Original Article

Microbiological Surveillance of Operation Theatres: Five Year Retrospective Analysis from a Tertiary Care Hospital in North India

Dipender Kaur Najotra, Aneeta Singh Malhotra[1], Poonam Slathia, Shivani Raina, Ashok Dhar

Departments of Microbiology and [1]Pathology, Acharya Shri Chander College of Medical Sciences and Hospital, Jammu, Jammu and Kashmir, India

Abstract

Introduction: Microbiological contamination of air and environment in the operation theaters (OTs) are major risk factor for surgical site and other hospital-associated infections. **Objectives:** The aim was to identify bacterial colonization of surfaces and equipment and to determine the microbial contamination of air in the OTs of a tertiary care hospital. **Materials and Methods:** Five years (January 2010–December 2014) retrospective analysis of the data obtained from routine microbiological surveillance of the five OTs of the hospital was done. Surface samples were taken with wet swabs from different sites and equipment. Bacterial species were isolated and identified by conventional methods. Air quality surveillance of OTs was done by settle plate method. **Results:** A total of 4387 samples were collected from surfaces and articles of various OTs. Out of these only 195 (4.4%), samples showed bacterial growth and yielded 210 isolates. The predominant species isolated was *Bacillus* with 184 (87.6%) isolates followed by coagulase-negative *Staphylococcus* 17 (8.1%), *Staphylococcus aureus* 6 (2.9%), and *Enteroccoccus* spp. 3 (1.4%). Analysis of the OT air samples showed least colony forming unit (cfu) rate of air (27 cfu/m^3) in ophthalmology OT and highest rate of 133 cfu/m^3 in general surgery OT. **Conclusion:** The study shows that OTs of our hospital showed a very low bacterial contamination rate on surface swabbing and a cfu count per m^3 of air well within permissible limits.

Keywords: *Microbiological, operation theater, surgical site infection, surveillance*

Introduction

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.[1-4] Sources of infection can either be endogenous or exogenous from the theater environment like air, surfaces, articles in operation theater (OT). The Factors on which the rate of postoperative infections depend are effective sterilization and disinfection procedures, surgical technique, theater design, bacterial contamination of theater air, OT discipline, and appropriate use of prophylactic antibiotics.[4-7]

Microbiological surveillance is an important part of infection control program, providing data regarding types, and counts of microbial flora.[8,9] 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.

Materials and Methods

This retrospective study, analyzing the microbiological surveillance data from OTs over a period of 5 years from January 2010 to December 2014 was conducted at a tertiary care hospital. The study was approved by Institutional Ethical Committee. 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 five OTs of the hospital. They were labeled properly and transported immediately to the microbiology laboratory for processing. Inoculation was done on

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Address for correspondence:
Dr. Dipender Kaur Najotra, 207-D, Uttam Nagar, Kunjwani Bye Pass, Jammu - 180 010, Jammu and Kashmir, India. E-mail: kaurdipender@gmail.com

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Blood Agar and MacConkey Agar and incubated at 37°C for 24 h under aerobic condition. Bacterial species were isolated and identified by conventional methods.[10]

Air sampling was done by settle plate method. Open Blood 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 h when the OTs were operational following the schedule 1/1/1.[11] These plates after incubation at 37°C for 24 h in microbiology laboratory were observed for growth and number of colonies per plate were counted. Further, this colony forming unit (cfu) count/plate was expressed as cfu/m^3 by Omeliansky formula;[12] $N = 5a \times 10^4 (bt)^{-1}$ where N = colony forming unit per cubic meter of air (cfu/m^3), a = number of colonies per petridish, b = surface area of petridish in cm^2, and t = time exposure (minutes).

Results

A total of 4387 surface swab samples were taken from the five OTs of the hospital during the study. Out of these, 900 samples per OT were collected from General Surgery, Urology, Orthopedics and ENT OTs whereas 787 samples were from Ophthalmology OT. The culture positivity rate of these surface swabs was 4.4% (195/4387) and 4192 (95.6%) samples were culture negative. These 195 culture positive swabs yielded 210 isolates. Therefore, single isolate was obtained from 180 swabs and 15 swabs gave two isolates. *Bacillus* spp. with 184 (87.6%) isolates was the most common bacterial isolate followed by coagulase-negative *Staphylococcus* (CoNS) with 17 (8.1%) isolates [Figure 1]. The highest number of culture positive swabs (n = 92) and isolates (n = 98) were obtained from General Surgery OT where 6 samples yielded two isolates. Least number of culture positive samples (n = 7) were obtained from Ophthalmology OT where each sample gave one isolate [Table 1].

The bacterial cfu/m^3 counts of air were in range of 27–133 with Ophthalmology OT having the least count and General Surgery OT the highest count [Figure 2].

Discussion

Microbial contamination in OT leading to postoperative infections can have serious implications for patients and 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.[13] Careful selection of specimens to be cultured is essential to obtain meaningful data. Infections 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.[14] Of all the procedures and protocols, the environmental disinfection and instrument sterilization definitely requires the most critical monitoring.

In the present study, 4387 surface swabs were collected from five OTs of the hospital with a bacterial contamination rate of 4.4% (n = 195) 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 5 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

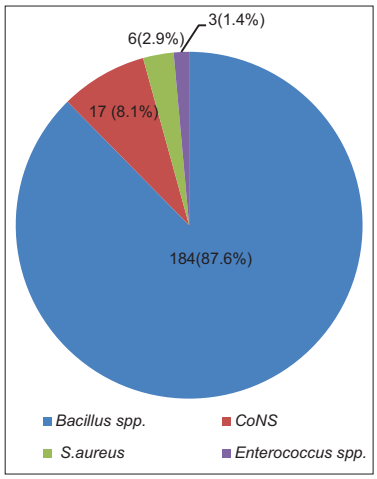

Figure 1: Species-wise distribution of isolates obtained from surface samples

Table 1: Operation theater wise distribution of n=210 bacterial isolates from surface swabs

Name of OT	*Bacillus* spp.	CoNS	*Staphylococcus aureus*	*Enterococcus* spp.
General Surgery	85	9	2	2
Urology	42	2	0	1
Orthopedics	38	2	0	0
ENT	13	4	3	0
Ophthalmology	6	0	1	0
Total isolates	184	17	6	3

CoNS: Coagulase-negative *Staphylococcus*; OT: Operation theater

Species-wise distribution of isolates obtained from surface samples

Species isolated	n (%)
Bacillus spp.	184 (87.6)
CoNS	17 (8.1)
Staphylococcus aureus	6 (2.9)
Enterococcus spp.	3 (1.4)
Total	210

CoNS: Coagulase negative *Staphylococcus*

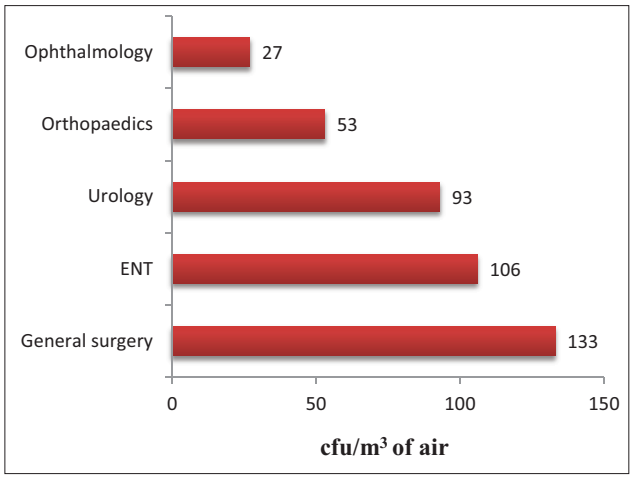

Figure 2: Colony forming unit count of air from various operation theaters on air sampling

Colony forming unit count of air from various operation theater's on air sampling

Name of the OT	Cfu/m^3
General surgery	133
ENT	106
Urology	93
Orthopaedics	53
Ophthalmology	27

Cfu/m^3: Colony forming unit per cubic meter; OT: Operation theater

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.[3,7,9,15] Six isolates of *Staphylococcus aureus* were obtained during 5 years of surveillance which although is very low at 2.9% 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.[16,17]

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.[18] The OTs are considered suitable for carrying out most forms of surgical procedures only when the bacterial load is <180/m^3 of air.[19] In the present study, the count ranged between 27 and 133 cfu/m^3 of air which is well within permissible limits and correlates well with studies from Gujarat and Udaipur.[3,9] Whereas there are other studies which have reported a very high counts from air sampling.[20,21] 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 Surgery OT.[9]

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.

Conclusion

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 m^3 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.

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Conflicts of interest

There are no conflicts of interest.

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