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A COMPARATIVE STUDY ON ACTIVE AND PASSIVE METHODS OF AIR SAMPLING AT DIFFERENT AREAS IN A TERTIARY CARE HOSPITAL, TELANGANA

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A B S T R A C T

Introduction: Microbiological contamination of various operation theatres of tertiary care hospitals by potential pathogens has led to the rise in incidence of health care associated infections. The aim of the present study is to assess, compare and correlate microbial contamination levels in operation theatres using both an active and passive sampling methods.

Material &Methods: A prospective study conducted in the Department of Microbiology, Modern Government Maternity Hospital, Hyderabad, Telangana, for a period of 1 month from July 1st to August 1st, 2023. Sampling was performed in 7 Operation theatres both at rest (before beginning the surgical activity) and during surgery. Air from one operating room per day was sampled by both Active and Passive methods at the same time, at rest and during surgery for one month. In Active sampling method, microbiological air sampler is used which physically draws a known volume of air over a particle collection device media i.e., Sheep blood agar and the number of colonies grown on the media is measured in CFU/$m^3$of air. In passive sampling method, Sheep blood agar plates were placed in OTs, according to 1/1/1 rule and results are expressed in CFU/m^2/hour.

Results: The mean number of colonies is 17.4 CFU/ m^3 and 63.1 CFU/m^2/hour at rest; 42.4 CFU/ m^3 and 186.69 CFU/m^2/hour during surgery for active and passive air sampling methods respectively. Statistical analysis (spearmen's rank correlation coefficient) confirmed that the two methods are correlated with each other in a comparable way with the quality of air.

Conclusion: The microbiological quality of the air in operating theatres is a significant parameter to control healthcare associated infections, and regular microbial monitoring can represent a useful tool to assess environmental quality and to identify critical situations which require corrective intervention. Hence, it is possible to conclude that both the methods are correlated with each other, but passive method can be used for general monitoring of air contamination, such as routine surveillance programs.

Keywords: Air sampling, Active method, Passive method, Health care associated infections.

INTRODUCTION

Microorganisms that cause infections in healthcare facilities include bacteria, fungi and viruses and are not only found in the patient's own endogenous flora, but can also originate from health care personnel and from environmental sources [1]. Environmental contamination plays an important role in transmission of multi drug resistant organisms [2]. In particular air contamination in high-risk health care departments like Operation theatres pose a threat to patients' condition and might increase the nosocomial infection [3]. In the past couple of decades there has been increasing

evidence of environment contamination to the acquisition of nosocomial pathogens leading to health care associated infections [4].Approximately 10% of all infections show serious consequences like increased duration of hospital stay and costs, patient mortality, morbidity among post-operative patients with multidrug-resistant strains [5]. This is particularly true in high-risk healthcare departments where patients are more susceptible because of their health conditions, or in operating theatres because of tissue exposure to air [3]. For this reason, hospital environmental monitoring and control procedures can be an effective support in reducing nosocomial infections [3].Therefore, there is importance of microbial surveillance of environmental matrices. Through air sampling it is possible to evaluate microbial contamination in environment at areas of high risk of infection [3]. Microbiologic air sampling is used to determine the numbers and types of microorganisms, or particulates, in indoor air [6]. Moreover, these controls can be used to check the efficiency of both the Conditioned and Controlled Ventilation System (CCVS) and the team's hygiene procedures. However, although there is much published research, procedures have not been firmly established and there is still debate on the sampling techniques to be used, their frequency of application and even on the usefulness of such checks and controls [7]. International guide lines offer different methods and different types of sampling instruments, leaving the method of choice to us depending on the workload of OTs and facilities like manpower availability.

The present study aims to assess, compare and correlate the microbial air contamination levels in operation theatres by Active and Passive methods of air sampling.

In Active monitoring a microbiological air sampler physically draws a known volume of air over a particle collection device which can be a solid culture media or a nitrocellulose membrane and the number of colonies grown are measured in CFU (colony forming units)/m3 of air. This system is applicable when the concentration of microorganisms is not very high, such as in an operating theatre and other hospital-controlled environments [8].

Passive monitoring uses "settle plates", which are standard Petri dishes containing culture media, which are exposed to the air for a given time in order to collect biological particles which "sediment" out and are then incubated. Results are expressed in CFU/plate/time or in CFU/m2/hour [9]

MATERIALS AND METHODS

This is a prospective study conducted from July 1st, 2023, to August 1st, 2023 in 7 Operation theatres at Modern Government Maternity Hospital, Hyderabad, Telangana after taking ethical clearance from our institution. Following the study protocol, air from one operating room per day was sampled by both Active and Passive methods simultaneously. In each room sampling was performed at rest (in the early morning before the beginning of surgical activity) and in operational (during surgery).Both active and passive methods collected 33 air samples each, at rest and during surgery. In both the methods, Sheep Blood agar media is labelled with sample number, time and date of the collection. These sterile culture media plates were transported to OT in a sterile sealed plastic container.

Passive method:

Passive air sampling (settle plate's methods) was done by the 1/1/1 scheme. In this, the Petri dish plates of a diameter 9 cm containing culture media were placed for 1 hour, 1 meter above the floor, about 1 meter away from the walls in OT's. After the procedure is completed, these exposed plates were transported to Microbiology lab in a sterile container and were incubated at 37°C for 24 hours for bacterial growth and 7 days for fungal growth. Results were expressed in CFU/m2/hour using Index of Microbial air contamination (IMA) as per Swiss Hospital association standards. Maximum acceptable levels of IMA in OTs, at rest is ≤786.4 CFU/m2/h (≤5 CFU/9 cm diameter plate/h) and during surgery is 3932.1 CFU/m2/h (≤25 CFU/9 cm diameter plate/h).

Active method:

In this method, the Air Petri sampling system (Himedia-LA637) was used for air samplings. This system sucks air through a perforated plate. The air containing particles were impacted onto the culture media surface (sheep blood agar) on to a standard Petri dish plate. The sampling equipment determines the volume of around 1600 L of air. After collecting the air samples, the culture media plates were transported to the Microbiology lab and were incubated at 37°C for 24 hours for bacterial growth and 7 days for fungal growth. The colonies were counted and expressed as colony-forming units. The number of CFUs was read using the positive hole conversion table provided by the manufacturer, and the value was expressed in CFU/m3. Maximum acceptable levels were taken as the standards determined by International Standard Organization (ISO 14698), for air microbial contamination in operating theatres with turbulent air flow: at rest ≤ 35 CFU/m3 and ≤ 180 CFU/m3 in operational.

The number of CFUs that are within the acceptable limits are termed as satisfactory and exceeding the maximum acceptable limit are termed as Unsatisfactory.

Statistical analyses of data were done using Mean ±SD, percentages, and scatter plot graphs. Data analysis was performed using SPSS version 25 software. The Spearmen rank correlation coefficient was used to assess the correlation between the results of these two methods.

RESULTS

A total of 132 air samples were collected in 7 operation theatres. Each of the 33 air samples was collected at rest and during surgery by active and passive methods. Of which 48.4% and 63.6% showed unsatisfactory results with passive method compared to active method at rest and during surgery respectively.

TABLE 1: Comparison between the results of Active and Passive methods:

	At rest		During surgery	
	Active method (33 samples)	Passive method (33 samples)	Active method (33 samples)	Passive method (33 samples)
Unsatisfactory	6% (2)	**48.4%** (16)	42.4% (14)	**63.6%** (21)
Satisfactory	93% (31)	51.1% (17)	57.5% (19)	36.3% (12)

TABLE 2: Comparison of mean and standard deviation of active and passive methods at rest and during surgery:

	Active air sampling		Passive air sampling	
	Mean	Standard deviation	Mean	Standard deviation
OTs at rest (33)	17.4	14.4	63.1	28.8
OTs during surgery (33)	42.4	22.1	186.6	84.3

The Spearmen's correlation test between Active and passive moments during operation, at rest in operation theatres shows correlation with R_s at rest= 0.7; during operation = 0.4. The correlation between methods at rest ($R^2 = 0.634$; $p < 0.05$) and during operation ($R^2 = 0.2$; $p < 0.05$), was also demonstrated by the linear regression model.

FIGURE 1: Correlation between CFUs of operation theatres at rest detected by Active air sampling and passive air sampling , $R^2 = 0.634$

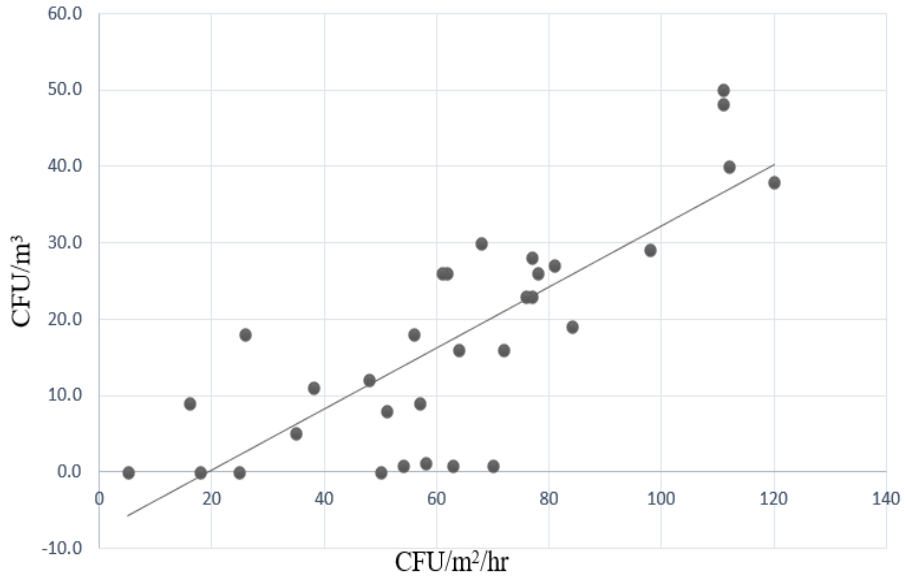
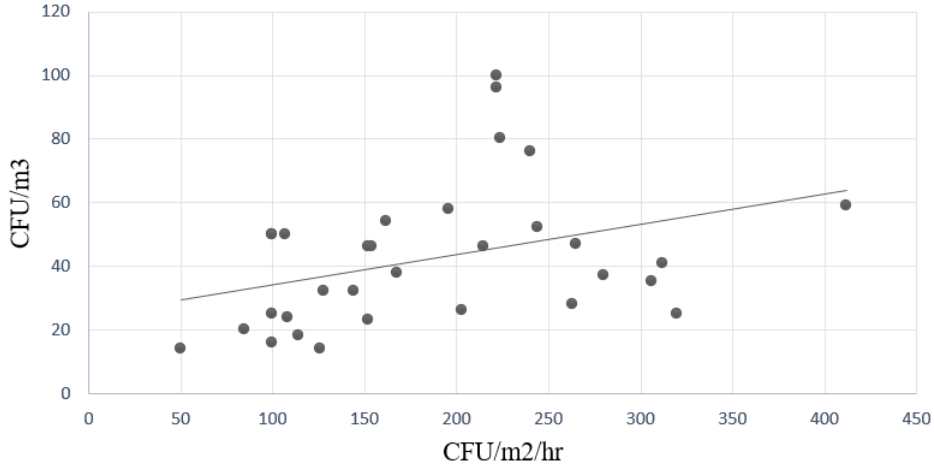


FIGURE 2: Correlation between CFUs of operation theatres during operation detected by Active air sampling and Passive air sampling, $R^2 = 0.2$.



In operational sampling period, showed higher values of colonies than at rest with both active and passive methods as would be expected due to the inevitable microbial dispersion from people.

DISCUSSION

Microbial contamination in operation theatres is becoming a leading cause of Nosocomial infections. The most important goal for any OTs should be reducing microbial contamination of air, surfaces, and equipment. This can be achieved by regular monitoring and surveillance of air sampling. The active air sampling procedure method is applicable at areas where the microbial load is less. The passive air sampling method provides us a valid risk in assessing the microorganisms as it analyses the harmful airborne microorganisms falling onto a surgical site (3). For these reasons, it is important to know the method used to assess the microbiological quality of air in the hospital environment. Thus, we have compared two air sampling methods, active and passive, to assess the microbial quality of air.

In the present study, out of 33 air samples collected at rest, 2 samples by active method and 16 samples by passive method were reported a greater number of CFUs than the maximum acceptable levels. Among 33 air samples collected during surgery 12 and 21 number of samples has exceeded the maximum acceptable levels of CFUs by Active and Passive methods respectively. It has shown that passive method reported more appropriate results than active method. Karigoudar et al had the similar findings as in this study and proved that passive method is better than the active method in assessing the microbial contamination of air (4). Kaur et al. reported that the settle plate method was a crude method to analyse airborne contamination. However, it provides a simple and cost-effective means of assessing microbial contamination (10). Pasquerella et al conducted a study on microbial samplings in OTs by active and passive methods has demonstrated that both methods can be used to evaluate microbial air quality.however, in particular during the activity, passive sampling can be suggested for routine microbial monitoring (11).

The study conducted by Rumpa et al., at Delhi tertiary care hospital demonstrated that both methods correlate when the procedure is stringently followed (12). The present study also has shown the notable correlation between two methods, significant p value with passive method and suggests that passive method is helpful in assessing viable air borne contamination. Napoli et al. documented in his study that the active method is reliable, even though many others do not recommend an active method for assessing airborne contamination in the hospital, but both the methods have advantages and disadvantages. The active method needs a device for air sampling, thereby makes it costly than the passive method but allows the analyses of larger volumes of air in a lesser time.The disadvantages are that it produces noise during sampling and thus disturbs the operating team. The main advantage of the active method (sieve impactor air sampler) is that all the suspended particles in the air were collected. Advantages of passive sampling are simple and cheap but do not interrupt the microorganisms' movement in the air during the air sampling procedure. The passive method reproduces contamination by dust particles settling onto the wound site better than the active method. However, its disadvantages are, even the large particles are pulled by gravity and collected onto the collecting surface media (12). The discrepancies in the values of CFU obtained by these two methods can be clarified by the fact that sampling of air by passive method helps in collecting even the larger particles which settled by gravity. The sieve impactor air sampler in the active method draws a fixed volume of air containing particles of variable sizes (13).

CONCLUSION

Regular monitoring of microbial contamination is essential to identify critical situations in Hospital. The microbiological quality of air is one of the tools and can be monitored by two methods, active and passive. It is an important parameter to control health care associated infections. In the present study passive method has shown more accurate results than active method as the former method allows a direct measure of the number of microorganisms settling on the media surface and latter method obtains information on the concentration of all inhalable particles. Thus, the study concludes that when strict protocol is followed, both the methods correlate in a comparable way with quality of air but passive method is recommended in regular microbial monitoring such as in routine surveillance programs due to its cost effectiveness, lack of special equipment requirements and its ability to estimate the risk of air borne microorganisms to surgical wounds during surgery, making it more relevant.

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REFERENCES

1. Sehulster, L., Chinn, R. Y., CDC, & HICPAC (2003). Guidelines for environmental infection control in health-care facilities. Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC). MMWR. Recommendations and reports: Morbidity and mortality weekly report. Recommendations and reports, 52(RR-10), 1–42.
2. Suleyman, G., Alangaden, G., &Bardossy, A. C. (2018). The Role of Environmental Contamination in the Transmission of Nosocomial Pathogens and Healthcare-Associated Infections. Current infectious disease reports, 20(6), 12. https://doi.org/10.1007/s11908-018-0620-2
3. Napoli, C., Marcotrigiano, V. & Montagna, M.T (2012). Air sampling procedures to evaluate microbial contamination: a comparison between active and passive methods in operating theatres. BMC Public Health 12, 594
4. Karigoudar RM, Wavare SM, Kakhandki L, Bagali S, Kumar IH (2020). Comparison of Active and Passive Methods of Air Sampling to Evaluate the Microbial Contamination of Air in Operation Theatres. J Pure Appl Microbiol.;14(4):2691-2697. doi: 10.22207/JPAM.14.4.47
5. Haque, M., Sartelli, M., McKimm, J., & Abu Bakar, M. (2018). Health care-associated infections - an overview. Infection and drug resistance, 11, 2321–2333. https://doi.org/10.2147/IDR.S177247
6. Desai, S &Kikani, Kunjan & Mehta, Sanjay. (2012). Microbiological Surveillance of Operation Theaters& Intensive Care Units of Teaching Hospital in Surendranagar, Gujarat. GUJARAT MEDICAL JOURNAL. 67.
7. Pasquarella, C., Albertini, R., Dall'aglio, P., Saccani, E., Sansebastiano, G. E., & Signorelli, C. (2008). Il campionamentomicrobiologicodell'aria: lo stato dell'arte [Air microbial sampling: the state of the art]. Igiene e sanitapubblica, 64(1), 79–120.
8. Center for Disease Control and Prevention (CDC) (2003). Guidelines for environmental infection control in health-care facilities., Atlanta, Available at http://www.cdc.gov/ncidod/dhqp/gl_environinfection.htm. Accessed April, 2012
9. Pasquarella, C., Pitzurra, O., & Savino, A. (2000). The index of microbial air contamination. The Journal of hospital infection, 46(4), 241–256. https://doi.org/10.1053/jhin.2000.0820
10. N, K.C, H. (2007). Air bacterial isolations from operation theatres in a tertiary care hospital in India, J Clin of Diagn Res. 1(2), 87-89.
11. Pasquarella, C. I. M., Auxilia, F., Barchitta, M., Cristina, M. L., D'Alessandro, D., Mura, I., Nobile, M., Veronesi, L., Albertini, R., & Agodi, A. (2023). Air microbial sampling in operating theatres by active and passive methods: equation correlation from the GISIO-ISChIA study results and comparison with the EU GGMP recommendation, towards the definition of threshold values. Acta bio-medica :AteneiParmensis, 94(1), e2023017. https://doi.org/10.23750/abm.v94i1.14012
12. Saha R, Agarawal S, Khan AM (2017). Air sampling procedures to evaluate microbial contamination: A comparison between active and passive methods at high-risk areas in a Tertiary Care Hospital of Delhi. J Patient Saf Infect Control.
13. Najotra, D. K., Malhotra, A. S., Slathia, P., Raina, S., & Dhar, A. (2017). Microbiological Surveillance of Operation Theatres: Five Year Retrospective Analysis from a Tertiary Care Hospital in North India. International journal of applied & basic medical research, 7(3), 165–168. https://doi.org/10.4103/ijabmr.IJABMR_281_16