, the TVACs stood at 14.65 - 167.40 CFU/ m^3; after the room was cleaned and air-controlled, the TVACs was recorded at only 9.50 - 38.40 CFU/m^3. This showed a statistically significant difference (diff=30 CFU/m^3; significance level of 0.05) between before and after. The surgery rooms were sterilized with UV irradiation in a short span of time (<2 h). Furthermore, Guida et al.[13] found that the TVACs of airborne microorganisms before dental procedures was 86.6 CFU/m^3 while the count was lower at 82.34 CFU/m^3 during dental procedures. In contrast, Bârlean et al.[14] observed an increase in aerosol colonies to 429.6 CFU/m2 after 4 hours of dental procedures, compared to 129 CFU/m2 before any clinical treatment. The clinical procedures conducted by dentists varied based on patient requirements, including prophylactic measures such as calculus removal using ultrasonic scalers for 10-20 minutes, and/or operative dental treatments involving drilling with air-driven, water-cooled handpieces. Notably, the use of rubber dams for adult patients and oral pre-procedural rinses with antiseptic solutions were not implemented.

Kedjarun et al.[15] attributed a reduction in microbial counts during dental procedures to the improvements made to the ventilation system of a clinic. Such improvements include increasing the number of suctions, filtering and purifying fans; using rubber dam sheets; and decreasing the number of patients.

The Dental Safety Goals and Guidelines for 2023 suggest three ventilation systems for improving the dental environment. The first is natural ventilation, which involves opening windows, although they should not be opened during treatment. The second is mechanical ventilation, which includes options such as Fan Filter Units, Exhaust Fan Units, and Air Cleaners. The third option is Hybrid or Mix-Mode Ventilation, which combines mechanical and natural ventilation.[16] Furthermore, C. Hallier et al.[17] studied the amounts of airborne microorganisms in a dental clinic with and without aerosol vacuum cleaners. The study found that the average count of those microorganisms was 5.6 CFU/m^3 in the clinic with aerosol vacuum cleaners during dental procedures, compared to 23.9 CFU/m^3 without. With regard to using rubber dam sheets, a study by Samaranayake et al.[18] pointed out that the dam sheets, when used in conjunction with mouth washers and aerosol vacuum cleaners, could reduce aerosols by 90-98%. In addition, T. Maurais et al.[19] assessed the effectiveness of air purifiers in reducing air microbes in a dental clinic and concluded that they helped to reduce air contamination to a great extent during dental procedures.

The utilization of heating, ventilation and air-conditioning (HVAC) systems led to a positive impact, evidenced by enhancements in vital signs, quicker recovery, and increased physical activity. This beneficial effect was evident in shorter hospital stays for patients with respiratory conditions.[20] Bacterial growth and survival depend on environmental conditions, including temperature. Elevated temperatures have been observed to markedly enhance bacterial growth; nevertheless, ventilation has the potential to mitigate this increase.[21] However, the data of temperature and air changes in dental clinics were not included in the study.

Higher TVACs were observed in the morning before dental procedures. Because the air had not been circulated through the ventilation system, causing aerosols to disperse during the night and prior to morning dental procedure. The study of Kedjarune U. et al.[15] indicated a similar observation and explained that bacteria grew and spread at night during which the ventilation system was off. Furthermore, before dental procedures, the Post-Upgrade Dental Clinic had "poor" air quality (93 CFU/dm^2/hr) compared to "fair" air quality in the Pre-Upgrade Dental Clinic and Special Dental Clinic (58 and 71 CFU/dm^2/hr, respectively). It could be explained that the Post-Upgrade Dental Clinic had a sealed environment, which blocked air in- and outflows and subsequently caused bioaerosols to proliferate. In contrast, the walls of the Pre-Upgrade Dental Clinic were not completely sealed, leaving the air to flow in and out and thus reducing the spread of airborne microorganisms. Moreover, the Dental Clinic closes on the weekends; thus, idle time in the Clinic allowed the spread of aerosols to accelerate. On the contrary, the Special Dental Clinic and its ventilation system are in operation every day; aerosols had less time to accumulate. Therefore, other than different ventilation settings, the timing of clinical procedures and the frequency at which such ventilation systems are used have a major impact on air contamination in dental clinics.

In this research, the setting of the dental clinics are a multi-chair dental units, which differs from a private dental clinic. In the multi-chair clinic, the air can spread to other dental units if ventilation is inadequate. However, this differs from the private dental clinic, where each clinic room contains only a single dental unit. Therefore, the air contamination is minimized, reducing the likelihood of spreading to others. The Pre and Post-Upgrade Dental Clinics, there were 1.5-meter partitions separating each dental unit, with the dental units being 3.3 meters apart from one another. In the Special Dental Clinic, the partitions almost reached the ceiling allowing each dental unit to be in an isolated, yet connected, space. With regard to this, Holliday et al.[22] concluded that although a dental clinic may not have partitions of the height of the ceiling (i.e., only 1.5 meter in height), the spread of aerosols and air contamination could be reduced by using suction and filtering fans to expel clean air into the dental clinic together with using aerosol vacuum cleaners. This helps prevent aerosols from spreading across dental units.

The average amount of fungal colonies over three days showed a statistically significant difference, but for bacterial colonies during dental procedures, there was no statistically significant difference. Obbard et al.[23] found that bacterial air contamination infections are associated with the number of people in a room, whereas fungal air contamination is not associated with the number of people. Additionally, Hiwar et al[24]. found that there was no significant correlation between airborne total fungi (TF) and temperature, relative humidity, or CO2 levels.

In the Pre-Upgrade Dental Clinic, the TVACs before dental procedures differed from day to day to a statistically significant extent due to unsealed environment. Thus, varied weathers and outdoor air conditions lead to different degrees of air contamination in the room.[25] A similar observation was noted by Tolabi et al.;[26] the opening of doors before and during dental procedures, which allows the air to flow, affect air contamination in dental clinics. Furthermore, American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) suggested increasing the rate of air filtering where possible in order to reduce air contamination in dental clinics. In the case of dental procedures that cause much diffusion of droplets and aerosols, the American College of Surgeons recommended using high-efficiency particulate absorbing filters (HEPA filters) to reduce the risk of infection during surgeries.[27]

The Covid-19 pandemic led hospitals - private, public and university - to improve their ventilation systems in dental clinics. This study indicated that the Special Dental Clinic and Pre-Upgrade Dental Clinic had “fair” air quality both before and during clinical procedures, despite their different ventilation settings. Given the same air quality observed in these two Dental Clinics, the air-controlling system in the Special Dental Clinic cost more than the one in the Pre-Upgrade Dental Clinic. Additionally, the ventilation upgrade made for the Dental Clinic (Post-Upgrade) resulted in “good” air quality during dental clinics; however, that also came with additional costs. Therefore, it is imperative that the most appropriate and cost-effective ventilation system be chosen and developed to suit the need and budget of each dental hospital. The ventilation of dental clinics can be developed by Central HVAC with HEPA H13 filters, similar to the Special dental clinic and the Post-Upgrade dental clinic. Alternatively, it can be improved by air purifiers and exhaust fans, like the Pre-upgrade dental clinics. Thus, the microbial air contamination decreased during dental procedures. In addition, Microbial air contamination tends to increase before dental procedures, so the ventilation system should be activated before starting any dental treatment.

Therefore, further studies may be conducted in more dental clinics, with higher utilization rates and under different ventilation settings (i.e., with and without filtering fans), to enhance the generalizability, comparability, and applicability of research findings towards effective and cost-efficient improvements for dental clinics and thus a safer environment for both dental practitioners and patients.

Conclusion

This study of microbial air contamination in dental clinics with two different ventilation systems and settings at the Faculty of Dentistry, Khon Kaen University, found that The IMA indicated “fair” air quality for the Special Dental Clinic and the Pre-Upgrade Dental Clinic, both before and during dental procedure. In contrast, the Post-Upgrade Dental Clinic indicated “poor” before dental procedure and “good” air quality in during dental procedure. TVACs before and during dental procedures, showed a statistically significant difference for each of the ventilation settings. The TVACs were less during dental procedures.

Acknowledgements

We thank the members of the maxillofacial team, and microbiology laboratory for their contributions inpatient care.

Conflict of interest statement

None declared.

Funding statement

The research center of Faculty of Dentistry, Khon Kaen University.

References

1. Phelan AL, Katz R, Gostin LO. The Novel Coronavirus Originating in Wuhan, China: Challenges for Global Health Governance. JAMA 2020;323(8):709-10
2. Meng L, Hua F, Bian Z. Coronavirus disease 2019 (COVID-19): emerging and future challenges for dental and oral medicine. J Dent Res 2020;99(5):481-87
3. The International Health Policy Program, Thailand (IHPP), Socio-Economical Effects from COVID-19 pandemic in Global and Thailand. Bangkok: Ministry of Public Health; c2019-2023 [cited 2023 Jan 27]. Department of Disease Control; [about 25 screens]. Available from https://ddc.moph.go.th/uploads/publish/1177420210915075055.pdf.
4. Caggiano M, Acerra A, Martina S, Galdi M, D'Ambrosio F. Infection control in dental practice during the COVID-19 pandemic: what is changed. IJERPH. 2023;20(5):3903.
5. Wang Q, Wang X, Lin H. The role of triage in the prevention and control of COVID-19. ICHE. 2020; 41(7):772-76.
6. Yadav N, Agrawal B, Maheshwari C. Role of high-efficiency particulate arrestor filters in control of air borne infections in dental clinics. SRM J Res Dent Sci 2015;6(4):240-2.
7. Pasquarella C, Albertini R, Dall'aglio P, Saccani E, Sansebastiano GE, Signorelli C: Air microbial sampling: the state of the art. Ig. Sanita Pubbl 2008;64(1):79-120.
8. Pasquarella C, Pitzurra O, Savino A. The index of microbial air contamination. J Hosp Infect 2000;46(4): 241-56
9. Inyawilert K, BunSyatratchata O, Klangthong A, Kamsa-ard S, Luengpailin S, Rattanathongkom A. Bacterial air contamination inside the dental clinic II and special dental clinic at the dental hospital, faculty of dentistry, khon kaen university. Khon Kaen Dent J 2016;19(2): 107-14
10. Manarte-Monteiro P, Carvalho A, Pina C, Oliveira H, Manso MC. Air quality assessment during dental practice: Aerosols bacterial counts in an universitary clinic. Rev Port Estomatol Med Dentária e Cir Maxilofac 2013;54(1):2-7
11. Jain M, Mathur A, Mukhi PU, Ahire M, Pingal C. Qualitative and quantitative analysis of bacterial aerosols in dental clinical settings: Risk exposure towards dentist, auxiliary staff, and patients. J Family Med Prim Care 2020;9(2):1003-008
12. Dehghani M, Sorooshian A, Nazmara S, Baghani AN, Delikhoon M. Concentration and type of bioaerosols before and after conventional disinfection and sterilization procedures inside hospital operating rooms. Ecotoxicol Environ Saf 2018;164:277-82
13. Guida M, Gallé F, Di Onofrio V, Nastro RA, Battista M, Liguori G, et al. Environmental microbial contamination in dental setting: a local experience. J Prev Med Hyg 2012;53(4):207-12
14. Bârlean L, Iancu LS, Minea ML, Dănilă I, Baciu D. Airborne microbial contamination in dental practices in Iasi, Romania. Ohdmbsc 2010;9(1):16-20
15. Kedjarune U, Kukiattrakoon B, Yapong B, Chowanadisai S, Leggat PA. Bacterial aerosols in the dental clinic: effect of time, position and type of treatment. Int Dent J 2000;50(2):103-7
16. Thai Dental council [homepage on the Internet]. Dental safety guide line 2023, [updated 2024; cited 2024 Mar 5]. Available from: https://dentalcouncil.or.th/ upload/files/1WExCviGHZFpLU4Q0gmSd6MsXzcy DbK.pdf
17. Hallier C, Williams DW, Potts AJC, Lewis MAO. A pilot study of bioaerosol reduction using an air cleaning system during dental procedures. Br Dent J 2010; 209(8):E14
18. Samaranayake LP, Fakhruddin KS, Buranawat B, Panduwawala C. The efficacy of bio-aerosol reducing procedures used in dentistry: a systematic review Acta Odontol Scand 2021;79(1):69-80

19. Maurais MT, Kriese LNJ, Fournier MM, Langevin LL, Mac Leod B, Blier LS, et al. Effectiveness of selected air cleaning devices during dental procedures. Mil Med 2023;188(1-2):e80-85
20. Lenzer B, Rupprecht M, Hoffmann C, Hoffmann P, Liebers U. Health effects of heating, ventilation and air conditioning on hospital patients: a scoping review. BMC Public Health 2020;20(1):1287.
21. Qiu Y, Zhou Y, Chang Y, Liang X, Zhang H, Lin X, et al. The effects of ventilation, humidity, and temperature on bacterial growth and bacterial genera distribution. Int J Environ Res Public Health. 2022 Nov 20;19(22):15345.
22. Holliday R, Allison JR, Currie CC, Edwards DC, Bowes C, Pickering K, et al. Evaluating contaminated dental aerosol and splatter in an open plan clinic environment: Implications for the COVID-19 pandemic. J Dent 2021;105:103565
23. Obbard, JP, Fang LS. Airborne concentrations of bacteria in a hospital environment in singapore. Water, Air, & Soil Pollution 2003;144(1):333-41.
24. Hiwar W, King MF, Shuweihdi F, Fletcher LA, Dancer SJ, Noakes CJ. What is the relationship between indoor air quality parameters and airborne microorganisms in hospital environments? A systematic review and meta-analysis. Indoor Air 2021;31(5):1308-322.
25. Chegini FM, Baghani AN, Hassanvand MS, Sorooshian A, Golbaz S, Bakhtiari R, et al. Indoor and outdoor airborne bacterial and fungal air quality in kindergartens: Seasonal distribution, genera, levels, and factors influencing their concentration. Build Environ [Internet]. 2020;175:106690. Available from: https://doi.org/10.1016/j.buildenv.2020.106690
26. Tolabi Z, Alimohammadi M, Hassanvand MS, Nabizadeh R, Soleimani H, Zarei A. The investigation of type and concentration of bio-aerosols in the air of surgical rooms: A case study in Shariati hospital, Karaj. MethodsX 2019;6:641-50.
27. Mousavi ES, Kananizadeh N, Martinello RA, Sherman JD. COVID-19 outbreak and hospital air quality: a systematic review of evidence on air filtration and recirculation. Environ Sci Technol 2021;55(7):4134-4147

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การปนเปื้อนจุลินทรีย์ในอากาศ ในคลินิกทันตกรรมที่มีระบบปรับอากาศที่แตกต่างกัน

วทัญญู ขอดแก้ว สมเกียรติ เหลืองไพรินทร์** อังคณา คลังทอง****

บทคัดย่อ

การศึกษานี้มีวัตถุประสงค์เพื่อเปรียบเทียบการปนเปื้อนจุลินทรีย์ในอากาศ ก่อนและระหว่างทำหัตถการในคลินิกทันตกรรมที่มีระบบระบายอากาศแตกต่างกัน 2 แบบ ได้แก่ แบบแรกคลินิกทันตกรรมก่อนปรับปรุงระบบระบายอากาศ ซึ่งมีระบบปรับอากาศแบบเดี่ยว และมีเครื่องฟอกอากาศแบบตั้งพื้น แบบที่สองคือคลินิกทันตกรรมพิเศษ และคลินิกทันตกรรมหลังปรับปรุงระบบระบายอากาศ โดยทั้งสองคลินิกมีระบบระบายอากาศและระบบปรับอากาศเป็นแบบรวมศูนย์กลาง โดยเปรียบเทียบการปนเปื้อนจุลินทรีย์ในอากาศกับดัชนีการปนเปื้อนในอากาศ การเก็บตัวอย่างแบคทีเรียและเชื้อราโดยใช้จานวุ้นอาหารเลี้ยงเชื้อผสมเลือด และ Sabouraud Dextrose Agar (SDA) วางจานวุ้นห่างจากศีรษะคนไข้ 50 เซนติเมตร สูงจากพื้น 1 เมตร ห่างจากผนังประมาณ 1 เมตร โดยวางไว้เป็นเวลา 1 ชั่วโมง ทั้งก่อนและระหว่างการทำหัตถการเป็นเวลาสามวัน ผลการทดลองพบว่าคลินิกทันตกรรมพิเศษและคลินิกทันตกรรมก่อนปรับปรุงระบบระบายอากาศ มีการปนเปื้อนจุลินทรีย์ก่อนและระหว่างทำหัตถการเท่ากับ 71 และ 46 โคโลนีต่อตารางเดซิเมตรต่อชั่วโมง และ 58 และ 45 โคโลนีต่อตารางเดซิเมตรต่อชั่วโมงตามลำดับ นอกจากนี้คลินิกทันตกรรมหลังปรับปรุงระบบระบายอากาศมีการปนเปื้อนจุลินทรีย์ก่อนและระหว่างทำหัตถการเท่ากับ 93 และ 15 โคโลนีต่อตารางเดซิเมตรต่อชั่วโมงตามลำดับ จากสถิติ Wilcoxon Sign-Rank test เปรียบเทียบการปนเปื้อนจุลินทรีย์ในอากาศก่อนและระหว่างการทำหัตถการทั้งสามคลินิก พบว่ามีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติ (P<0.001) เมื่อพิจารณาจากการเก็บข้อมูลทั้งสามวัน โดยใช้สถิติ Kruskal Wallis test พบว่าคลินิกทันตกรรมพิเศษ (ในช่วงก่อนและระหว่างการทำหัตถการ) และคลินิกทันตกรรมก่อนปรับปรุงระบบระบายอากาศ (ระหว่างการทำหัตถการ) มีการปนเปื้อนจุลินทรีย์ในอากาศแตกต่างกันอย่างไม่มีนัยสำคัญทางสถิติ นอกจากนี้พบว่ามีการปนเปื้อนจุลินทรีย์ในอากาศแตกต่างกันอย่างมีนัยสำคัญทางสถิติ ในคลินิกทันตกรรมก่อนปรับปรุงระบบระบายอากาศ (ก่อนทำหัตถการ) และคลินิกทันตกรรมหลังปรับปรุงระบบ (ก่อนและระหว่างการทำหัตถการ) (P<0.001) ข้อสรุปของการศึกษาคือ คลินิกทันตกรรมพิเศษ และคลินิกทันตกรรมก่อนปรับปรุงระบบระบายอากาศทั้งก่อนและระหว่างทำหัตถการ มีดัชนีการปนเปื้อนในอากาศอยู่ในระดับ ปานกลาง ในทางกลับกัน คลินิกทันตกรรมหลังปรับปรุงระบบระบายอากาศมี ดัชนีการปนเปื้อนในอากาศก่อนทำหัตถการอยู่ในระดับ แย่ และระหว่างทำหัตถการอยู่ในระดับ ดี และการปนเปื้อนจุลินทรีย์ในอากาศของระบบระบายอากาศทั้งสองแบบ พบว่าการปนเปื้อนจุลินทรีย์มีปริมาณน้อยลงในขณะทำหัตถการอย่างมีนัยสำคัญทางสถิติ

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