ORIGINAL ARTICLE

The bacterial profile of surgical site infection occurring within one week after surgery in a tertiary care centre

Sasikumari O, Sreekumary PK[1], Jayalekha B[1]

Department of Microbiology, Government Medical College, Thiruvananthapuram, [1]Department of Microbiology, Government Medical College, Kottayam, Kerala, India

ABSTRACT

Background and Objectives: Surgical site infection (SSI) continues to be a major healthcare-associated infection. The objective of the study was to find the bacterial profile of SSI occurring within one week of surgery and to determine their antibiotic sensitivity pattern in a tertiary care centre. **Materials and Methods:** Pus from the surgical sites was cultured, the organisms were identified and their antibiotic sensitivity was found by conventional methods. Data were collected to assess the risk factors. The infection rate was compared with the available standards. **Results:** During the one-year study period, 2472 post-operative patients were followed up, of whom 227 got infected. The infection rate was 9.2% which was high compared to the Centers for Disease Control statistics of 1.9%. The predominant isolate was *Staphylococcus aureus* 50 (28.2%), followed by *Escherichia coli* 48 (27.1%). **Interpretation and Conclusion:** Inpatients were studied for the first one week only because this was the optimum period for contracting infections. Moreover, majority of the patients got discharged from the hospital after one week. *S. aureus* was the predominant pathogen in Class I wounds, and *E. coli* was predominant in Class III wounds.

Key words: Hospital care-associated infection, multidrug-resistant organisms, surgical site infection

INTRODUCTION

The US Centers for Disease Control (CDC) has defined surgical site infection (SSI) as an infection that occurs after surgery in the part of the body where the surgery took place, within 30 days after surgery, or up to one year after surgery in patients receiving implants.[1]

According to the CDC, one-to-three cases out of 100 surgeries get infected. There is, however, considerable variation in each class according to the type of surgery being performed. The incidence of infection varies from surgeon to surgeon, from hospital to hospital, from one surgical procedure to another and, most importantly, from one patient to another.

There is also a gradual change in the bacterial profile of SSI, over time. Now, multidrug-resistant (MDR) strains of bacteria such as Acinetobacter spp. are emerging as pathogens.

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MATERIALS AND METHODS

The study was done in the Department of Microbiology and General Surgery, Government Medical College, Kottayam, Kerala, during a period of one year from March 2011.

Inclusion criteria

All the cases of SSI that occurred within one week after surgery, in the Department of General Surgery, during a period of one year from March 2011 were included in the study.

Address for correspondence: Dr. Sasikumari O, E-mail: sasikumarimohan@gmail.com

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Exclusion criteria

Patients admitted to the Paediatric Surgery Unit were excluded from the study.

Procedure

The infected surgical site was cleaned with sterile normal saline. The pus was collected using sterile cotton swabs or was aspirated. The identification of bacteria was done based on microscopy, culture and biochemical properties using the standard laboratory procedures. Antibiotic sensitivity testing of bacterial isolates was done using Stokes' disc diffusion method.

In patients with features of sepsis, blood samples were taken for culture and sensitivity.

Detection of Extended-spectrum beta-lactamase (ESBL), AmpC β-lactamases, Metallo β-lactamase, Carbapenemase production and inducible resistance were done by conventional methods.

In-use testing of disinfectants was done randomly once in a month during the study period. For in-use testing, the saline and Betadine solutions which were used for routine dressing of wounds were randomly selected. One millilitre of the disinfectant was mixed with 9 ml nutrient broth in a sterile container. A drop of this mixture was placed on ten different areas of two nutrient agar plates. One plate was incubated at 37°C for three days and the other for seven days at room temperature. More than five colonies in one plate are taken as positive, i.e., it shows the failure of the disinfectant.

RESULTS

A total of 2472 post-operative cases were admitted to Government Medical College, Kottayam, during the study period. Out of these, 227 patients got infected during the first week after surgery. Only 177 samples yielded bacterial isolates. Fifty samples were sterile. The most common isolate was *Staphylococcus aureus* 50 (28.2%) followed by *E.coli* 48 (27.1%) [Table 2].

Patients belonging to 50–59 years were the major group affected, 56 (24.7%).

A total of 138 males (60.8%) were infected being more than females.

SSI was maximum in laparotomy wounds - 141 (72 emergency laparotomy and 69 elective gastrointestinal surgery), followed by 24 cases of amputation wounds, 24 cases of mastectomy, 17 cases of mass removal, nine cases of herniorrhaphy and hernioplasty, six cases of vascular surgery, four cases of thyroidectomy wounds and two cases of hydrocele.

Infection was seen maximally on the fourth post-operative day. SSI was present in all cases where the patient had diabetes mellitus (27 cases), malignancy (49 cases) and HIV (one case).

Culture negative SSI was noticed in fifty cases (22%) . These were all clean surgeries of Class I [Table 1].

Outcome

Out of the 227 cases of SSI, 153 (67.4%) cases got completely healed, 11 cases (4.8%) died and 63 cases (27.8%) had a prolonged period of infection or got discharged to local hospital for further wound dressing. There was no follow-up of such cases.

DISCUSSION

During the study period, 2472 cases were admitted to the post-operative wards after surgery. A total of 227 cases of SSI occurred during this period and there were 177 isolates. The overall infection rate was 9.2% which is high compared to the rates of SSI reported by the CDC, Atlanta, USA, which quotes an overall infection rate of 1.9%. Since the inclusion criteria were surgeries done under the Department of General Surgery, majority of the cases studied were laparotomy and mastectomy cases. Among the laparotomy cases, a good number of them were emergency cases due to perforation peritonitis. The indication for mastectomy was mainly malignancy and that itself contributed to infection due to poor local microcirculation, general ill health and malnutrition. The indication for amputation was mostly diabetes mellitus and that itself contributed to the progression of infection. The thyroidectomy wounds were the minimally infected wounds. Only four cases were infected.

Apart from these factors, the high infection rate is also because the study centre is a tertiary health care centre with a lot of complicated referrals from different hospitals.

Considering the age statistics, the most common age group which developed SSI was 50–59 years - 56 cases (24.67%). The reasons being underlying comorbid conditions, leading to frequent hospitalisation and alteration in the normal flora, anaemia, diabetes mellitus, etc. Majority of the SSI studies worldwide show maximum SSI at an age group above 60 years.

Considering the gender statistics, 138 patients were male (60.79%) and 89 patients were female. A study of post-operative wound infection among post-surgical patients at Calicut Medical College, Kerala, India, on September 30, 2012, by Prasanna Gupta also shows

increased SSI in males,[2] yet another study by Paulo De Tarso *et al.* also shows male predominance.[3]

The most critical factors in the prevention of post-operative infections are the sound judgement and proper technique of the surgeon and the surgical team, as well as the general health and disease state of the patient – all these are factors difficult to quantify.

Majority of the elective surgery cases were admitted only on the day of surgery or the immediate pre-operative day. Literature suggests that the increase in the duration of pre-operative stay in hospital increases the risk of SSI. Hence, this risk was minimal in this study.

It was observed that in the 227 cases studied, majority of the infections occurred on the fourth post-operative day - 63 cases (27.75%). This could be the time required for the microbes to overcome the immune mechanisms of the body and to set up an infection.

SSI was present in all cases where the patient had diabetes mellitus (27 cases), malignancy (49 cases) and HIV (one case).[4]

Culture negative SSI was noticed in fifty cases (22%). These were all clean surgeries of Class I. In a study conducted in Bombay by Lilani *et al*., 3 out of 17 infected wounds were sterile.[5] In another study by Mohanty *et al*., 36.33% of samples were culture negative.[6]

A total of 177 isolates were obtained and the predominant isolate was S*taphylococcus aureus*, fifty cases (28.2%) - with thirty cases of MSSA and twenty cases of methicillin-resistant *S. aureus* (MRSA). Enteric organisms such as *Escherichia coli* accounted for 48 cases (27.1%) and *Klebsiella pneumoniae* 22 cases (12.4%).

The percentage of enteric organisms was high because laparotomy was the major bulk of the cases studied. This is in accordance with a study conducted by Nichols *et al.* on gastrointestinal surgeries, showing that Gram-negative bacilli (*E. coli* and *K. pneumoniae*) predominate in abdominal surgeries.[7]

There were 17 pure culture isolates of *Staphylococcus epidermidis*, accounting for 9.5% of the isolates. *S. epidermidis* was considered as a causative agent of SSI only in those cases where the organism was repeatedly isolated from the pus, after cleaning the site thoroughly with sterile normal saline. Studies conducted in India show varying prevalences: 5.1% in Misra *et al.* to 0% in Lilani *et al.* Studies in South Africa by Adegoke *et al.*[8] show 5% isolation of coagulase-negative Staphylococcus from SSI. However, in advanced countries, *S. epidermidis* is among the leading pathogens – 12%–14% as documented by Jarvis *et al.* (CDC) and also in literature.

Table 1: Overview of culture done

Number of isolates (%)	Number of sterile culture (%)	Total number of cases
177 (77.9)	50 (22.1)	227

Table 2: Bacterial profile of surgical site infection

Microorganism isolated	Number	Percentage	
MSSA	30	16.9	28.2
MRSA	20	11.3	
Escherichia coli	48	27.1	
Klebsiella pneumoniae	22	12.4	
Staphylococcus epidermidis	17	9.6	
Pseudomonas aeruginosa	23	12.9	
Acinetobacter baumannii	12	6.7	
Enterococcus faecalis	3	1.7	
Proteus mirabilis	2	1.12	
Total	177	100	

MSSA: Methicillin-susceptible *Staphylococcus aureus*; MRSA: Methicillin-resistant *Staphylococcus aureus*

Table 3: Antibiotic sensitivity pattern of Gram-positive bacteria

Antibiotics	MSSA (%)	MRSA (%)	*Staphylococcus epidermidis* (%)	*Enterococcus faecalis* (%)
Penicillin	0	0	1 (5.88)	0
Ampicillin	0	0	1 (5.88)	2 (66.7)
Gentamicin	14 (46.6)	0	8 (47.5)	0
Erythromycin	9 (31)	0	5 (29.4)	0
Cefoxitin	30 (100)	0	17 (100)	-
Cephalexin	30 (100)	0	5 (29.4)	0
Amikacin	30 (100)	16 (80)	17 (100)	0
Vancomycin	30 (100)	20 (100)	17 (100)	3 (100)
Linezolid	30 (100)	20 (100)	17 (100)	
Rifampicin	30 (100)	20 (100)	17 (100)	-
Total	30	20	17	3

MSSA: Methicillin-susceptible *Staphylococcus aureus*; MRSA: Methicillin-resistant *Staphylococcus aureus*

Antibiotic sensitivity pattern

Staphylococcus aureus [Table 3]

Of all the cases of staphylococcal infection, 20 (11.2%) were resistant to Cefoxitin, i.e., MRSA. None of them were sensitive to Penicillin or Ampicillin. Among the MRSAs, no isolates were found resistant to Vancomycin, Linezolid, Rifampicin or Teicoplanin. Among the Erythromycin-resistant strains - 16 cases (38%) showed inducible Clindamycin resistance.

Escherichia coli

All the 48 (26.8%) isolates were from abdominal surgeries (gastrointestinal surgery wounds, peritonitis wounds and

Table 4: Antibiotic sensitivity pattern of Gram-negative bacteria

Antibiotics	*Escherichia coli* (%)	*Pseudomonas aeruginosa* (%)	*Klebsiella pneumoniae* (%)	*Acinetobacter baumannii* (%)	*Proteus mirabilis* (%)
Ampicillin	0	0	0	0	0
Gentamicin	19 (39.5)	9 (39.13)	13 (59.1)	3 (25)	0
Cephalexin	4 (8.33)	-	3 (13.6)	1 (8.3)	0
Amikacin	40 (83.3)	17 (73.9)	22 (100)	3 (25)	1 (50)
Cefotaxime	8 (16.6)	-	7 (31.8)	0	1 (50)
Ceftazidime	-	12 (52.2)	-	-	-
Ciprofloxacin	12 (25)	9 (39.13)	16 (72.7)	3 (25)	2 (100)
Cefoperazone + Sulbactam	40 (83.3)	-	22 (100)	4 (33.3)	2 (100)
Piperacillin + Tazobactam	33 (68.75)	21 (91.3)	18 (81.8)	3 (25)	2 (100)
Meropenem	48 (100)	20 (86.9)	22 (100)	8 (66.6)	2 (100)
Polymyxin	-	23 (100)	-	10 (83.3)	-
Total	48	23	22	12	2

appendectomy wounds). Ampicillin sensitivity was 0%. Cefoperazone-Sulbactam has higher rate of sensitivity than Piperacillin-Tazobactam. There were 40 (83.3%) ESBL producers among the *E. coli* isolates [Table 4].

Enterococcus faecalis

Only three isolates were obtained. Two were Ampicillin-sensitive, and all the three were Vancomycin-sensitive. All isolates were resistant to Penicillin, Gentamicin, Erythromycin, Cephalexin and Amikacin, with high-level resistance to Gentamicin.

Pseudomonas aeruginosa

Out of 23 cases, 12 of them (52.2%) were sensitive to Ceftazidime (III generation Cephalosporin). There were three isolates of MDR *Pseudomonas aeruginosa* with resistance even to Imipenem but were sensitive to Polymyxin B. Among these three isolates, one isolate showed modified Hodge test positive, indicating Carbapenemase production. They were isolated from a case of laparotomy in an HIV patient, and two other cases were also laparotomy with malignancy of colon as indication for surgery. All the three patients infected with these organisms died.

Staphylococcus epidermidis

There were 17 isolates of *S. epidermidis*, and of these, only one isolate was sensitive to Penicillin. 29.4% were sensitive to Cephalexin. All the17 (100%) isolates were sensitive to Amikacin, Cefoxitin and Vancomycin.

Acinetobacter baumannii

There were 12 isolates of Acinetobacter spp. All of them were *Acinetobacter baumannii* that showed maximum antibiotic sensitivity to Imipenem 8 (66.6%) followed by Cefoperazone-Sulbactam 4 (33.3%) All of them were ESBL positive and were resistant to quinolones and aminoglycosides as well.

Klebsiella pneumonia

All the 22 isolates were from abdominal surgeries (gastrointestinal surgery wounds, peritonitis wounds, appendisectomy wounds, retroperitoneal wounds). *K. pneumoniae* isolates showed maximum sensitivity to Imipenem 22 (100%), Amikacin 22 (100%), Cefoperazone-Sulbactam 22 (100%) followed by Piperacillin-Tazobactam 18 (81.8%). All the isolates obtained were resistant to Ampicillin.

Blood culture was done only for one patient with fever as indication, but blood culture was negative after six days of incubation.

Of the 227 subjects, 153 patients improved with appropriate antibiotics and wound toilet. The outcome of 63 patients could not be followed up due to discharge to local hospital for further management:

- 11 (4.8%) patients under study expired during hospitalisation
- All the deceased were elderly patients (>55 years)
- Three patients had infection with MDR *P. aeruginosa*
- Eight patients died due to poor general condition of the patient. The prime reason was the presence of associated malignancy of the gastrointestinal tract, breast, etc.

Death rate in this study was 4.8%, which is more than the WHO statistics (2.1%) but comparable with Indian scenario.

'In use' test of the dressing saline and Betadine lotion was done. The solutions were sterile.

Limitations of the study

- The number of surgery cases admitted in the post-operative wards only were studied. There were

minor surgery cases which were discharged after observation and they are not included in the study. The SSI in that group is not known

- The present study included only those SSIs occurring during the first seven days after surgery. Majority of them get discharged from hospital by then. However, there are numerous cases who get infected after seven days and who has not been included in the study. Hence, the actual number of SSIs may be much more.

CONCLUSION

During the study period of one year, 2472 post-operative cases were studied. There were 227 (9.2%) cases of SSI during the first week after surgery. Only 178 samples yielded growth, and fifty samples were sterile. The main bacterial isolate was *S. aureus* 50 (28.2%), of which twenty were methicillin-resistant, followed by *E. coli* 48 (27.1%) of which 40 were ESBL producers.

Of the 227 cases, 11 (4.8%) cases died. All these cases had comorbid conditions such as diabetes mellitus or malignancy.

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Conflicts of interest

There are no conflicts of interest.

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