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Original Research Article

Antibiotic-resistance profile of bacteria isolated from patients with surgical site infections-Study at rural-based tertiary hospital

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ABSTRACT

Background: Surgical site infections are common health care associated infections which results in significant morbidity and mortality of patient. SSI may lead to increase hospital stay and healthcare costs.
Aims & Objective: The main aim of study was to find incidence rate of SSI and evaluate various risk factors. In the present study bacteriological profile and antibiotic resistant pattern of pathogens were analyzed.
Materials and Methods: The current prospective study was carried out at a rural-based hospital, Vadodara. 350 operated cases from various departments were included in this study.
Result: Out of total 350 patient, 45 cases of surgical site infection were identified. Thus the incidence of SSI was 12.8%. The high prevalence of SSI was observed among male patient and patient in age group 35-60 years (42.2%).
The statistical analysis results showed that type of wound (significant p value = 0.0001), duration of surgery >2 hours (significant p value = 0.031), diabetes (significant p value = 0.027), and prolonged hospital stay > 7 days (significant p value = 0.0001) were associated with SSI.
The highest prevalence was of *Klebsiella pneumoniae* (31.1%) followed by *Staphylococcus aureus* (22.2%).
Conclusion: The SSI rate in our current study was high. Consistent infection prevention and control measures need to be implemented at our hospital and proper surveillance need to be carried out.

1. Introduction

Surgical site infections (SSIs) are healthcare-associated infections that develop within 30 days of surgery or within 90 days for few surgical procedures such as breast, cardiac and joint surgeries including implants.[1] Surgical site infections are common health care associated infections which results in significant morbidity and mortality of patient. SSI may lead to increase hospital stay and healthcare costs.

In India SSI rate varies widely ranging from 1.6% to 38%. This variation in SSI rate is due to difference in hospital environment, patient population and infection control practices. Various predisposing factors that promote development of SSIs include duration of hospital stay, obesity, diabetes mellitus, smoking and immunocompromised status of patient.[2]

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The source of microorganisms causing SSIs are usually patient endogenous flora. Exogenous source of infection are microorganisms from surgical instruments or the OT theatre environment that contaminate the surgical site.[3] The most common bacteria involved in postoperative wound infection are *Staphylococcus aureus, Pseudomonas spp, Klebsiella spp., Enterococcus spp. and Escherichia coli*.[4]

In India approximately 60-70% of population lives in rural areas. In rural based hospital usually quality of health services are compromised and system for surveillance of HAI are not properly established. Due to research gap true magnitude of SSI burden cannot be estimated. With this aim current study was carried out to find incidence of SSI at rural based hospital, Vadodara. The findings of our study will help to strengthen infection control practices and improve patient care at rural based hospital settings.

2. Objectives

The main aim of study was to find incidence rate of SSI and evaluate various risk factors. In the present study bacteriological profile and antibiotic resistant pattern of pathogens were analyzed.

3. Materials and Methods

The current prospective study was carried out at the Department of Microbiology at a rural-based hospital, Vadodara. 350 operated surgical cases from various departments like Surgery, Orthopaedics, and Obstetrics and Gynaecology were included in this study.

3.1. Inclusion and exclusion criteria

All patients who fulfilled the criteria of surgical site infections were included in the study. All patients of both gender and age above 18 years were enrolled in present study. Patients undergoing second surgery at the same surgical site, patients on immunosuppressant treatment or immunocompromised patient were not included in the study. All patient undergoing outpatient procedures were excluded from SSI surveillance.

3.2. Sample collection procedure

Prior to sample collection all post surgical wound infections were cleaned with sterile normal saline. With the help of sterile swab sample were collected from depth of the wound. Aspirated material was collected with help of sterile syringe. All sample were immediately transported to microbiology laboratory for culture and sensitivity. All clinical samples were examined for color and consistency. All samples were cultured onto nutrient agar, blood agar, and MacConkey agar plates by quantitative culture method. All culture plates were aerobically incubated at 37°C. All bacterial isolates were identified based on morphology and cultural characteristics by conventional method and further species identification was done by Vitek 2.

Various risk factors such as type of surgical wound infection (Class I -Class IV), elective or emergency surgery, duration of surgery (more than or less than 2 hours), and any other predisposing conditions were recorded. According to CDC criteria surgical wound infection was classified under i.e. Class I- Clean, Class II- Clean contaminated, Class III- Contaminated, Class IV- Dirty.

3.3. Antibiotic susceptibility test

Further identification and antibiotic susceptibility testing of pathogens was done by Vitek 2 Compact bioMérieux.

For drug sensitivity breakpoints Clinical and Laboratory Standards Institute guidelines 2023 were used.

3.4. Statistical methods

To establish association between various risk factors and the development of SSI Chi-square test was used. At 95% confidence interval, a p-value of less than 0.05 was considered statistically significant.

4. Results

In our study total 350 patients undergoing various surgical procedures were included. About 45 cases of surgical site infection that fulfilled NHSN criteria were analyzed. Thus SSI rate during the our study period was 12.8% (n = 350).

Out of total 350 patients 240 were male and 110 were female patient. Out of 240 male patient, 32(13.3%) developed SSI and out of 110 female patient, 13(11.8%) developed SSI. Thus gender difference was not associated risk factor for SSI ($x^2 = 0.15$, p value = 0.69, not significant).

Age wise distribution of SSI cases are shown in Table 1. The highest prevalence of SSI was observed in age group 35-60 years (42.2%).

Table 1: Age wise distribution of SSI cases

Age wise distribution (years)	SSI (n=45)	% SSI
18-24	3	6.6%
25-34	10	22.2%
35-60	19	42.2%
>60	13	28.8%

Highest prevalence of surgical site infection was recorded among surgery department (53.3%) as shown in Figure 1.

Out of total 350 patients, 145 patients underwent abdominal surgeries, 98 patient underwent orthopaedic surgeries, 66, 17 and 24 underwent pelvic & urogenital, breast & axilla and neurosurgery surgeries, respectively.

Abdominal surgeries included laparotomy, appendicectomy, hernia repair surgery and hysterectomy.

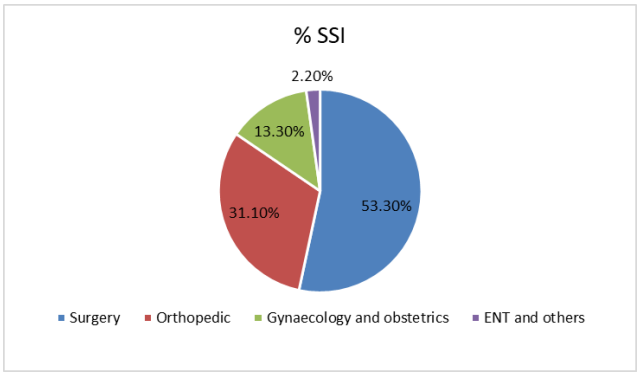

Figure 1: Prevalence of surgical site infection

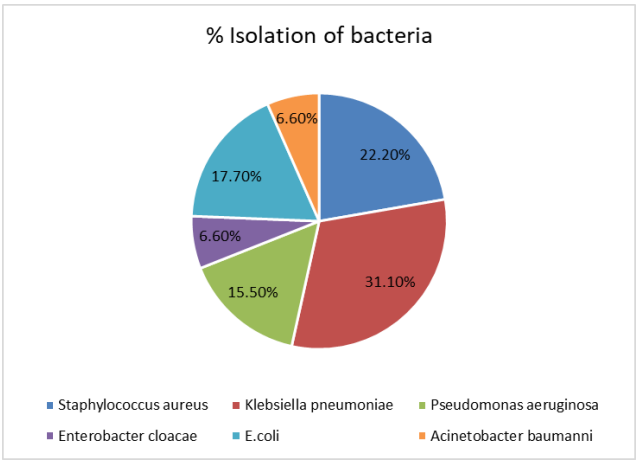

Figure 2: Proportion of various organisms isolated from surgical site infection

The proportion of SSI based on surgical site were as follows, abdomen 23 (51.1%), pelvic and urogenital surgery 9(20%), breast and axilla 1(2.2%), skin, bone and joint 11(24.4%), head and neck 1 (2.2%). (Table 2)

Table 2: Proportion of SSI based on surgical site

Type of Surgery	Total Cases(n=350)	No. of SSI
Abdominal surgeries	145	23
Orthopaedic surgeries	98	11
Pelvic & urogenital	66	9
Breast &axilla	17	1
Neurosurgery	24	1

Out of total of 350 surgical operations, 246 were elective procedure and the rest 104 were emergencies. More prevalence of SSI was observed among elective surgical procedures (86.6%) as compared to emergency procedures (13.3%).

Out of total of 45 SSI cases, 24 (53.3%) were deep surgical site infections, 14 (31.1%) superficial space SSI and 7 (15.5%) were organ spaced.

The statistical analysis results showed that type of wound (p value = 0.0001), duration of surgery >2 hours (p value=0.031), diabetes (p value = 0.027), and prolonged hospital stay > 7 days (p value=0.0001) showed significant association with SSI rate at p-value of ≤0.05 as shown in Table 3.

Figure 2 shows the distribution of various pathogens isolated from surgical site infection. The prevalence of gram-negative bacilli (77.5%) is more as compared to gram-positive cocci (22.2%). The highest prevalence was of *Klebsiella pneumoniae* (31.1%) followed by *Staphylococcus aureus* (22.2%).

In abdominal surgeries, the highest prevalence was of *Klebsiella pneumoniae*. Four isolates of *Staphylococcus aureus* were obtained from Orthopedic surgeries. *Enterobacter cloacae* and *E.coli* were mainly associated with Abdominal surgeries. Proportion of bacteria according to type of surgery is shown in Table 4.

Four isolated of the *Pseudomonas aeruginosa* isolates were multidrug resistant, sensitive to only to carbapenems group of antibiotics. Six of the *Staphylococcus aureus* isolates were methicillin resistant (MRSA), susceptible to Vancomycin, Linezolide and Teicoplanin.

Among gram-negative bacilli 8 *Klebsiella pneumoniae isolates*, 1 *Enterobacter cloacae* and 5 *E. coli* isolates were extended spectrum β-lactamase producer, sensitive only to imipenem and meropenem.

Antibiotic sensitivity of various organism as shown in Tables 5, 6 and 7.

5. Discussion

The National Action Plan in India was established for implementation of strategies with view to decrease the antimicrobial resistance rate and strengthening surveillance of health care-associated infection. According to recent ICMR data, Enterobacterales accounts for 18.5% of surgical site infection and of *Staphylococcus aureus* was 35%. Among non-fermenters, *Pseudomonas aeruginosa* showed prevalence of 26%.

Table 6 shows comparison between SSI rate of our study and other research articles.

The high SSI rate in our study might be due to lack of adequate infection prevention and control measures in the hospital.

In our study gender difference was not significant risk factor for SSI (x^2=0.15,p value=0.69). In study of Hernandez et al. carried out at Peruvian Hospital reported more SSI rate among male patient (65.6%).[9] In contrast, a study done by Shanmugam et al. reported almost equal SSI prevalence among females (52%) and males (48%).[10] The SSI prevalence among male patient was more due to heavy contamination of surgical wound.

Table 3: Association of various factors with SSI

Factors		SSI (n=45)	Non SSI (n=305)	Chi-square X^2 test	P value
Gender	Male	32	208	0.15	0.694
	Female	13	97		
Type of Wound	Clean	6	149	36.228	0.0001
	Clean contaminated	10	87		
	Contaminated	29	69		
Duration of Surgery	<2 hrs	7	95	4.61	0.031
	>2 hrs	38	210		
Associated risk factors	Diabetes	17	56	8.95	0.027
	Smoking	4	21	0.23	0.62
	Alcoholism (n=13)	2	11	0.07	0.78
	Prolonged hospital stay (>7 days) (n=63)	21	42	28.7	0.0001

Table 4: Proportion of bacteria according to type of surgery

Type of Surgery	*Staphylococcus aureus*	*Klebsiella pneumoniae*	*Enterobacter cloacae*	*E. coli*	*Pseudomonas aeruginosa*	*Acinetobacter baumannii*
Abdominal surgeries (n=23)	3	8	3	4	4	1
Orthopaedic surgeries (n=11)	4	1	0	3	2	1
Pelvic & urogenital (n=9)	2	5	0	1	1	0
Breast &axilla (n=1)	1	0	0	0	0	0
Neurosurgery (n=1)	0	0	0	0	0	1
Total No.of Isolates	10	14	3	8	7	3

Table 5: Antibiotic sensitivity of Gram positive cocci

Name of Antibiotic	*Staphylococcus aureus* (n=10)
Penicillin	0%
Cefoxitin	40%
Vancomycin	100%
Linezolid	100%
Erythromycin	70%
Clindamycin	60%
Levofloxacin	50%
Doxycycline	70%
Ampicillin	20%
Gentamycin	70%
Co-trimoxazole	50%
Rifampicin	100%
Daptomycin	100%
Teicoplanin	100%

In our present study, the proportion of SSIs among patient between age group 35-60 years was highest 42.2%. The possibility of SSI development increases as age advances due to certain predisposing factors like diabetes mellitus, co-morbid conditions and impaired immune system.

Similar findings were reported in study of Owens et al.[11] and Bharatnur et al.[12] who reported higher SSI rate among age group of 36-50 years which was 1.3 times among age group of 10-35 years.

The proportion of SSI based on surgical site were as follows, abdomen 23 (51.1%), pelvic and urogenital surgery 9(20%), breast and axilla 1(2.2%), skin, bone and joint 11(24.4%), head and neck and others 1 (2.2%). Allegranzi et al.[13] also concluded that abdominal surgeries have higher SSI rate .

Out of total of 350 surgical operations, 246 were elective procedure and the rest 104 were emergencies. More

Table 6: Antibiotic sensitivity of Gram negative bacilli

Antibiotic	*Klebsiella pneumoniae* (n=14)	*Enterobacter cloacae* (n=3)	*E. coli* (n=8)
Gentamicin	42.8%	66.6%	37.5%
Amikacin	35.7%	66.6%	37.5%
Meropenem	100%	100%	100%
Imipenem	100%	100%	100%
Piperacillin/Tazobactum	35.7%	66.6%	37.5%
Ceftriaxone	14.2%	33.3%	25%
Cefuroxime	14.2%	33.3%	25%
Cefepime	21.4%	33.3%	25%
Amoxicillin/clavulanic acid	14.2%	0%	12.5%
Ciprofloxacin	35.7%	66.6%	25%
Cefoperazone/sulbactam	42.8%	66.6%	37.5%

Table 7: Antibiotic sensitivity of Gram negative non-fermenter bacteria

Antibiotic	*Pseudomonas aeruginosa* (n=7)	*Acinetobacter baumannii* (n=3)
Piperacillin/Tazobactum	42.8%	66.6%
Ceftazidime	28.5%	33.3%
Cefoperazone/sulbactam	42.8%	66.6%
Cefepime	14.2%	33.3%
Imipenem	100%	100%
Meropenem	100%	100%
Gentamicin	28.5%	66.6%
Amikacin	42.8%	66.6%
Ciprofloxacin	42.8%	66.6%
Levofloxacin	28.5%	33.3%

Table 8: Comparison between SSI rate

S. No.	SSI Rate in other studies	Author
1	12.8%	Present study
2	5.5%	Nivitha et al.[5]
3	5.4%	Golia et al.[6]
4	7.3%,	Iqbal et al.[7]
5	22.2%	Setty et al.[8]

prevalence of SSI was observed among elective surgical procedures (86.6%) as compared to emergency procedures (13.3%). Our study findings are in contrast to Tabiri et al.[14] findings who reported that emergency cases had a higher number of SSIs (23.8%) as compared to elective cases (7.4%).

Out of total of 45 SSI cases, 24 (53.3%) were deep surgical site infections, 14 (31.1%) superficial space SSI and 7 (15.5%) were organ spaced. Our study findings are similar to the study by Dessie et al.[15] who reported superficial SSI as 42.1% and deep SSI as 57.9% (112 cases).

The statistical analysis results showed that type of wound (p value=0.0001), duration of surgery >2 hours (p value=0.031), diabetes (p value=0.027), and prolonged hospital stay > 7 days (p value=0.0001) showed significant association with SSI development. In the study of Lilienfeld et al.[16] and Talbot,[17] reported that SSI rate was higher among diabetic patient (50%). Our study findings are similar to study of Nivitha et al[5] who reported that patients who had a hospital stay longer than seven days have a higher risk of developing SSI than those who stayed less than or seven days. ($p < 0.0001$).

The isolation rate of gram-negative bacilli (77.5%) is more as compared to gram-positive cocci (22.2%). Six of the *Staphylococcus aureus* isolates were methicillin resistant (MRSA), susceptible to Vancomycin, Linezolide and Teicoplanin. Among gram-negative bacilli 8 *Klebsiella* isolates, 1 *Enterobacter* isolate and 5 *E. coli* isolates were ESBL producers,. Study conducted by Varsha et al.[18] reports that *Escherichia coli* (31.25%) was the commonest pathogen, followed by *Pseudomonas aeruginosa* (25%) and *Staphylococcus aureus* 22%.

6. Conclusion

The SSI rate during our study period was 12.8% (n = 350).

Study results showed that type of wound (p value = 0.0001), duration of surgery >2 hours (p value = 0.031), diabetes (p value=0.027), and prolonged hospital stay > 7 days (p value=0.0001) were independent risk factors for SSI.

The duration of pre- and post-operative patient stay must be kept to the minimum to reduce SSI rate. Periodic surveillance of SSI must be done to identify various risk factors of SSI and it will help to strengthen Infection prevention and control measures in our hospital.

7. Source of Funding

None.

8. Conflict of Interest

None.

References

1. Magill SS, O'Leary E, Janelle SJ, Thompson DL, Dumyati G, Nadle J, et al. Changes in Prevalence of Health Care-Associated Infections in U.S. Hospitals. *N Engl J Med*. 2018;379(18):1732–44.
2. CDC. National and State Healthcare-Associated Infections Progress Report; 2023. Available from: https://www.cdc.gov/healthcare-associated-infections/php/data/progress-report.html.
3. Ban KA, Minei JP, Laronga C, Harbrecht BG, Jensen EH, Fry DE, et al. American College of Surgeons and Surgical Infection Society: Surgical Site Infection Guidelines, 2016 Update. *J Am Coll Surg*. 2016;224(1):59–74.
4. Gaynes RP. Surgical-site infections and the NNIS SSI Risk Index: room for improvement. *Infect Control Hosp Epidemiol*. 2000;21(3):184–5.
5. Mohan N, Gnanasekar D, Sowmya TK, Ignatious A. Prevalence and Risk Factors of Surgical Site Infections in a Teaching Medical College in the Trichy District of India. *Cureus*. 2023;15(5):e39465.
6. Golia S, Kamath ASB, Nirmala AR. A study of superficial surgical site infections in a tertiary care hospital at Bangalore. *Int J Res Med Sci*. 2014;2(2):647–52.
7. Iqbal F, Younus S, Asmatullah, Zia OB, Khan N. Surgical Site Infection Following Fixation of Acetabular Fractures. *Hip Pelvis*. 2017;29(3):176–81.
8. Nagaraja MS, Nagappa DH, Giriyaiah CS, Gowda NR, Naik R. A study on surgical site infections (SSI) and associated factors in a government tertiary care teaching hospital in Mysore, Karnataka. *Int J Med Public Health*. 2014;4:171.
9. Hernandez K, Ramos E, Seas C, Henostroza G, Gotuzzo E. Incidence of and risk factors for surgical-site infections in a Peruvian Hospital. *Infect Control Hosp Epidemiol*. 2005;26(5):473–7.
10. Shanmugam G, Rangam S, Kayalvili K, Sundaram L. Prevalence of surgical site infections and antimicrobial sensitivity pattern in patients attending a Tertiary Care Hospital in South India: a prospective study. *J Patient Saf Infect Control*. 2017;5:12–7.
11. Owens CD, Stoessel K. Surgical site infections: epidemiology, microbiology and prevention. *J Hosp Infect*. 2008;70:3–10.
12. Bharatnur S, Agarwal V. Surgical site infection among gynecological group: risk factors and postoperative effect. *Int J Reprod Contracept Obstet Gynecol*. 2018;7:966.
13. Allegranzi B, Nejad SB, Combescure C, Graafmans W, Attar H, Donaldson L, et al. Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. *Lancet*. 2011;377(9761):228–41.
14. Tabiri S, Yenli E, Kyere M, Anyomih TTK. Surgical Site Infections in Emergency Abdominal Surgery at Tamale Teaching Hospital, Ghana. *World J Surg*. 2018;42(4):916–22.
15. Dessie W, Mulugeta G, Fentaw S, Mihret A, Hassen M, Abebe E. Pattern of bacterial pathogens and their susceptibility isolated from surgical site infections at selected referral hospitals. *Int J Microbiol*. 2016;2016:2418902.
16. Lilienfeld DE, Vlahov D, Tenney JH, Mclaughlin JS. Obesity and diabetes as risk factors for postoperative wound infections after cardiac surgery. *Am J Infect Control*. 1988;16(1):3–6.
17. Talbot TR. Diabetes mellitus and cardiothoracic surgical site infections. *Am J Infect Control*. 2005;33(6):353–9.
18. Shahane V, Bhawal S, Lele U. Surgical site infections: A one year prospective study in a tertiary care center. *Int J Health Sci (Qassim)*. 2012;6(1):79–84.

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