Original article

Microbial contamination in a pediatric surgery operation theatre

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ABSTRACT

Background: In surgical patients, 38% of nosocomial/ health care associated infections are surgical site infections (SSI). The exogenous causes of SSI include microbial contamination of operation theatre environment, equipment, and personnel. The objective of this study was to generate local data involving microbial contamination of operation theatre environment, equipment, and personnel.

Methods: This cross sectional survey was conducted in Pediatric Surgery Operation Theatre, Mayo Hospital, Lahore from August 2018 to September 2018. Samples for bacterial culture were taken by theatre sister and list in charge using cotton swabs moistened in normal saline. After informed consent, 53 samples were taken from the dominant hand and anterior nares of theatre staff (surgeons, nurses, theatre assistants and anesthetists), and 33 samples from operation theatre equipment and environment (laryngoscope, anesthesia machine, operation table, wall and floor of the theatre, dirty area, and store.). Air samples were collected by night staff using settle plate method on blood agar. After collection, all samples were transported to laboratory within 15 minutes, where pathologist performed antimicrobial susceptibility testing for all bacterial isolates using the Kirby-Bauer disc diffusion method.

Results: This study had 24 (45%) of the samples from anterior nares, and 29 (55%) samples from dominant hand, while 33 samples were taken from theatre environment and equipment. Positive bacterial growth from theatre staff was seen in 9 (17%) out of 53 collected samples. *Staphylococcus aureus* was present in 5 (55.6%) of these 9 samples, while *Staphylococcus epidermidis* was present in 3 (33.3%), and 1 (11.1%) sample revealed *Escherichia coli*. In samples from operation theatre environment and equipment, 11 samples (33.3%) out of 33 samples had bacterial growth. Most common growth obtained was bacillus species (90.9%) either alone or as mixed growth, while 1 (9.1%) was *Staphylococcus aureus*.

Conclusion: Despite observing standard protocols of theatre sterilization, microbial contamination was noted in 33.3% of samples collected from theatre and 17% from personnel. The main microorganism isolated from theatre environment and equipment' samples was Bacillus (90.9%), and *Staphylococcus aureus* (55.6%) from theatre personnel.

Keywords:

Microbial contamination, Operation theatre, Nosocomial infection, Health care associated infection, Surgical site infection

INTRODUCTION

Nosocomial infections or health care associated infections account for 7% in developed and 10% in developing countries.[1] Globally mortality is 3.6% and the cost of treatment in USA alone is more than $5 billion annually.[2] In patients undergoing surgery, 38% of nosocomial infections are surgical site infections (SSI).[3] Overall around 20% of health care associated infections are SSI. These infections pose a burden towards hospital resources in terms of diagnostic tests, management and nursing care.[4]

SSI are caused by endogenous and exogenous factors. Major exogenous causes of SSI are due to microbial contamination of operation theatre environment, equipment and personnel.[3,5] Despite antibiotic prophylaxis, SSI still cause havoc in terms of morbidity, mortality, economic burden and increasing risk of infection transmission to health care givers.[6]

Ample measures should be taken to prevent these infections, as most of the SSI pathogens are multi drug resistant and include methicillin-resistant *Staphylococcus aureus* (MRSA), Vancomycin Resistant Enterococci (VRE), extended spectrum beta lactamases and multidrug resistant pseudomonas.[7] While main focus for prevention of theatre related infection is on structural aspects like choice of material for floors and surfaces, and theatre design keeping dirty and clean areas separate, positive pressure, hourly air filtration exchange, laminar air flow to avoid air borne contamination, still the major preventive measures involve commitment of theatre staff to allow patient flow in orderly manner, use meticulous scrubbing and

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draping techniques, proper sterilization of operation theatre equipment and instruments, and prophylactic use of antibiotics. Hygiene protocols should be followed by all personnel including surgeons, operating theatre assistants, anesthesiologists, sisters, and cleaning staff. Nasal carriage of *Staphylococcus aureus* by personnel are an important factor causing infection and proper hand hygiene alone can reduce SSI from 5-82% caused by micro-perforations of surgical gloves.[3,8,9]

This study highlighted the problem of microbial contamination in operation theatre environment, equipment, and personnel. The rationale of the study was to generate local data and based on this data focus on the areas found deficient.

MATERIALS AND METHODS

This cross sectional survey was conducted in Pediatric Surgery Operation Theatre, Mayo Hospital, Lahore from August 2018 to September 2018. This theatre is a dedicated, purpose built theatre with annual turnover of around 10,000 cases. It has four operating areas, separate dirty and clean areas, sterilization room, storage area, changing rooms, recovery area, and offices. To maintain standards, routinely samples are collected by infection control department in coordination with pathology department. Other than washing, and bi-monthly fumigation, theatre is regularly cleaned by using Actisol (potassium monopersulphate and alcohol) for walls and floors, Actosed (solution of sodium percarbonate, tetra acetyl ethylene diamine, corrosion inhibitors, auxiliary substances) for equipment, and ultraviolet radiation to avoid air borne contamination.

Ethical permission was taken (IRB No 2182/RC/KEMU dated 16.12.19) for this study. Pathology department was informed beforehand to arrange for time, date, number of tests to be carried out in on specific day, and provision of swab sticks. A sample size of 86 was calculated.[10] Non probability purpose sampling technique was used. Sterile cotton swabs dipped in normal saline were used to take samples from theatre and personnel (surgeons, nurses, theatre assistants, anesthetists, and cleaning staff) by theatre sister in charge and list in charge. After informed consent, 53 samples were taken from personnel from anterior nares (near to vestibule, if not suffering from upper respiratory tract infection) and dominant hand (inter digital area, dorsal, palmar aspect, if not suffering from skin infection) in between the cases, at a time specified by pathology department. Total 33 samples were also taken from operation theatre equipment and environment (laryngoscope, anesthesia machines, operation table, wall, floors, dirty area, sterilization area, storage room) in similar manner. Air samples were collected by night sister using settle plate method on blood agar. All samples were sent to pathology department within 15 minutes of collection for antimicrobial susceptibility testing.

Antimicrobial susceptibility testing for all bacterial isolates was performed using the Kirby-Bauer disc diffusion method. A 0.5 McFarland's solution was used to dilute the collected sample and then sample was inoculated on Muller Hinton agar and then applied to antibiotic disc through disc diffusion method, according to the organism isolated after 24hours of incubation at 37ºC the zone of inhibition around the disc was studied and sample was reported. Results of antimicrobial susceptibility tests were recorded and reported on day 5 by the pathologist

Methicillin resistance was tested using 1 µg oxacillin disc and in case of zones of inhibition ≤12 mm, organisms were labeled as methicillin resistant. Antimicrobial susceptibility test of ESBL-producing *P. aeruginosa* was done by disc diffusion method using *P. aeruginosa* ATCC 27853 as control strain. Vancomycin agar screen test was performed using Brain Heart infusion (BHI) agar with 6µg/ml vancomycin. Any growth indicated resistance to vancomycin. All results of antimicrobial susceptibility were interpreted as per Clinical and Laboratory Standards Institute (CLSI) guidelines.[11,12]

Collected data was entered on SPSS version 23 and was analyzed. Quantitative data like age was measured as means and standard deviation and qualitative variables like gender and bacterial isolates as frequency and percentages.

RESULTS

This cross sectional survey included 32males (60%) and 21 females (39%) samples from theatre personnel. Positive bacterial growth from theatre staff was seen in 9 (17%) of the samples. 44 (83%) samples from staff had no bacterial growth. Two (22.2%) samples from dominant hand and seven (77.8%) samples of anterior nares had positive bacterial growth, with *Staphylococcus aureus* isolated in 5 (55.6%), Escherichia coli in 1 (11.1%), and *Staphylococcus epidermidis* in 3 (33.3%). Both positive hand samples were taken from the surgeons, while 4 out of 7 positive nares samples were from nurses, 1 from surgeon, 1 from anesthetist, and 1 from cleaning staff.

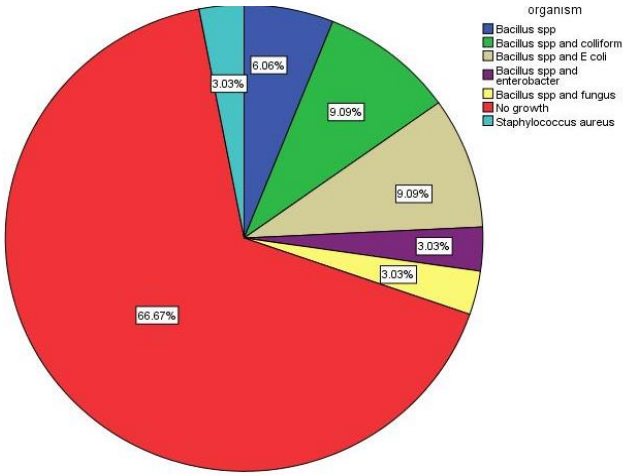

Figure 1. Type of microorganisms isolated from operation theatre environment and equipment

Bacterial growth was seen in 11 (33.3%) samples from theatre environment and equipment, while 22 (66.7%) samples came out to be negative for any growth, as depicted in Figure 1. Bacillus was isolated in 10 out of 11 samples (90.9%), either separately or as mixed growth with other coliforms, *Escherichia coli*, Enterobacter, and fungus. *Staphylococcus aureus* was isolated in 1 (9.1%) sample, however it was MRSA.

Table 1 shows distribution of samples and positive bacterial growth according to area of theatre environment and equipment.

DISCUSSION

Despite emphasis towards theatre environment cleanliness, 11 out of 33 samples (33.3%) from theatre environment and equipment had microbial contamination, and predominant growth was Bacillus species (90.9%) either alone or as mixed growth. It was mainly present in floor and air samples. Samples from personnel had 17% contamination (9 out of 53 samples) and *Staphylococcus aureus* was predominant in 5 samples of anterior nares (55.6%). MRSA was found in only one sample.

These results are consistent with other studies. Edem and colleagues showed staphylococcus in 46 of their 48 positive growth samples from theatre staff.[7] Kumar and coauthors had similar results showing positive growth in 25% of nasal samples and 30-50% had bacterial growth on theatre staff hands.[13] This can further be reduced by following guidelines, so that staff with upper respiratory tract infection or skin infection should not participate in theatre activities.[14,15] The reason for relatively less bacterial growth in samples from anterior nares and dominant hand of theatre personnel (17%) in this study may be due to exclusion of staff from study with upper respiratory tract infections and skin infections.

Saleem and colleagues demonstrated that antibiotics resistance was widespread with MRSA in 8.1% of nasal samples and 24.1% in hand samples of surgeons.[9] In this study however, only one sample of MRSA was noted. Local data on bacterial isolates from operation theatre is not available but a study conducted in different wards of Khyber Teaching Hospital revealed that out of 200 samples, 37 came out as MRSA.[16] Frequency of nosocomial infection in one of the study conducted in Pakistan showed results of 29%.[17] Our pediatric surgery ward and intensive care unit antibiogram showed that the commonest microbe isolated was *S. aureus* (49.7%), followed by Pseudomonas (30.1%) and *E. coli* (11.04%), which shows a trend towards pathogens causing nosocomial infection, especially SSI.[18][15] The isolation of *Staphylococcus aureus* in 55.6% of samples may indicate towards a possible cause of SSI later on.

The positive growth on equipment shows lack of proper sterilization technique used by that theatre staff. Routine use of Actisol as a disinfectant for cleaning theatre environment (walls and floor) after each list and in between cases, and Actosed for cleaning table, anesthesia machine and laryngoscope after every case may provide adequate cover if carried out properly. According to Centres for disease control (CDC) guidelines for infection control in operating room any disinfectant can be used, but following the instructions strictly according to the manufacturer is a must.[19,20]

This study is of a single operation theatre of a tertiary care hospital and doesn't calculate the incidence of postoperative surgical site infections or nosocomial infection caused by microbial contamination of theatre environment. The samples were collected by different persons on different times specified by pathology department and this can lead to bias in culture results.

Routinely WHO hand washing techniques are used preoperatively.[14] Still the implementation of proper techniques for cleanliness are recommended to decrease prevalence of microbial contamination in operation theatre, as casual attitudes can cause increase in nosocomial infections.

CONCLUSION

Despite observing standard protocols of theatre sterilization, microbial contamination was noted in 33.3% of samples collected from theatre and 17% from personnel. The main microorganism isolated from theatre environment and equipment' samples was

Table 1. Area wise presence of bacterial growth

Sampling sites	Operation theatre 1	Operation theatre 2	Operation theatre 3	Operation theatre 4	Dirty area	Sterilization area	Storage area
Laryngoscope	No growth	No growth	No growth	No growth			
Anesthesia machine	No growth	No growth	No growth	No growth			
Operation table	No growth	No growth	No growth	Growth			
Wall				No growth			
Floor		No growth	No growth	Growth	Growth	Growth	Growth
Air	No growth	Growth	Growth	Growth	Growth	Growth	Growth
Suction machine	No growth	No growth	No growth	No growth			

Bacillus (90.9%), and *Staphylococcus aureus* (55.6%) from theatre personnel.

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