International Journal of Medical Research Professionals
P-ISSN: 2454-6356; E-ISSN: 2454-6364
DOI: 10.21276/ijmrp

IJMRP

Original Research Article.

Microbiological Profile of Air and Surface Contamination in Operation Theatres and Intensive Care Units of a Teaching Hospital in Rural North India

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ABSTRACT

Background: Harbouring of potential pathogens in operation theatres (OTs) and intensive care units (ICUs) of hospital is a major cause of patient's morbidity and mortality. Environmental monitoring by the microbiological testing of surfaces and equipments is useful to detect changing trends of types and counts of microbial flora. High level of microbial contamination indicates the needs for periodic surveillance aimed at early detection of bacterial contamination levels and prevention of hospital acquired infections.

Aim: The aims of the study were to count CFU (colony forming unit) rate of indoor air, to identify bacterial colonization of surface and equipments isolated from Operation theatres, ICUs and Labour room of a teaching hospital in district Kangra, Himachal Pradesh.

Methods: This retrospective study, analyzing the microbiological surveillance data from OTs over a period of 2 years from January2017 to December2018 was conducted at a tertiary care hospital. Air sampling of 8 OT's, 4 ICU's and 1 LR were done by settle plate method. Swabs were taken from different sites, equipments and bacterial species were isolated and identified from them as per standard guidelines.

Result: A total of 105 air samples were collected for 2 year from 8 OT's, 4 ICU's and 1 LR. The bacterial CFU/m^3 /min counts of air from all OTs ranged from Superspeciality OTS showed less bacterial CFU rate of air (0-5 CFU/m^3) followed by Opthalmology OT (5-8 CFU/m^3) and highest in Gynae (30-46 CFU/m^3). CCU showed less bacterial CFU rate (10-15 CFU/m^3) followed by Surgery ICU (28-35 CFU/m^3) and highest in PICU (38-42 CFU/m^3), Labour room showed 42-51 CFU/m^3. Bacterial species were isolated from 43.85 % out of total 157 swab samples taken from all OTs and ICUs. The most common isolate was Bacillus species 46% followed by CONS (22%). Pathogenic organisms isolated were 10% Gram negative bacilli which included 3% Non-Fermenters, the common isolate was Klebsiella spp. amongst gram negatives.

Key: HAIs (Hospital Acquired Infections), OT (Operation Theatres), ICU (Intensive Care Units), LR (Labour Room), CFU (Colony Forming Units).

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Article History:

Received: 12-02-2019, **Revised:** 07-03-2019, **Accepted:** 30-03-2019

Access this article online	
Website: www.ijmrp.com	Quick Response code
DOI: 10.21276/ijmrp.2019.5.2.019	

INTRODUCTION

Hospital acquired infections (HAIs) prolong hospital stays, create long-term disability, increase resistance to antimicrobials, represent a massive additional financial burden for health systems and cause unnecessary deaths.

Microbial contamination of hospital environment, especially in an operating theatre and other specialized units had continued to increase prevalence of nosocomial infections.[1-3] Invasive procedures, high antibiotic usage and transmission of bacteria between patients due to inadequate infection control measures may explain why OTs and ICUs are "hot zones" for the emergence and spread of microbial resistance.[4]

Sources of infection can either be endogenous or exogenous from the theatre environment like air, surfaces, articles in operation theatre (OT). So the preventive measure may be achieved by making improvement in cleaning by using disinfectants, needs periodic fumigation of these OTs and with routine microbial surveillance. 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.[5,6]

Of all the procedures and protocols, the environmental disinfection and instrument sterilization definitely requires the most critical monitoring. Controlling airborne pathogens in health facilities is not only important for the safety of the patient, but it is also important for hospital. There is a clear need for surveillance and early warning systems that can pick up signs of emerging and/or increasing microbial resistance at the local, regional and national level.[7,8]

Microbiological surveillance" provides data about the factors contributing to infection. Environmental monitoring by the microbiological testing of surfaces and equipments is useful to detect changing trends of types and counts of microbial flora. Evaluation of the quality of air in operating theatres can be performed routinely by microbiological sampling and particle counting. The quality of indoor air depends on external and internal sources such as ventilation, cleaning procedures, the surgical team and their activities.[7,9]

AIM

The present study is focused on to evaluate the level of microbial contamination in operating theatres of hospital, intensive care units and labour room.

MATERIALS AND METHODS

This retrospective study, analyzing the microbiological surveillance data from OTs and ICUs over a period of 2 years from January 2017 to December 2018 was conducted in the department of Microbiology, DRPGMC & Hospital Kangra at Tanda. 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 eight OTs of the hospital. They were labelled 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 h under aerobic condition.

Air sampling was done by settle plate method. Open Blood Agar plates labelled with sample number, theatre 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.Air samples were also taken in medicine ICU (MICU), general ICU (ICU2), neonatal ICU (NICU), paediatric ICU (PICU), and cardiothoracic ICU (CTI) at three consecutive times, with a 3-4 months interval between each sampling. In all theatres, air was supplied by a ventilation system designed to provide 15 air changes/hours (hr.). 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; $N = 5a \times 10^4 (bt)^{-1}$ where N = colony forming unit per cubic meter of air (cfu/m^3), a = number of colonies per petri dish, b = surface area of petri dish in cm^2, and t = time exposure (minutes). Approximately, 180 bacteria per cubic meter of air correspond to 10 colonies settling on a plate. The operating rooms were said to be conducive for carrying out operative procedures only when the bacterial load was less than 180 per cubic meters.[10,11] Even a single colony of Staphylococcus *aureus* and fungus is taken as unsatisfactory in operation theatres.

Microbial species were isolated and identified by conventional methods Isolation and identification of isolates were done as per standard guidelines. All isolates were divided in to three broad categories: 1) Normal flora e.g. Coagulase Negative Staphylococcus (CONS) 2) Contaminant e. g. Bacillus sp. 3) Pathogen e. g. Klebsiella sp

Figure 1: Colony forming unit count of air CFU/m^3 from various operation theatres on air sampling

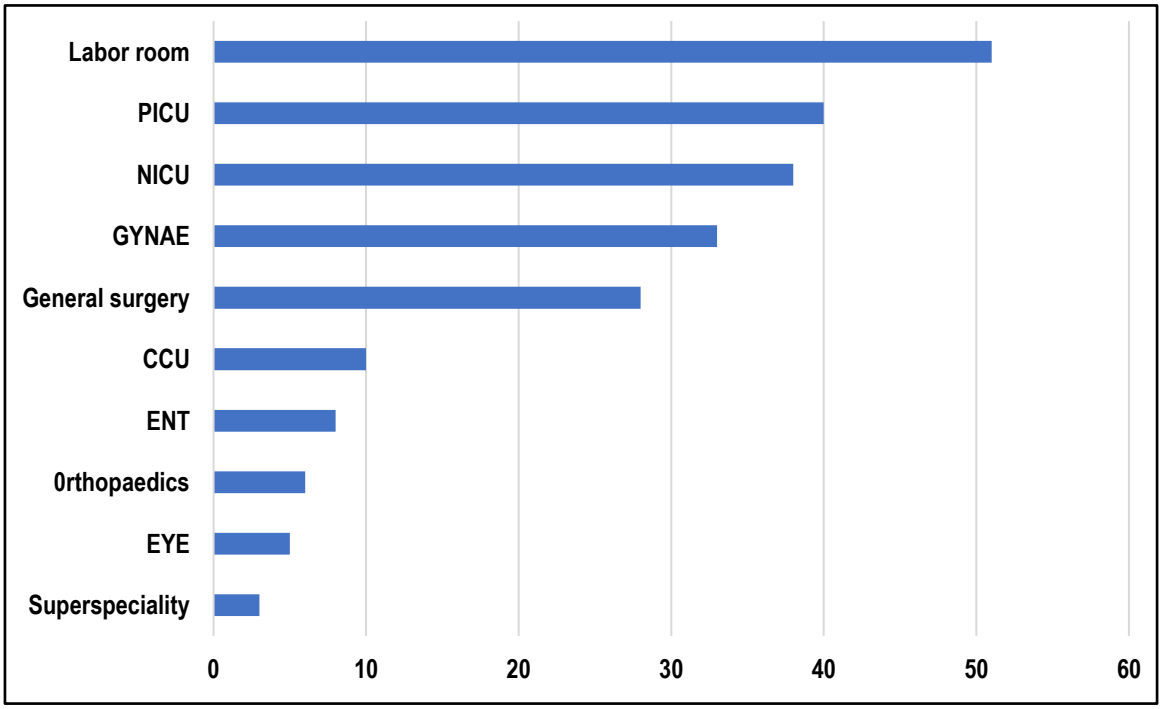


Figure 2: Species-wise distribution of isolates obtained from surface samples

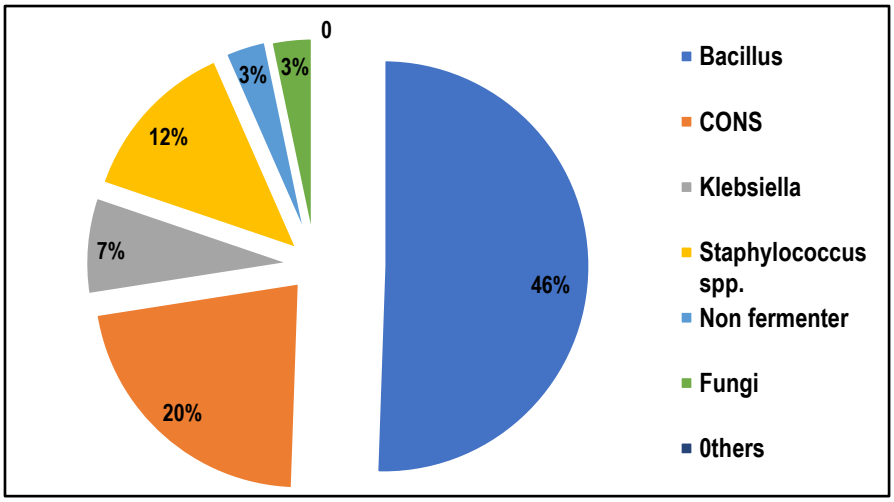
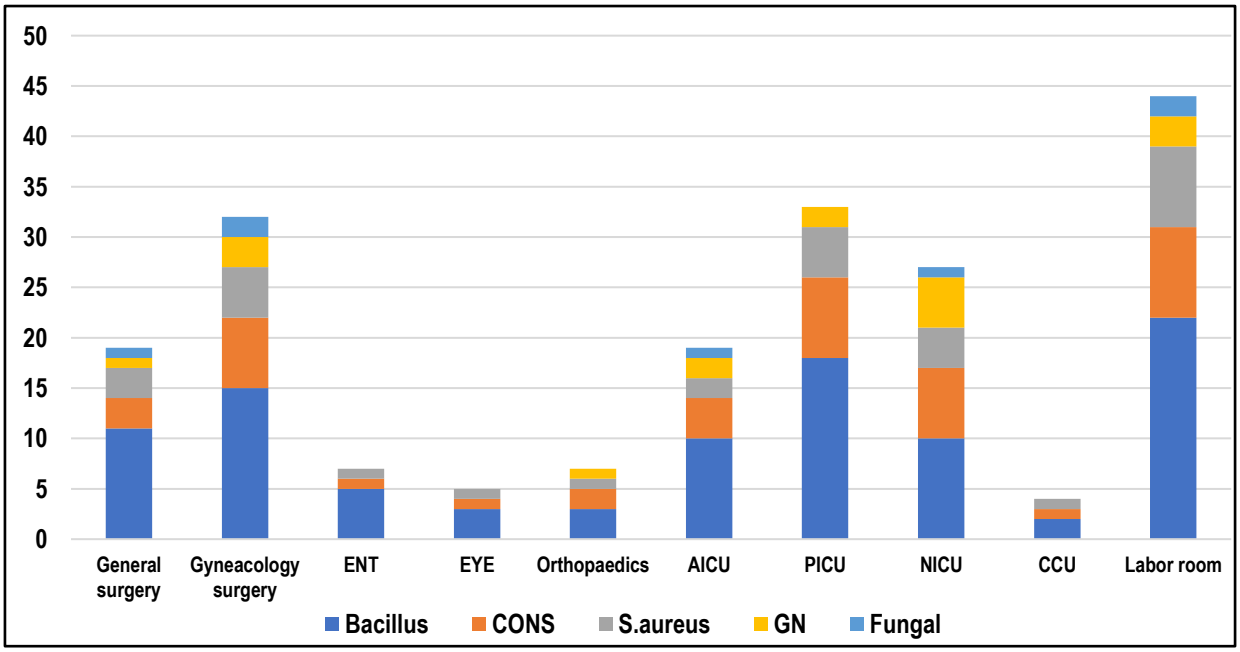


Figure 3:Species-wise distribution of isolates obtained from surface samples of OTs and ICUs



CONS = (Coagulase negative Staphylococcus spp.), S.*aureus*=*(*Staphylococcus *aureus)*

RESULTS

A total of 105 air samples were collected for 2 year from 8 OT's, 4 ICU's and 1 LR. The bacterial CFU/m^3 counts of air from all OTs ranged from, Super speciality OTS showed less bacterial CFU rate of air (0-5 CFU/m^3 followed by Ophthalmology OT (5-8 CFU/m^3) and highest in Gynae (30-46CFU/m^3). CCU showed less bacterial CFU rate (10-15 CFU/m^3) followed by Surgery ICU (28-35 CFU/m^3) and highest in PICU. NICU (38-42 CFU/m^3). Labour room showed 51 CFU/m^3 (Figure 1.) Microbial species were isolated from 72(45.8%) out of total 157 swab samples taken from all OTs and ICUs. Tables, Beds, trolley and BP apparatus were found to be more contaminated. Bacillus sp. 46% (contaminants) and Coagulase negative Staphylococcus spp.20% (normal flora) were most common isolates followed by Klebsiella (7%) (pathogens) etc. as shown in Figure 2. Almost all Specialized OTs were found free from pathogens in swab sampling. Only 4 (50%) OTs harboured pathogens like Klebsiella, Pseudomonas spp. Staphylococcus spp., Enterobacter etc. All 5 ICU harboured different bacterial species in swab sampling as shown in Figure 3.

DISCUSSION

Harbouring of potential pathogens in OTs and ICUs of hospital can pose a great risk to patients. Nosocomial 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.

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.

Only some OTs like cardiology OT and Ophthalmology OT where the strict fumigation is followed daily, are not exceeding the limit. Anjali K, et al, Rumana Farooq Mir et al, etc also reported in their study that Ophthalmology OT was the one with least contamination.[13,14] Bacterial air sampling in all OTs showed 5-59 CFU/m^3 of them are between 23-42 CFU/m^3 , similar results, 21-41 CFU/m3 have been reported by Qudiesat K et al.[8] In this study,30- 52 CFU/m^3 shown in ICUs similar to the study by Shresta CD et al,[3] and this heavy contamination may be due to

the reason that the fumigation procedure is not done frequently because of the presence of the patients day and night. The bacterial pathogens were isolated comprising of Klebsiella, coagulase negative Staphylococci spp, Pseudomonas etc, had the highest percentage of occurrence in swab samples while in settle plate samples Bacillus spp. and micrococci spp., showed highest percentage of occurrence. In study by Anjali et al. The most common isolate was Coagulase negative Staphylococcus species (5.8%) followed by Bacillus and Klebsiella species (4.4%) each.[13] In the study by Desai SN, The most common isolate was Bacillus species 34 (91.9%) followed by S. aureus 7 (18.9%).[15] Out of 8 OTs 45% were found to be colonized with contaminant Bacillus species. Similar result has been reported by Javed I et al and Sharma D et al.[7,16] All ICUs (100%) were observed colonized with contaminants as well as potential pathogens. OT table and drug trolleys are the most contaminated sites in OTs and beds, BP apparatus and floors are the most contaminated sites in ICUs similar to floors and tables as in study of Desai SN et al. [15] of surveillance depends on number and type of surgeries, outbreak of post-operative infection and availability of resources.

CONCLUSION

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.

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Source of Support: Nil. **Conflict of Interest:** None Declared.

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Cite this article as: Tamrakar Meenakshi, Chaudhary Anuradha, Rana Aditya, Gupta Veetheeanveshna, Jaryal Subhash Chand, Sood Anuradha. Microbiological Profile of Air and Surface Contamination in Operation Theatres and Intensive Care Units of a Teaching Hospital in Rural North India. Int J Med Res Prof. 2019 Mar; 5(2):83-86.DOI:10.21276/ijmrp.2019.5.2.019