Poll Res. 40 (1) : 243-247 (2021)

ISSN 0257–8050

AIR AND SURFACE BACTERIOLOGY IN SELECTED WARDS OF TERTIARY CARE CHARITABLE HOSPITAL

SHARAD CHAND[1], C.S. SHASTRY[1]* SHIVAKUMAR HIREMATH[2], JUNO J. JOEL[1], C.H. KRISHNA BHAT[1] AND UDAY VENKAT MATETI[1]

[1]Department of Pharmacy Practice, NGSM Institute of Pharmaceutical Sciences, Nitte (Deemed to be University), Deralakatte, Mangaluru 575 018, Karnataka, India
[2]Justice K.S. Hegde Charitable Hospital, Nitte (Deemed to be University), Deralakatte, Mangaluru 575 018, Karnataka, India

(Received 15 June, 2020; accepted 30 July, 2020)

ABSTRACT

Hospital environment plays a crucial role in the pattern of hospital-acquired infections (HAIs). HAIs are one of the leading causes of morbidity, financial loss, prolonged hospitalization, and even mortality. The objective of this study is to analyze the bacterial quality of indoor air and floor surface of selected wards of a tertiary care charitable hospital and to assess the deviations from the cleaning procedure. Active and passive sampling methods were used for the bacteriological evaluation of indoor air, and the surface bacteriology was carried out by the swab method. The standard operating procedures (SOPs) were followed during the study. The results of the study shows the satisfactory microbial index in the indoor air of hospital (Casualty 158 CFU/m^3, Special ward 158 CFU/m^3, General ward 545 CFU/m^3 and Laboratory 230 CFU/m^3) by settle plate method and satisfactory result by active plate method also (Casualty 146 CFU/m^3, Surgery OPD 153 CFU/m^3, General ward 223 CFU/m^3 and Laboratory 151 CFU/m^3) whereas there was an ineffective reduction of bacterial load (14 CFU) in the floor surface of general medicine wards. Though bacterial load in most of the wards were in the acceptable range, few deviations were identified, and the root causes for the ineffective reduction of bacteria was done by using a fishbone diagram. The appropriate suggestions were given to the hospital infection control committee.

KEY WORDS : Active sampling, Microbial index, Nosocomial infection, Passive sampling, Surface bacteriology

INTRODUCTION

Hospital-acquired infections (HAIs) are one of the leading causes of morbidity and mortality (Dancer, 2004). HAIs generated much attention in both developing and developed countries and discussed as a critical agenda in several scientific sessions, but no institution or nation has been able to come with an effective remedial solution (Chand *et al.*, 2020). The hospital environment plays a crucial role in the occurrence of nosocomial infections and the determination of the physical and mental health of the hospital staff. Poor work environment leads to psychological stress in addition to the occupational hazards (Pradhan, 2012 and Aryal *et al.*, 2019). The hospital environmental control procedure is an effective measure to minimize the risk of HAIs and related health issues (Nepal *et al.*, 2020a,b). Routine actions often considered for the prevention of HAIs include the use of antiseptics, disinfectants, sterilization techniques, and isolation of the susceptible patient. Hand hygiene, sanitation, timely cleaning, and safe disposal of biomedical waste are critical and routine needs of healthcare institutions (Sapkota *et al.*, 2016). Poor indoor air and surface quality of healthcare institutions are the fundamental cause of HAIs. Quantification and isolation of microbial load are some of the standard parameters to assess the quality of the hospital environment (Ikhtiar *et al.*, 2017). The objective of

this study is to analyze the bacterial quality of indoor air and floor surface of selected wards of a tertiary care charitable hospital and to assess the deviations from the cleaning procedure.

MATERIALS AND METHODS

Study design and ethical approval

This prospective and descriptive study was approved by the Nitte (Deemed to be University) Central Ethics Committee (Ref: NU/CEC/2019/0240) and registered in Clinical Trial Registry of India (CTRI Reg. No- CTRI/2019/08/020564). The study was carried out in Casualty, Special ward, General Ward, Surgery OPD, and Laboratory of Justice K.S. Hegde Charitable Hospital, Deralakatte, Mangaluru, Karnataka, India. This study was carried out for a period of six months, from February to August 2019. A total of 172 samples were collected (Kasdekar *et al.,* 2016).

Settle plate method

Out of 172 collected samples, 128 indoor air samples were collected by the settle plate method with 1/1/1 Scheme. Samples from Casualty, Special ward, General ward, and Laboratory were collected in different eight batches at the interval of one week over four weeks (Four batches before and four batches after cleaning). Each batch was having 16 samples, i.e., four samples from each room. All the samples were collected using a 90mm diameter standard Petri dish containing nutrient agar media and placed in four corners of the room. The average colony-forming units (CFU) were obtained as the mean value of all colonies count in four corners of the room. All the batches were carried out in the presence of control, which shows no microbial growth. The colony-forming unit per plate was then converted to the CFU/m^3 by using the Omeliansky formula (Kasdekar *et al.,* 2016). The final data was compared with the various standard reference ranges (Pasquarella *et al.,* 2000).

Active sampling method

A total of 12 samples of indoor air was collected by an active sampling method using the HI-MEDIA-LA474-1Nos Air Petri sampling system mark III in a 90mm diameter for 10 minutes at the rate of 100Litre/minute. CFU/m^3 was calculated by a positive hole conversion table (Anderson, 1958 and Napoli *et al.,* 2012). The obtained values were compared with various standards.

Surface bacteriology

Out of 172 samples, 32 (16 samples before and 16 samples after cleaning) floor samples were collected by swab method in eight different batches at the interval of one week over four weeks. Each batch was having four samples, i.e., one sample from floors of each area. Surface sampling was done to assess the effectiveness of disinfectant and cleaning procedures. Test tube along with cotton plugs and swab sticks soaked in 0.9% sodium chloride were sterilized by autoclave and taken to the sampling area. The area of 100 cm^2 was swabbed and kept immediately in a test tube and closed aseptically. Ten-milliliter of sterile phosphate buffer solution was kept in a test tube and shaken firmly. One milliliter of the solution was poured in a labeled Petri dish and incubated at 37 ^oC for 48 hours. The growth was observed and counted manually. The calculation was done using the standard formula (Public Health England, 2017).

Data Analysis

The reduction percentage in the bacterial count was calculated by the difference between before and after the cleaning of floors. The final values were compared with standard reference ranges. Paired T-Test was carried out for assessing the change in the indoor air bacteriology and surface bacteriology before and after the cleaning procedures by using the IBM SPSS 20.0 version. The continuous observation of cleaning procedures was carried out concerning the standard operating procedures based on national guidelines for clean hospitals (Kayakalp, 2015). Few deviations were noted, and root cause analysis was done by the fishbone diagram.

RESULTS

Microbiological load in room air in different areas of the hospital by settle plate method

A total of 128 samples were collected by the settle plate method. Sixteen samples were collected before, and 16 samples were collected after the cleaning procedures in each of the designated areas. There was no significant reduction in bacterial load observed before cleaning and after cleaning. The mean data found are summarized in Table 1.

Indoor microbiological load in areas of the hospital by active sampling method

A total of 12 samples was taken from different four

Table 1. Pre and post-cleaning differences by the settle plate method in selected wards

Ward	Average CFU count/plate Before cleaning	Average CFU/m^3	Mean± SD	Average CFU count/plate After cleaning	Average CFU/m^3	Mean± SD	p-value
Casualty	11	158	11.13±4.21	11	158	10.5±3.84	0.495
Special Ward	14	201	13.81±4.82	11	158	11.25±4.75	0.051
General Ward	40	574	41.44±11.8	38	545	38.13±9.18	0.295
Laboratory	17	244	15.94±3.37	16	230	15.06±4.8	0.182

*CFU: Colony Forming Unit; SD: Standard Deviation

areas by active sampling method at different times of the day. The average data obtained were considered for analysis, and the details are tabulated in Table 2.

Microbiological load in the floor of different areas of the hospital

The surface bacteriology shows the significant reduction of bacteria after cleaning the floors of hospital areas. The highest decrease was observed in the laboratory department, with around 86% reduction in bacterial load. The decline was statistically significant in casualty and general wards, whereas not significant statistically in special wards and Laboratory. But clinically, it was reduced in all four departments. The complete data is referenced in Table 3.

During the observation of cleaning procedures, several deviations were noted, which are illustrated as a Fishbone diagram in Fig. 1.

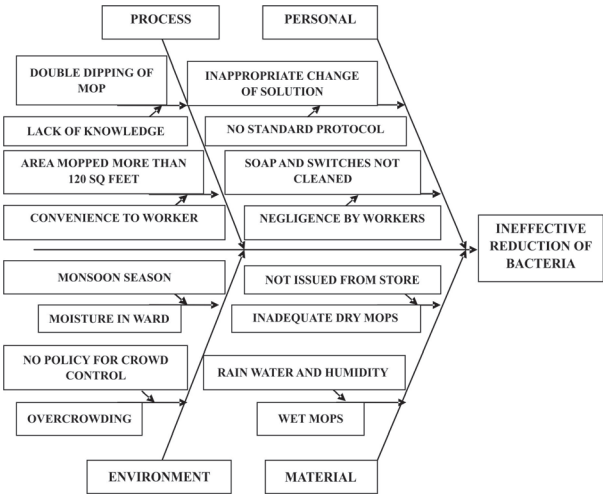

Fig. 1. Root cause analysis of the inefficient reduction of bacterial load in general wards

DISCUSSION

The settle method for bacteriology carried out in the selected ward of the hospital showed the total CFU in the range of intermediate pollution. All the wards had the bacterial range in the permissible limits for microbial contamination, according to the European Union Good Manufacturing Practice (Dancer, 2004

Table 2. Number of CFU/plate and CFU/m^3 observed by active sampling method in selected wards

Ward	Time	CFU/plate	Average CFU	CFU/m^3
Casualty	Morning 8:30-8:40AM	128	123	146
	Afternoon 12:30-12:40PM	119		
	Evening 4:00-4:10PM	121		
Surgery outpatient department	Morning 8:45-8:55AM	130	133	153
	Afternoon 12:45-12:55PM	137		
	Evening 4:15-4:25PM	133		
General Ward	Morning 9:00-9:10AM	173	171	223
	Afternoon 1:00-1:10PM	172		
	Evening 4:30-4:40PM	168		
Laboratory	Morning 9:15-9:25AM	132	126	151
	Afternoon 1:15-1:25PM	122		
	Evening 4:45-4:55PM	123		

*CFU: Colony Forming Unit

Table 3. The bacterial reduction percentage and statistical analysis of surface bacteriology (before and after cleaning)

Ward	Before cleaning Average CFU	Mean± SD	After cleaning Average CFU	Mean± SD	Reduction percentage	p-value
Casualty	18	17.5±1.91	03	3±1.41	83.33%	0.001*
Special Ward	15	14.74±10.9	04	3.5±1.29	73.33%	0.109
General Ward	53	52.5±6.86	14	13.5±3.19	73.58%	0.001*
Laboratory	29	28.75±19.19	04	4±1.63	86.20%	0.081

*CFU: Colony-forming Unit SD: standard Deviation; *P-value<0.5 considered as statistically significant

and CEC, 1993). The air bacteriology by settle plate methods results was in the range of class C, and class D which was similar to that was found in the study conducted by Ikthiar *et al.,* 2017 and Getachew *et al.,* 2018) but the count is less than study carried out by (Shiferaw *et al.,* 2016).

The active method also shows a similar result of air quality for bacteria in compliance with the sanitary standards for nonindustrial premises (CEC, 1993). The results obtained by active sampling methods were in the intermediate degree of air pollution which was similar to the study conducted by the (Aydin *et al.,* 2013 and Kunwar *et al.*, 2019) but were less than in the survey conducted by the (Chakrabarty *èt al.,* 2014).

The Swab method of bacteriological evaluation from the surface of ward areas had shown the mixed pattern of the results. Casualty and Laboratory show an effective reduction of more than 80% in bacterial load, whereas the special and general medicine ward shows more than 70%, which is quite an effective reduction in the clinical setup. Despite more than 70% and 80% reduction in bacterial load in special wards and Laboratory, this was found to be statistically insignificant. The decline of 70% and 80% of bacterial count in casualty and general medicine ward showed a statistically significant reduction (Dancer, 2004; Getachew *et al.,* 2018).

The bacterial reduction in the general medicine was 73.58%, which was a statistically significant reduction, but clinically it was not in acceptable range (i.e., <5), which can be justified by the high patient flow in the general wards. The study results were in accordance with the study conducted by (Pradhan *et al*., 2012). Whereas the result was less in comparison to the study conducted by the (Getachew *et al.,* 2018). The detailed root cause analysis was carried out, and few deviations from SOPs were identified (CMMS, 2020). The fishbone diagram was also suggested to implement in the hospital as a continuous quality improvement tool, and other appropriate suggestions were also recommended. This study was limited by the selection of a few wards from the hospital

CONCLUSION

Hygiene and cleanliness are ongoing processes. Hence continuous monitoring of the hospital environment is an integral part of hospital hygiene. In this study, environment monitoring was done by active and passive methods. The surface sampling was done by the swab method. The air microbiology yielded satisfactory results in compliance with the several standard guidelines. The surface bacteriology showed a significant reduction of bacteria statistically but ineffective reduction clinically in the general medicine ward. The root cause analysis was done, and various reasons were identified by using the Ishikawa (Fishbone diagram) tool of quality improvement, and several recommendations were made.

ACKNOWLEDGMENTS

We would like to thank Ms. Chaithra R. for her selfless help during microbiological estimations.

REFERENCES

Anderson, A.A. 1958. New sampler for the collection, sizing, and enumeration of viable airborne particles. *J Bacteriol.* 76 (5): 471-484.

Aryal, S., Shastry, C.S. and Chand, S. 2019. The linkage between occupation and stress among community health workers: an indo-global perspective. *Biomedicine.* 33 (03) : 388-393.

Aydin, Ç.N., Uçar, FB. and Haliki, U.A. 2013. Determination and comparison of microbial loads in atmospheres of two hospitals in Izmir, Turkey. *Ann Agric Environ Med.* 20(1): 106-110.

CEC. 1993. Commission of the European Communities, "Indoor air quality and its impact on man," *Report*

no. 12, Biological Particles in Indoor Environments, Commission of the European Communities, Brussels, Belgium.

Chakrabarty, P.S., Maiti, PK. and Dey, R. 2014. The study of bacterial Population in Air Samples of a Tertiary Care Hospital. *J of Evolution of Med and Dent Sci*. 3 (25) : 7044-7052.

Chand, S., Shastry, CS. and Hiremath, S. 2020. Water, sanitation, hygiene and biomedical waste disposal in the healthcare system: a review. *Biomedicine*. 40(01) : 14-19.

CMMS. 2020. Available from https://www.cms.gov/medicare/provider-enrollment-andcertification/qapi/downloads/fishbonerevised.pdf accessed on [7th June 2020].

Dancer, SJ. 2004. How do we assess hospital cleaning? A proposal for microbiological standards for surface hygiene in hospitals. *Journal of Hospital Infection*. 56(1) : 10-15.

Getachew, H., Derbie, A. and Mekonnen, D. 2018. Surfaces and Air Bacteriology of Selected Wards at a Referral Hospital, Northwest Ethiopia: A Cross-Sectional Study. *International Journal of Microbiology*. Article ID 6413179. https://doi.org/10.1155/2018/6413179.

Ikhtiar, M., Alzad, H., Paramita, S. and Yadi. 2017. Microbiological Assessment of Indoor Air of Takalar County Hospital Wards in South Sulawesi, *Indonesia. Science Journal of Public Health*. 5(3): 172-177. doi: 10.11648/j.sjph.20170503.13

Kasdekar, M.M., Duthade, M.M. and Damle, A.S. 2016. Air quality monitoring of operation theaters in government medical college and hospital, Aurangabad, India. *Int. J. Curr. Microbiol. App. Sci*. 5(6) : 42-49.

KAYA KALP. 2015. National guidelines for clean hospitals. Ministry of Health and Family Welfare, *Government of India*: 1-116.

Kunwar, A., Tamrakar, S. and Poudel, S. 2019. Bacteriological Assessment of the Indoor Air of Different Hospitals of Kathmandu District. *International Journal of Microbiology*. Article ID 5320807, https://doi.org/10.1155/2019/5320807

Napoli, C., Marcotrigiano, V. and 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.

National Infection Service Food Water and Environmental Microbiology Standard Method: Detection and enumeration of bacteria in swabs and other environmental samples. 2017. *Public Health England*: 22. Document number FNES4.

Nepal, S., Giri, A. and Nepal, S. 2020a. Outdated and unused medicines disposal practice among the undergraduate paramedical students - a pharmacist's intervention. Le *Pharmacien Hospitalier et Clinicien*. https://doi.org/10.1016/j.phclin.2020.05.003

Nepal, S., Giri, A. and Bhandari, R. 2020b. Poor and unsatisfactory disposal of expired and unused pharmaceuticals: a global issue. *Current Drug Safety*. doi : 10.2174/1574886315666200626164001.

Pasquarella, C., Pitzurra, O. and Savino, A. 2000. Index of microbial air contamination. *Journal of Hospital Infection*. **46**(4) : 241-256.

Pradhan, S.B. and Shrestha, C.D. 2012. Microbiological surveillance of hospital environment in a Medical College Hospital in Kathmandu, Nepal. *Int J Infect Microbiol*. 1 (2) : 76-79.

Sapkota, B., Gupta, G.K. and Shrestha, S.K. 2016. The microbiological burden in air culture at various units of a tertiary care government hospital in Nepal. *AMJ*. 9 (1) : 1-7.

Shiferaw, T., Gebbre-silasse, L. and Mulisa, G. 2016. Bacterial indoor-air load and its implications for healthcare-acquired infections in a teaching hospital in Ethiopia. *Int J Infect Control*. (12) 1 : 1-9.