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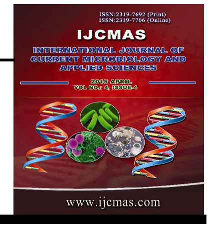

Original Research Article

Microbial etiology and risk factor analysis of paediatric surgical site infections in a tertiary care hospital

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A B S T R A C T

Keywords

Surgical Site Infections, Paediatric surgery, Infection rate, Infection density, *Escherichia coli*, *Staphylococcus aureus*

The prospective, observational study characterized the surgical site infections in 190 neonates and 503 infants and children operated and managed in a paediatric surgical unit of a tertiary care centre in northern India, a critical aspect inadequately addressed till now. The infection rate was found to be 3.6% in neonates and 11.9% in infants and children. The infection density was found to be 10.8 episodes per thousand patient days. 67 cases of SSI were detected, out of which 56 were superficial & 11 were deep. The risk factors significantly associated with presence of SSI were surgical wound class, emergency surgeries, duration of surgery, site of surgery, indications for surgery, anaemia, use of drain and intraoperative blood transfusion. The predictors of SSI using multivariate logistic regression with their odd's ratio, 95% confidence interval are Contaminated wound class (aOR .045; 95% CI 0.557 to 53.7), Perforation peritonitis cases(OR 38.205; 95% CI 1.303 to 1120.04) and blood transfusion (OR 6.682; 95% CI 3.166 to 14.1).*Escherichia coli* was the most common isolate to be followed by *Staphylococcus aureus.* Forty six percent of *S. aureus* isolates were methicillin resistant (MRSA).

Introduction

Surgical site infections (SSIs) in modern surgery continue to be a major problem for healthcare practitioners across the globe. It is a manifestation of disturbed host-bacteria equilibrium in favour of bacteria. Surgical site infections after the operative procedure, results when bacteria either endogenous to the patient or exogenous to the wound, achieve dominance over the host resistance power. It's a real risk as it complicates the outcome of the operative procedure in terms of morbidity as well as mortality. The rates of SSI differ between children and adults, because of unique susceptibilities of each population[1].Children differ from adults in various aspects as far as health care associated infections are concerned. Factors unique to paediatric patients include differences in the process of care, such as the type and amount of physical contact between patients and health care workers (e.g., feeding and diapering); differences in developmental immunity; congenital anomalies that disrupt anatomic barriers; different sources of infection and social interactions that may increase the transmission of microbes, such as sibling visitation etc. The differences between adult and paediatric patients regarding the appropriate treatment and preventive measures, highlights the need for paediatric-specific quality measures to guide infection prevention and treatment practices[2].

Despite the numerous publications on the incidence of and risk factors for SSI in adults, there have been only few reports from the south- eastern Asian region (including India) on this aspect. This study was carried out for a better understanding of surgical site infections in paediatric cases which could lead to their prevention and better management.

The aim and objective of this study was to isolate and identify the microbes causing surgical site infections, their antimicrobial susceptibility pattern and the association of the various risk factors associated with the development of SSIs.

Methodology

A prospective observational study was carried out in the departments of Microbiology and Paediatric Surgery, Lady Hardinge Medical College and associated Kalawati Saran Children's hospital, New Delhi from November 2011 to March 2013. The study included neonates, infants and children operated in paediatric surgery unit of KSCH, New Delhi. This tertiary-level 350-bedded children's hospital has 30 beds in the paediatric surgery unit. The patients in the study group underwent surgery in the pediatric surgery OT which deals with both elective and emergency surgeries. All the cases were administered prophylactic parenteral antibiotics, the exact choice of antibiotics depending upon the indication for the surgery. After surgery, the patients were shifted from the OT on the third floor to the PSU located on the second floor of the KSCH building. Postoperatively, in the PSU, the patients were managed by the paediatric surgery team with necessary assessment and advice from the microbiologists.

Data was collected on a predesigned, pre tested performa from every patient regarding the various risk factors and demographic details. The questionnaires included information about intrinsic factors such as age, sex, nutritional status and among extrinsic factors were those related to the operative procedure like type of procedure (emergency/elective),indication for surgery, duration of operation, transfusion of blood products, use of drain, preoperative and postoperative stay. Surveillance of these cases was conducted during the daily rounds by the medical team.

During the postoperative stay patients were observed for the presence of signs and symptoms suggestive of surgical site infection like pain, redness, localized swelling or oozing of pus from the suture site, fever etc. and reported accordingly if needed. After discharge patients were advised to look for signs and symptoms of SSI and were asked to report immediately if any of them were present. All patients without implants were followed up in the paediatric surgery OPD till postoperative day 30. SSIs were diagnosed as per CDC guidelines 1999[3].Depending upon the clinical features and the decision of attending paediatric surgeon, relevant samples like pus were collected as per the standard methods[4,5,6]

Statistical testing was conducted with the statistical package for the social science system version SPSS 17.0. Univariate analysis was performed to determine the statistically significant risk factors. Multivariate logistic regression analysis was performed to determine the independent predictor of SSI. For all statistical tests, a p value less than 0.05 was taken to indicate a significant statistical difference

Result and Discussion

A total of 693 patients (190 neonates and 503 infants and children) undergoing emergency / elective operative procedures comprised the study group. All the cases were followed up from day one of surgery till the postoperative day 30 as per the CDC guidelines. The infection rate was found to be 3.6% in neonates and 11.9% in infants and children. The incidence density was 10.8 per 1000 patient days.

During the study period, 190 neonates were observed. Seven neonates who developed SSI, were operated for neonatal intestinal obstruction and anterior abdominal wall defects like omphalocele and gastroschisis. These neonates had a clean contaminated surgical wound and interrupted suturing was done in all the cases. The mean birth weight of neonates who developed SSI was in the range of 2.12±0.35 kg as compared to 2.34±0.31 kg in neonates who did not develop SSI. 57% of neonates with SSI were of low birth weight and an equal number were preterm too. C-reactive protein was raised (>0.6mg/dl) and termed CRP positive in 14.28% cases. The mean haemoglobin concentration of the neonates were within normal limits with 57% of them having a Hct> 45%. The onset of infection ranged from a period of 3days to 7 days, with a median value of 3day.

Infants and children were mainly operated for cleft lip, cleft palate, appendicectomy, surgery for pyloric stenosis, biliary atresia, intestinal obstruction, perforation peritonitis, intussusceptions, congenital pouch colon, midgut volvulus, cholecystectomy, surgery for hirschsprung disease, anorectal malformations, hypospadias, exostrophy bladder, PUJ obstruction and thoracic surgeries. The rates of SSIs were highest in case of contaminated surgeries like perforation peritonitis and lowest in clean surgeries like cleft lip and cleft palate.

The distribution of risk factors analysed in this study is shown in table 1.

The maximum rate of SSI was seen in the 1-5 year age group followed by infants. The rate of SSI was more in males as compared to females. Majority of the cases had elective operative procedures however the development of SSI was higher in the cases that had emergency operative procedure.The SSI rate was high in the cases with contaminated type of wound as compared to the clean and clean contaminated wound.The duration of operative procedures in all the cases were divided into two groups namely operative procedures lasting for less than 2.5 hours and more than 2.5 hours. The higher rate of SSIs was seen in the group which had operation procedure lasting for more than 2.5 hours. The mean duration of operative procedure in SSI cases was 3.07 ± 0.86. Out of total 503 patients, 81% patients had a preoperative stay of 1-5 days. The rate of SSI was highest for this duration of stay. The cases were also assessed for malnutrition by Gomez classification of weight for age. It was found that 51.49% patients were normal while 48.49% were malnourished. The other risk factors analysed included anaemia, use of drain and intraoperative blood transfusion. All the three parameters were found to be significantly associated with increased SSIs as compared to other group not having SSIs.

According to univariate analysis, the risk factors found to be significantly associated with presence of SSI were surgical wound class, emergency surgeries, duration of surgery, site of surgery, indications for surgery, anaemia, use of drain and intraoperative blood transfusion.

Multivariate logistic regression model was used to identify independent risk factors for SSI. The predictors of SSI using multivariate logistic regression with their odd's ratio, 95% confidence interval are Contaminated wound class (aOR .045; 95% CI 0.557 to 53.7), Perforation peritonitis cases (OR 38.205; 95% CI 1.303 to 1120.04) and blood transfusion (OR 6.682; 95% CI 3.166 to 14.1).

Pus from all the cases were subjected to microscopic and cultural studies. In neonates, *Klebsiella pneumoniae* and *Acinetobacter baumanii* were the major isolates. Among infants and children, *Escherichia coli* were the most common isolate to be followed by *Staphylococcus aureus.*

Antimicrobial susceptibility was performed on all the isolates. Their antimicrobial resistance pattern is shown in table 2 and 3. The current study was a single centre study carried out in 190 neonates and 503 infants and children operated in the paediatric surgery unit of Kalawati Saran Children's Hospital, New Delhi. The SSIs were defined by the CDC criteria[3], which are followed in most of the studies[9-18]. In our study, the SSI rate was found to be 11.9% in infants and children and 3.6% in neonates. In the various international studies, SSI rates varied from 1.2% to 23.6%[9,10,11,12,13,14]. The lower rates of SSI in the study of Varik K. et. al. and Horwitz JR et.al. could be ascribed to lower proportion of contaminated wounds in their study[9,10]. Davenport M et.al. reported a SSI rate of 16.6% in paediatric population whereas Ameh EA et.al. in a study of SSI in sub-Saharan Africa reported a very high SSI rate of 23.6%, which can be attributed to higher proportion of emergency operative procedures included in their studies[14,16]. To the best of our knowledge, there are very few published studies on SSI in paediatric population in India. A study done in Rohtak in 1984 by Sharma LK et.al. found the SSI rate of 5.43% in their study population[17]. The Incidence density in our study was found to be 10.8 per 1000 patient days. This aspect has not been discussed in other studies. From none of our cases, sepsis could be confirmed by the laboratory tests.According to the type of SSI, the highest percentage of SSI was seen in superficial category. Other studies have corroborated this finding[9,16,17,18].

The maximum rate of infection in our study was found to be in 1-5 year age group. This aspect has also not been addressed in other studies[16,17]. Bhattacharya N. et.al. reported a higher rate of SSI in infants as compared to neonates and other age group[15].The rate of SSI in our study was more in males (70%) as compared to females (30%). No significant statistical difference in the rate of SSI according to the sex was seen in our study. Other studies have corroborated this finding[10,11,12,13].The maximum percentage of SSI in our study was seen in the month of July and the least percentage was seen in the month of November. The increased number of cases of SSI in the month of July could be ascribed to hot and humid conditions existing in that period. This aspect has also not been addressed in other studies[10-13]. In our study, the SSIs in the cases who had an emergency operation were higher than those who had an elective operation. This finding has been corroborated in other studies[17,18]. In our study, higher rates of SSI were seen in cases who had an abdominal operative procedure than those who had other site operation site. This appears to be understandable as the gut flora has a huge load of bacteria with anaerobes outnumbering the aerobes by several fold. Three other studies have corroborated this finding[10,11,13]. The gut flora could contaminate easily the wound site. However, in one study the SSI rate was found to be higher in cases having general surgery[12] than in those who had abdominal surgery. The rate of SSI according to the wound class in our study was seen to be highest in cases with contaminated wound. This is understandable as the microbial flora in the wound has a higher quantum of microbes[15,16,17]

Higher rates of SSI were seen in group who had operative procedure lasting for more than 2.5 hours in comparison to group who had operative procedure lasting for less than 2.5 hours. This could be explained on the basis that there could be a greater chance of wound contamination in a surgery with longer duration. This finding was corroborated in another study where it was found that cases who had duration of surgery >4 hours in comparison to the group with <4 hours, to be significantly associated with increased rate of SSI.

Other risk factors like presence of anaemia was found to be significantly associated with increased rate of SSI. This finding has also been corroborated in two other studies[11,12,13]. This is understandable as poor oxygenation in the tissue can impede the immune response. Use of drain postoperatively was also found to be significantly associated with the development of SSI, as the presence of a foreign body can encourage the development of infection at the wound site. This aspect has not been addressed in other studies. The relationship between blood products and SSIs has been a matter of debate for more than two decades. Several studies have supported the association between the use of blood products and the development of postoperative surgical site infections[9,12,13]. Allogenic blood products have immunomodulatory effects that may increase the risk of nosocomial infections. It is also possible that the transfusion of blood products acts as a marker for individuals with a greater number of co morbidities and other SSI risk factors, which independently places them at an inherently greater risk for infection. Intra operative blood transfusion was also significantly associated with development of SSI. This could be ascribed to the invasive procedure of blood transfusion increasing the chances of infection.

In our study *Staphylococcus aureus* (25%) was the commonest gram positive cocci isolated from SSI cases whereas *Escherichia coli* (30%) were the commonest gram negative bacilli isolated. Similar results were reported by Togo et.al. and Varik et.al.in most cases of SSI, the organism is either patient's endogenous flora or may be endemic in the hospital environment.

The other less common but important pathogens isolated from SSI cases include members of Enterobacteriaceae namely *Acinetobacter spp* (15%), *Klebsiella species* (8%), *Citrobacter freundii* (3.3%), *Proteus vulgaris* (3.3%), *Pseudomonas aeruginosa* (5%) and *Enterococcus species* (3.12%). These have also been reported as common pathogens in other studies[13,17].Emergence of multidrug resistant strains of hospital pathogens has presented a challenge in the provision of good quality in-patient care. Inappropriate use of antibiotics in the hospital is largely responsible for this catastrophe.

Table.1 Risk factor analysis for surgical site infections

Variable	Classification	SSI Present	SSI Absent	P value
Age	<1 yr	16	99	0.646
	1-<5yr	18	282	
	5-<10yr	15	104	
	10-<15	9	46	
	>15	2	12	
Sex	F	18	114	0.481
	M	42	329	
Operation Duration	<2.5 hr	24	283	0.000
	>2.5 hr	36	160	
Type of surgery	Emergency	14	38	
	Elective	46	405	
Surgical Wound Class	Craniofacial	0	47	0.176
	Throcic	2	10	
	Abdominal	53	264	
	Urogenital	3	84	
	Perineal	2	37	
	Gluteal	0	1	
Preoperative Stay	<1	14	34	0.155
	1-5	37	375	
	>5-10	5	22	
	>10	4	12	
Malnutrition	Grade 1	14	149	0.818
	Grade 2	13	51	
	Grade 3	5	12	
	Normal	28	231	
Wound Class	Clean	5	134	0.001
	Clean Contaminated	23	236	
	Contaminated	32	73	

Table.2 Profile of antimicrobial resistance pattern from the isolated Gram positive cocci pathogen

Isolate	V	Tei	Lz	Amp	G	Cip	P	Ac	Cx	Co	E	Cd	Te	Azt
S. aureus	0	0	0	73.3	13.3	46.6	73.3	33.3	46.66	60	60	33.3	40	14.28
Coagulase negative *Staphylococcus*	0	0	0	66.6	50	66.6	66.6	16.6	50	33.3	83.3	24	66.6	16.6

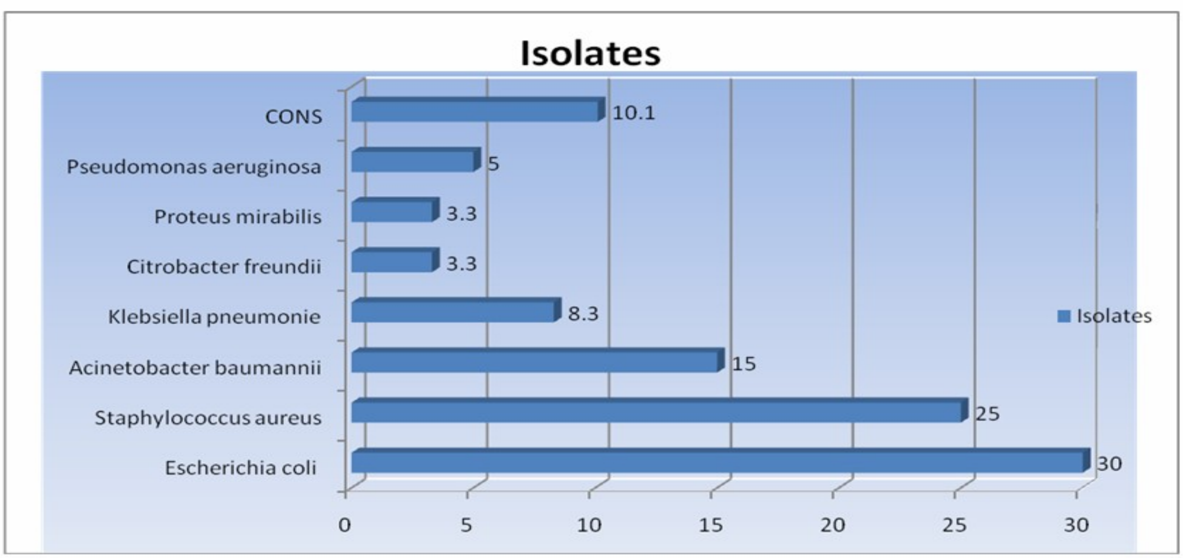
V-Vancomycin, Tei- Teicoplanin, Lz- Linezolid, Amp- Ampicillin, G- Gentamicin, Cip- Ciprofloxacin, P-Penicillin, Ac- Amoxycillinclavulanic acid, Cx- Cefoxitin, Co- Trimethoprim sulphamethoxazole, E-Erythromycin, At-Azithromycin,Cd- Clindamycin,T-Tetracycline

Table.3 Profile of antimicrobial resistance pattern from the isolated gram negative bacilli

Isolate	Ak	Ac	Cip	Caz	Ctx	Ctr	Cpm	G	I	Pt	Le	Nt	Tg	Ao	Cl
E. coli	26.3	57.9	63.15	52.6	68.42	63.2	36.8	47.3	21	42.1	31.5	26.3	0	60	0
Klebsiella spp.	40	80	33.3	80	80	60	80	5.2	20	25	0	25	0	0	0
C.freundii	50	100	75	50	50	100	100	0	0	0	50	0	0	0	0
P.vulgaris	50	100	50	50	100	100	100	80	50	0	100	0	0	100	-
Pseudomonas aeruginosa	0	33.3	0	66.6	33.3	66.6	0	0	0	0	0	0	-	0	0
Acinetobacter spp.	57.2	85.7	72.85	85.7	85.7	85.7	91.67	71.4	57.2	57.2	42.8	57.2	0	50	0

Ak- Amikacin, Ac- Amoxycillin-clavulanic acid, Cip- Ciprofloacin, Caz- Ceftazidime, Ctx- Cefotaxime, Ctr-Ceftriaxone, Cpm- Cefepime, G- Gentamicin- I- Imipenem, Pt- Piperacillintazobactum, Le-Levofloxacin, Nt-Netilmicin, Tg-Tigecycline, Ao- Aztreonam, Cl- Colistin

Figure.1 Cultural profile of SSI cases



*Values represented in percentage

One of the most prevalent multidrug resistant bacteria isolated was *Staphylococcus aureus*. While considering sensitivity pattern, all gram positive cocci were hundred percent sensitive to vancomycin, teicoplanin and linezolid. Forty six percent (approximately) of *Staphylococcus aureus* isolates were MRSA which is an alarming sign. MRSA infections are of great concern due to high morbidity and mortality rates. No vancomycin resistant *Staphylococcus aureus* or *Enterococcusspecies* were identified in the study. Maximum sensitivity among gram negative organisms was demonstrated to imipenem, piperacillin-tazobactum, tigecycline, netilmicin, aztreonam and colistin. Cephalosporins and quinolones were ineffective against most of the pathogens isolated in our study. This may be due to extensive and overuse of cephalosporins and quinolones in our hospital setup.

SSI is a global health problem both in economic and human term. Rate of SSI is affected by multiple factors. The current study performed in the PSU of KSCH, New Delhi had a high incidence rate of SSIs, with an infection density of 10.8 per 1000 patient days. This institution being a tertiary care centre, many cases might have presented late with inadequate treatment from the neighbouring states which gives a skewed picture. In the present study, the risk factors significantly associated with presence of SSI were surgical wound class, emergency surgeries, duration of surgery, site of surgery, indications for surgery, anaemia, use of drain and intraoperative blood transfusion. To minimize the current SSI rate in our paediatric surgical unit, these specific risk factors need to be specifically addressed. *E.coli* and *Staphylococcus aureus* were the most common organism isolated so appropriate therapeutic approach and efficient preventive modalities are important. Effective infection control measures and a good regular surveillance can reduce SSI rate to an acceptable level.The results of the present study underline the importance of more studies in this area, and of establishing specific guidelines for SSI in pediatrics population.

References

1. Russel, R.C.G., Williams, N.S., Bulstrode, C.J.K. 2008. Principles of Paediatric Surgery. In Bailey & Love's Short Practise of Surgery, 25th edition. Hodder Arnold;p. 71-89
2. Alexis, M., Elward, M.D., Kathleen, A. Steps to Reduce Nosocomial Infections in Children.
3. Mangram, A.J., Horan, T.C., Pearson, M.L., et.al.1999. CDC Guideline for prevention of surgical site infection. Hospital infection control practices advisory committee.Infect Control Hosp Epidemiol. 20(4):250-78
4. Duguid,J.P., Marmion, B.P., Collee, J.G. et.al.1996. Laboratory strategy in the Diagnosis of Infective syndromes. In: Collee, J.G. ,Marmion, B.P., Andrew, G.F., Simmons, A.s, eds. Mackie & McCartney Practical Medical Microbiology .14th ed. Churchill Livingstone , Elsevier: p53-94.
5. Collee, J.G., Marr, W.1996. Specimen collection, culture containers and media .In : Collee, J.G., Marmion, B.P., Andrew, G.F., Simmons, A., eds. Mackie & McCartney Practical Medical Microbiology .14thed, Churchill Livingstone. Elsevier.: p95-111.
6. Richard, B.,Thomson, J.R..2007. Specimen collection, Transport, and

processing: Bacteriology.In: Murray, P.R., Baron, E.J., Jorgensen, J.H. Manual of clinical Microbiology, 9th ed, ASM Press :291-329.

7. Collee, J.G., Miles, R.S.1996 .Tests for identification of bacteria. In:Collee, J.G., Marmion, B.P., Andrew, G.F., Simmons, A., eds. Mackie & McCartney Practical Medical Microbiology. 14th ed. Churchill Livingstone, Elsevier: p131-149.
8. Mathew, A., Franklin, R., William, A. et al.2012. Performance standards for antimicrobial susceptibility testing. Clinical and Laboratory Standards Institute; 32 (Suppl 3):25-110
9. Horwitz, J.R., Chwals, W.J,et.al..1998.Paediatric Wound Infections A Prospective Multicenter study. Annals of Surgery; 227(4):553-558.
10. Varik, K., Kirsimagi, U., et.al. 2010. Incidence and risk factors of Surgical Wound Infection in Children: A prospective study. Tartu University, Estonia. Scandinavian J of Surgery: (99):162-66.
11. Mousavi, S.A., Mousavi, S.J.2008. Surgical site infection in children a single centre study. Research Journal of Biological Sciences ; 3 (8): 880-883, 2008.
12. Casanova, F.C., Herruzo, R., Diez, J.2006. Risk factors for Surgical Site Infections in Children. Infection Control and Hospital Epidemiology ;27(7):709-715.
13. Togo, A., Coulibaly, Y., Dembele, B.T. et.al.2011. Risk factors for Surgical Site Infections in children at the teaching hospital Gabriel Toure, Bamako. Journal of Hospital Infection 79.371-372.
14. Davenport, M.,Doig, C.M.1993. Wound infection in paediatric surgery: A study in 1,094 neonates. Journal of paediatric surgery;28(1):26-30
15. Bhattacharyya, N., Kosloske, A.M.1990. Postoperative wound infection in pediatric surgical patients: a study of 676 infants and children. J Pediatr Surg;25(1):125-9
16. Ameh, E.A., Mshelbwala, P.M., Nasir, A.A., et.al.2009. Surgical Site Infection in Children: Prospective Analysis of the Burden and Risk Factors in a Sub-Saharan African Setting ;10(2): 105-109
17. Sharma, L.K., Sharma, P.K.,1986. Postoperative wound infection in a pediatric surgical service. J Pediatr Surg;25(1):125-9