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IP International Journal of Medical Microbiology and Tropical Diseases

Journal homepage: https://www.ijmmtd.org/

Original Research Article

Microbiological surveillance of operation theatres of a tertiary care hospital in Mizoram, north eastern part of India: 4 years retrospective analysis

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ARTICLE INFO

Article history:
Received 28-11-2021
Accepted 07-01-2022
Available online 12-02-2022

Keywords:
Microbiological surveillance
Operation theatres
Omeliansky formula
Settle plate method
Swabbing technique

ABSTRACT

Background: Healthcare associated infections are important cause of patient morbidity and mortality. Microbiological contamination of air and environment in the operation theatres (OTs) are major risk factor for surgical site and other hospital-associated infections.
Aims: To identify bacterial colonization of surfaces, equipments and to determine the microbial contamination of air in the OTs of a tertiary care hospital in Lunglei, Mizoram which is in north eastern part of India.
Settings and design: Four years (January 2016 – December 2020) retrospective analysis of a data obtained from routine microbiological surveillance of the OTs.
Materials and Methods: Surface samples were taken with wet swabs from different sites and equipments, and Settle plate method for air in the OTs. Bacterial species were isolated and identified by conventional method.
Statistical analysis: The colony forming unit (CFU) count/plate was expressed as CFU/m3 by Omeliansky formula.
Results: The culture positivity rate of surface swab samples was 6.4% (60/937). Bacillus spp. with 45 (67.16%) isolates was the most common baterial isolates. The bacterial CFU/m3 counts of air in the two OTs were in the range of 90 to 166 before fumigation. Staphylococcus aureus with 43(42.16%) was the predominant species obtained and the least common species obtained was Enterococcus faecalis with13 (12.74%). The bacterial CFU/m3 counts of air was one in both the OTs after fumigation.
Conclusion: Settle plate method for air and swabbing technique for surfaces are proved to be valuable techniques in detecting the contamination level in our set up with limited resources.

1. Introduction

Approximately 5 -10 percent of patients admitted to acute care hospitals in developed countries, and more than 25 percent of such patients in developing countries, have been found to acquire infections which were not present or incubating at the time of admission; in the USA, it has been estimated that 1.5 million such infections occur annually, causing 15,000 deaths. Such hospital acquired, or nosocomial infections add to the morbidity, mortality, and costs that one might expect from the underlying illness alone. This is tragic since it is believed that as many as 20 percent of nosocomial infections in developed countries, and 40 percent in developing countries, are preventable.[1]

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https://doi.org/10.18231/j.ijmmtd.2022.005

Hospital-associated infections are an important source of morbidity and mortality with postoperative, surgical site infections (SSI) being the second most common cause after urinary tract infections.[2–5] Hospital infections are, even today, one of the main problems of public health.[6] Much importance was given, in recent years, to the contamination of the hospital environment in the onset of these infections. One of the most controversial and debated issues is the qualitative and quantitative role of the environment in the process of patient contamination, in particular the role of adjacent surfaces and furniture. It is known that these surfaces act as reservoirs for microorganisms, increasing the risk of cross-contamination through direct and/or indirect contact with the patient.[7–10] Recent studies have focused on the role of hospital environment sanitation processes, establishing a correlation between microbiological contamination of surfaces in direct contact with the patient and Healthcare Associated Infections (HCAI).[11] The spread of microorganisms is undoubtedly related to the presence of the patients themselves, the latter being the first source of contamination of the environment and especially of all those sites that are closely associated with them, such as the bed, the bedside table, the power supply carriage etc., which are frequently touched ("high-touch surfaces") and easily contaminated.[12]

Microbiological surveillance is an important part of infection control program, providing data regarding types, and counts of microbial flora.[13,14] The present study was conducted to identify bacterial colonization of surfaces and equipment in the OTs and to determine the microbial contamination of air in the OTs of a tertiary care hospital in Lunglei, southern part of Mizoram.

2. Materials and Methods

We obtained institutional ethics board exemption for this study. This retrospective study, analyzing the microbiological surveillance data from OTs over a period of 4 years from January 2017 to December 2020 was conducted at a tertiary care hospital in Lunglei, southern part of Mizoram which is in north-eastern part of India. Two sampling procedures used in the study were surface swabbing and settle plate method. Sterile gloves, masks, and sterile gown were worn for collection to prevent the contamination of media and OT surface being swabbed. The surface samples were taken after proper sterilization and disinfection of the OTs, before the entry of surgery and support team. Sterile swabs soaked in nutrient broth were used for sample collection from different sites and equipment (instrument trolley, table top, lights, monitor, wall, floor, etc.) of two OTs of the hospital. They were labeled properly and transported immediately to the microbiology laboratory for processing. Inoculation was done on Blood Agar and MacConkey Agar and incubated at 37°C for 24 hours under aerobic condition. Bacterial species were isolated and identified by conventional methods.[15] Air sampling was done by settle plate method. Open Blood and MacConkey Agar plates labeled with sample number, theater site, time and date of sample collection were kept at about 1 m above the ground, 1 m from the wall and exposed for 1 hour when the OTs were operational following the schedule 1/1/1.[16] These plates after incubation at 37°C for 24 hours in microbiology laboratory were observed for growth and number of colonies per plate were counted. After fumigation, the same method was repeated.

2.1. Statistical analysis

The colony forming unit (cfu) count/plate was expressed as cfu/m3 by Omeliansky formula;[17] $N = 5a \times 104\ (bt)-1$ where N = colony forming unit per cubic meter of air (cfu/m3), a = number of colonies per petridish, b = surface area of petridish in cm2, and t = time exposure (minutes).

3. Results

A total of 937 surface swab samples were collected from the two OTs of the hospital during the study. 534 surface swab samples were collected from General OT and 403 from Ophthalmology OT. The culture positivity rate of these surface swab samples was 6.4% (60/937) and 877 (93.6%) samples were culture negative. These 60 culture positive swabs yielded 67 isolates. Therefore, single isolate was obtained from 60 swabs and 7 swabs gave two isolates. Bacillus spp. with 45 (67.16%) isolates was the most common bacterial isolate followed by Coagulase negative Staphylococcus (CoNS) with 11 (16.41%) isolates [Table 2]. The higher number of culture positive swabs (n=52) and isolates (n=59) were obtained from General OT where 7 samples yielded two isolates. Whereas the culture positive samples (n=8) obtained from Ophthalmology OT gave one isolate each. [Table 1]

The bacterial cfu/m^3 counts of air in the two OTs were in the range of 90 to 166 before fumigation [Table 5]. Staphylococcus aureus with 43 (42.16%) was the predominant species obtained followed by Klebsiella spp. with 32 (31.37%) and Coagulase negative Staphylococcus (CoNS) with 14 (13.73%). The least common species obtained was Enterococcus faecalis with 13 (12.74) [Table 3]

The bacterial cfu/m^3counts of air was 1 in both the OTs after fumigation [Table 6]. The isolate obtained was Staphylococcus aureus [Table 7].

4. Discussion

This work has highlighted the presence of pathogens that are potential cause of nosocomial infections on the surfaces we assessed with 6.4 percentage of positivity.

Microbial contamination in OT leading to postoperative infections can have serious implications for patients and

Table 1: Operation theatre wise distribution of n = 67 bacterial isolates from surface swabs

Name of OT	Bacillus spp.	CoNS	Staphylococcus aureus	Enterococcus faecalis	Total
General OT	42	9	7	1	59
Ophthalmology OT	3	2	2	1	8
Total	45	11	9	2	67

CoNS: Coagulase negative Staphylococcus; OT: Operation theatre

Table 2: Species - wise distribution of isolates obtained from surface samples

Species isolated	n (%)
Bacillus spp.	45 (67.16)
CoNS	11 (16.41)
Staphylococcus aureus	9 (13.43)
Enterococcus faecalis	2 (3)
Total	67

CoNS: Coagulase negative Staphylococcus

Table 3: Species-wise distribution of isolates obtained from General OT on air sampling done before fumigation

Species isolated	n (%)
Staphylococcus aureus	43 (42.16)
CoNS	14 (13.73)
Klebsiella spp.	32 (31.37)
Enterococcus faecalis	13 (12.74)
Total	102

CoNS: Coagulase negative Staphylococcus

Table 4: Species-wise distribution of isolates obtained from Ophthalmology OT on air sampling done before fumigation

Species isolated	n (%)
Staphylococcus aureus	15 (27)
CoNS	23 (42)
Klebsiella spp.	17 (31)
Total	55

CoNS: Coagulase negative Staphylococcus

Table 5: Colony forming unit count of air from two operation theatres on air sampling done before fumigation

Name of the OT	Cfu/m^3
General OT	166
Ophthalmology OT	90

Cfu/m^3: Colony forming unit per cubic metre; OT: Operation theatre

Table 6: Colony forming unit count of air from two operation theatres on air sampling done after fumigation

Name of the OT	Cfu/m^3
General OT	1
Ophthalmology OT	1

Cfu/m^3: Colony forming unit per cubic metre; OT: Operation theatre

Table 7: Species-wise distribution of isolates obtained from the two OTs on air sampling done after fumigation

Name of the OT	Species isolated	n
General OT	Staphylococcus aureus	2
Ophthalmology OT	Staphylococcus aureus	2

their families. Any case of suspected hospital-acquired infection (HAI) is investigated by including cultures from other body sites of the patient, other patients, staff, and environment.[18] Careful selection of specimens to be cultured is essential to obtain meaningful data. Infections and prolong hospital stays, create long-term disability, increase resistance to antimicrobials, represent a massive additional financial burden for health systems and cause unnecessary deaths. Thus, the solution is a well-implemented infection control program which can improve staff education and accountability, also by conducting research to adapt and validate surveillance protocols based on the reality of developing countries to achieve acceptable performance. This can reduce the incidence of HAIs by around one-third.[19] Of all the procedures and protocols, the environmental disinfection and instrument sterilization definitely requires the most critical monitoring.

In the present study, 937 surface swabs were collected from two OTs of the hospital with a bacterial contamination rate of 6.4% (n = 67) which is quite low compared to other studies where positivity rate ranged from 14.7% to 100%. The probable reason for this variability is first these studies were all for a short duration of few months whereas the observation period in the present study was extended for 4 years. Second, the swabs were collected before the commencement of surgeries after proper sterilization and disinfection whereas in some studies either the swabs were taken randomly or the time of collection has not been mentioned. In this study, Bacillus spp. which is considered to be an environmental contaminant was the predominant isolate followed by CoNS which is a commensal organism. This is in concordance with other studies from India and abroad.[4,14,20,21] Nine isolates of Staphylococcus aureus were obtained during 4 years of surveillance which although is very low at 13.43% is a potential pathogen and an important cause of skin and soft tissue infections. Similarly, CoNS and Enterococcus spp. are also an important cause of SSI's.[22,23]

The microbiological quality of air is the reflection of the hygienic conditions of the OT. Settle plates are supposed to be more sensitive in detecting the increase of microbial air contamination related to conditions that could compromise the quality of the air in operating theaters.[24] The OTs are considered suitable for carrying out most forms of surgical procedures only when the bacterial load is <180/m3 of air.[25] In the present study, the count ranged between 90 to 166 cfu/m3 of air which is well within permissible limits and correlates well with studies from Gujarat and Udaipur.[4,14] Whereas there are other studies which have reported a very high counts from air sampling.[26,27] The highly variable results in different studies can be ascribed to various factors like method of surveillance (active air sampling or passive air sampling), time of sampling, i.e. at rest or operational, ventilation of OTs and last but not the least the disinfectants being used and the methods of sterilization employed. Highest cfu count per cubic meter of air in our study was obtained from General Surgery OT and least from Ophthalmology OT which is in line with the study by Anjali et al. and is most probably due to highest patient load in the General OT.[14]

Our study highlights the fact beyond any doubt that periodic and regular microbiological surveillance of OTs is essential to detect and control contamination. If appropriate measures are taken based on feedback will definitely decrease the SSI rate. Other side of the coin is that there are no standard guidelines in India pertaining to the method of sample collection or its frequency for microbiological surveillance of OTs. Therefore, more extensive studies are required in this field so that national guidelines can be formulated for monitoring and surveillance to enable the comparison of compliance between various health-care facilities.

The study shows that the microbiological quality of air and surfaces in OTs of our hospital is satisfactory with very low bacterial contamination rate on surface swabbing and a cfu count per m3 of air well within permissible limits. Settle plate method for air and swabbing technique for surfaces are very useful, convenient and cost effective methods for surveillance of OTs even in resource limited settings.

5. Conflicts of Interest

The authors declare no potential conflict of interest with respect to research, authorship, and/or publication of this article.

6. Source of Funding

None.

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Cite this article: Vanlalruati RSC, Khiangte L, Hmar V, Vanlalchhanhimi LV, Laldinmawii, Chongthu JL, Hmar L, Sailo L, Lalramnghaki. Microbiological surveillance of operation theatres of a tertiary care hospital in Mizoram, north eastern part of India: 4 years retrospective analysis. *IP Int J Med Microbiol Trop Dis* 2022;8(1):19-23.