

Bacteriological surveillance of operation theaters and other specialized care units of community hospitals across Kashmir valley, India

Abstract

Background: Bacterial contamination in operation theatres (OT's) and other specialized care units is a major factor for nosocomial infection. Surgical Site Infection (SSI) contributes to 33.1% of nosocomial infection. Microbial contamination of OT's is a major risk factor for surgical site infection. Aim of study is to identify bacterial colonization of indoor air of OT's, labor rooms (LR's) and specialized new born care units (SNCU's).

Material & methods: Air sampling of 29 (OT's), 9 (LR's) and 5 (SNCU's) was done by settle plate method. Surfaces samples were taken by wet swabs from different sites and equipments in nutrients broth. Samples were then transported to laboratory and processed according to standard operation procedures.

Results: Total of 184 swabs were taken, out of which 134 (72.82%) were found to be positive for bacterial growth. A total of 43 air samples were taken out of which 41 were found to be positive for bacterial contamination. Least CFU/m³ was found in ophthalmology OT (4.4-10 CFU/m³) and highest in gynecology and obstetrics OT (4.4-268.7 CFU/m³).

Conclusion: Surfaces and air in various health facilities of studied hospitals were found contaminated with different types of bacteria including potential pathogens that pose a great risk to patients. Hygiene and sanitation need to be improved in these hospitals to control nosocomial infection and for better management of patients.

Keywords: Kashmir, bacteriological surveillance, operation theaters, settle plate method

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Abbreviations: SNCU, specialised new born care unit; OT, operation theatre; LR, labour room; SSI, surgical site infection; CFU, colony forming unit; GNB, gram negative bacilli

Introduction

Microbial contamination of OT's is a major cause of nosocomial infections.¹⁻⁴ Nosocomial infections are an important cause of patient morbidity and death.⁵ Good hospital hygiene is an integral part of infection control programme. Microbial contamination in OT's is influenced by number of individuals present, ventilation, use of airflow methods, use of adequately sterilized equipment and contaminated surfaces.⁶ Microbiological surveillance provides data about factors contributing to infection. Environmental monitoring means microbiological testing of air, surfaces and equipment to detect changing trends of microbial counts and micro-flora.⁷ Lack of adherence to standard operating procedures can result in adverse patient outcomes in health care settings.⁸

Material and methods

The study was conducted in the Division of Epidemiology and Public Health, Directorate of Health Services Kashmir, J&K, India from January 2019 to June 2019. The permission for the study was taken from Director Health Services Kashmir. There are 10 district hospitals, one in each district of the valley which provides health care services to population of 72 lakh approximately.⁹ Two sampling methods used in the study were:

1. Settle plate method (for monitoring quality of air)

2. Surface swabbing.

Collection and transport of specimen

Air and surface samples were taken from OT's, LR's and SNCU's from district hospitals across Kashmir valley.

Air sampling

Air sampling was done by settle plate method. Blood agar and MacConkey agar plates (four sets, each comprising of one blood agar and one MacConkey agar) were placed at four locations in OT's, LRs and SNCU's one meter above ground, one meter away from the wall for one hour (1,1,1). These were then transported to laboratory and incubated at 37°C for 24 hours under aerobic conditions. After incubation, plates were observed for growth. Isolates were then identified using standard microbiological procedures and CFU/m³ were estimated using Omeliansky formula according to which

$$CFU/m^3 = ax1000$$

$$P \times t \times 0.2$$

a = No. of colonies on Petri plate.

P = Surface measurement of plate used in cm²

t = Time of exposure of Petri plate in minutes

Recommended conventional operation theatre values

I. An empty theatre bio load should not exceed 35 CFU/m³.

II. During surgery bio load should not exceed 180 CFU/m³.

During air sampling procedure, sterile gloves, surgical masks and protective gowns were used to prevent contamination of agar plates. Plates were checked visually for any bacterial growth before use.

Surface sampling

Moistened sterile cotton swabs in nutrient broth were used to collect samples from different sites like operation table, autoclaved instruments, drug trolley, walls, floor and light. All samples were properly labeled and immediately transported to microbiology laboratory. Swabs taken from different sites were inoculated on blood agar & MacConkey agar plates. These were incubated at 37°C for 18-24hrs under aerobic conditions. After incubation the isolates were identified by colony characteristics, gram reaction and standard biochemical tests.¹⁰

Results

Total of 184 swabs were taken from different critical care facilities. Out of 184 swabs, 134(72.82%) were found to be positive for bacterial growth and 50(27.17%) swabs were found to be sterile as shown in Table 1; *Bacillus spp.* accounts for (n=50, 26.17%), followed by *Coagulase Negative Staphylococcus* (CONS) (n=38,19.8%); *Acinetobacter spp.* (n=36 18.8%); *S. aureus* (n=29,18.8%); *Pseudomonas spp.* (n=28 14.65%); *Klebsiella spp.* (n=6, 3.14%); *E. coli* (n=3,1.5%) and *Enterobacter spp.* (n=1, 0.5%). Most common organism isolated from general surgery OT was *Acinetobacter spp.* (n=11, 26.19%); followed by *Enterobacter spp.* and *Klebsiella spp.* (n=1, 2.3%) each. *Bacillus spp.* (n=18, 33.9%) was the most common isolated organism from gynecology and obstetrics OT followed by *CONS* (n=9,16.9%); *S. aureus* (n=8,15.09%); *Acinetobacter spp.* (n=8,15.09%); *Pseudomonas spp.* (n=7,13.2%) and *Klebsiella spp.* (n=2, 3.7%). Most common organism isolated from ophthalmology was *Bacillus spp.* (n=6, 66.6%) followed by *CONS* (n=2, 22.22%), *E. coli* (n=1,11.11%). Most common organism isolated from orthopedics was *S. aureus* (n=3,37.5%) and *Acinetobacter spp.* (n=3,37.5%) followed by *CONS* (n=3,12.5%) and *Bacillus spp.*

(n=3,12.5%). Most common organism isolated from LR was *Bacillus spp.* (n=10,22.7%) and *Pseudomonas spp.* (n=10,22.7%) followed by *CONS* (n=9,20.45%) and *Acinetobacter spp.* (n=9,20.45%); *S. aureus* (n=3,6.8%); *Klebsiella spp.* (n=2,4.54%) and *E. coli* (n=1,2.27%). Most common organism isolated from SNCU was *Bacillus spp.* (n=9,30%) followed by *CONS* (n=6,20%); *S. aureus* (n=5,16.66%); *Acinetobacter spp.* & *Pseudomonas spp.* (n=4, 13.33%), each, followed by *Klebsiella spp.* (n=1,3.33%). Distribution of pathogens and their percentage from swabs, obtained from different operation theatres, labour rooms and specialised newborn care units is shown in Table 2. Bacterial CFU/m³ of air were in range of 4.4 CFU/m³ to 268.7CFU/m³ with ophthalmology theatre having lowest count and gynecology theatre, the highest count. Bacterial count (CFU/m³) of air from various operation theaters and critical care facilities (air sampling) is shown in Table 3.

Table 1 Distribution of Contaminated Swabs from operation theatre, labour rooms and specialised newborn care units

Name of OT	Total	Contaminated
		N (%)
General Surgery	47	34 (72.34)
OBG	52	37 (71.15)
Ophthalmology	18	8 (44.44)
Orthopaedics	10	7 (70)
L/R	36	28 (77.77)
SNCU	21	20 (95)
Total	184	134 (72.82)

OBG = Obstetrics & Gynaecology; LR = Labour Room; SNCU = Specialised Newborn Care Unit

Table 2 Organisms isolated from surfaces/articles of various operation theatre, labour room and specialised newborn care unit

Name of OT	<i>Bacillus</i>	<i>CONS</i>	<i>S. aureus</i>	<i>Acinetobacter</i>	<i>Pseudomonas</i>	<i>Klebsiella</i>	<i>E-Coli</i>	<i>Enterobacter</i>
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
General Surgery	6 (14.2)	6 (14.2)	10 (23)	11 (26.19)	7 (16.6)	1 (2.3)	-	1 (2.3)
OBG	18 (33.9)	9 (16.9)	8 (15.09)	8 (15.09)	7 (13.2)	2 (3.77)	1 (1.88)	-
Ophthalmology	6 (66.6)	2 (22.22)	-	1 (11.11)	-	-	-	-
Orthopedic	1 (12.5)	1 (12.5)	3 (37.05)	3 (37.5)	-	-	-	-
L/R	10 (22.7)	9 (20.45)	3 (6.8)	9 (20.45)	10 (22.7)	2 (4.54)	1 (2.27)	-
SNCU	9 (30)	6 (20)	5 (16.66)	4 (13.33)	4 (13.33)	1 (3.33)	1 (3.33)	-
Total	50 (26.17)	38 (19.8)	29 (15.1)	36 (18.8)	28 (14.65)	6 (3.14)	3 (1.5)	1 (0.5)

LR = Labour Room; SNCU = Specialised Newborn Care Unit; OBG = Obstetrics & Gynaecology;

CONS = Coagulase Negative Staphylococcus. (-) Not isolated.

Table 3 Bacterial count (CFU/m³) of air from operation theatres, labour rooms and specialised newborn care units

	Anantnag	Bandipora	Baramulla	Budgam	Shopian	Ganderbal	Kulgam	Kupwara	Pulwama	Srinagar
OBG	190.38	48	73	55.5	268.7	43	44.87	73	43.64	53.8
General Surgery	53	48	67	65.33	68.2	11.11	70.9	50	50.59	84.6
Orthopaedics	29.4	*	79	*	*	*	*	*	17.8	*
Ophthalmology	4.4	10	*	4.7	*	5	*	*	23.8	*
LR	133.18	72	*	55.1	89.74	6.1	18.37	22	53	33
SNCU	178.5	*	*	22.05	38.04	11.6	*	43.5	23.5	*

OBG = Obstetrics & Gynaecology; SNCU = Specialised Newborn Care Unit; LR = Labour Room

Organism isolated from air samples of various operation theaters labour rooms and SNCUs are shown in table 4, (*) theatre not available

Table 4 Organisms Isolated from air samples of various operation theatre, labour room and specialised newborn care unit.

Name of OT	Total no. of Samples	Organisms isolated						
		<i>Bacillus</i>	<i>CONS</i>	<i>S. aureus spp</i>	<i>Acinetobacter spp</i>	<i>Pseudomonas spp</i>	<i>Klebsiella spp</i>	<i>E-Coli spp</i>
		No (%)	No (%)	No (%)	No (%)	No (%)	No (%)	No (%)
OBG	9	2 (10)	5 (25)	5 (25)	5 (25)	3 (15)	-	-
General Surgery	9	3 (12)	7 (28)	6 (24)	3 (12)	5 (20)	-	1
Ophthalmology	4	5 (83.3)	-	1 (16.6)	-	-	-	-
Orthopaedics	3	2 (40)	1 (20)	2 (40)	-	-	-	-
LR	8	5 (26.31)	6 (31.7)	2 (10.52)	3(15.78)	1 (5.2)	1 (5.2)	1 (5.2)
SNCU	4	3 (33.33)	3 (33.3)	2 (22.22)	1(11.11)	-	-	-

CONS = Coagulase Negative Staphylococcus; *E.Coli* = *E - coli*; LR=Labour Room.(-) not isolated

Discussion

Aerobic cultures on non-selective media should not exceed 35CFU/m³ of air in an empty room and 180CFU/m³ of air during surgery for conventional theatre. Total of 43 air and 184 swab samples from different surfaces of operation theaters and other critical care facilities were taken during study period. Out of 43 air samples, 41 were found to be contaminated, but only 2 had CFU/m³ beyond acceptable level. These two critical care facilities were gynecology & obstetrics OT's. This is due to poor ventilation and cleaning practices and high traffic density of people to these OT's. Surface disinfection in these OT's is not done according to recommendations because of presence of heavy patient load. Duguid and Wallace, (1948) reported that increased activity enhanced the dispersion of bacteria and movement can shed upto 10⁴ skin scales per minute of which,10% contain cluster of micro-organisms.¹¹ Ophthalmologic OT's have lowest level of CFU/m³ (4.4-10 CFU/ m³); Anjali et al.¹² & Mir RF et al.¹³ & Kiranmai et al.¹⁴ & Javid et al.¹⁵ also have reported lowest level of contamination in ophthalmologic OT.¹²⁻¹⁵ It has been observed that counts in the range

of 700 – 1800/m³ were related to significant risk of infection and risk is slight when they are below 180 CFU/ m³.¹⁶ Settle plate method for air sampling showed highest percentage of *CONS* (n=22), followed by *Bacillus spp* (n=22). This is in line with other studies from India and abroad.^{4,12,15,17,18} *CONS* is considered as an exogenous organism. Source of *CONS* in the study can be normal skin flora of medical personnel, patients and fabrics.¹⁹ Other species isolated are *S. aureus* (n=18), *Acinetobacter spp.* (n=12), *Pseudomonas spp.* (n=9), *E. coli* (n=2) and *Klebsiella spp.* (n = 1). *S. aureus* was isolated in a study done by Qudiesat et al, Desai SN, and Yadav M et al.^{17,19,20} In addition Yadav M et al.²¹ also showed isolation of *Acinetobacter spp.* in their study. In our study *E. Coli*, *Klebsiella spp.* and *Pseudomonas spp.* are also isolated, Kiramai et al.¹⁴ has also showed isolation of same species.¹⁴ *S. aureus* and *CONS* are an important cause of SSI.^{22,23} Source of *S. aureus* may be anterior nares, axilla or groin of either health care personal or patient. This bacteria can survive for several month on dust in hospital environment. SNCU serves as nursery for sick neonates, so high level of sterility should be maintained there. In our study SNCU shows higher level of contamination with *Bacillus*

spp and *CONS* followed by *S. aureus* & *Acinetobacter spp.* Other gram negative organisms isolated are *Pseudomonas spp.*, *E. coli* and *Klebsiella spp.* This is in accordance to study done by Okon et al.⁴ *CONS* is an important cause of sepsis in premature newborns. High level of bacterial contamination may be attributed to high movement of medical staff and mother of babies in the neonatal units. Transmission of these bacterial species can occur during transportation of patients from ward to OT or from other specialized care units. A significant percentage of *Acinetobacter spp.* has been isolated in our study. Infected patients spread *Acinetobacter spp.* to air of health care facilities. Strain can remain in the air for about four weeks. Extensive air borne infection control measures must be taken to prevent infection. A total of 184 swabs from different surfaces were taken. After 24 hours of aerobic incubation at 37°C, 134 showed growth on culture media (72.82%). A total of 191 isolates were obtained from positive samples. Highest number of organisms obtained were *Bacillus spp* (n = 50, 26.17%), followed by *CONS* (n = 38, 19.8%), *Acinetobacter spp.* (n=36, 18.8%), *S. aureus* (n=29, 15.1%) and *GNB* (n=10, 5.14%). Such a high level of contamination is also reported by Okon et al.⁴ This high level of contamination may be again attributed to low adherence and compliance to infection control practices. Other factors contributing to such high level of contamination are a lack of hand hygiene practices, education level and awareness of health care professionals.

Conclusion

Microbial quality of air and surfaces in OT's may be considered a mirror image of hygienic conditions of hospital. Our study has shown that air and surfaces in different health care facilities of studied hospitals is contaminated with different types of bacteria. Presence of potential pathogens in OT's, LR's and SNCU's can pose a great risk to patients. Surveillance of OT's and other critical care facilities along with infection control measures is helpful in controlling nosocomial infection.

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Conflicts of interest

The author declares that there is no conflict of interest.

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