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Surgical Site Infection in Children a Single-Centre Study

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Abstract: Surgical wound infection is a significant cause of post-operative mortality and morbidity in children especially neonates. The aim of the present study was to determine prospectively the incidence of post-operative wound infections in children and to identify the risk factors associated with the development of wound infection. Despite a large series of literatures in adults, there have been a few reports concerning post-operative wound infections in children. All children undergoing operations on the pediatric surgical service during a 4.5 year period in our cente,r were post-operatively followed for 30 days after surgery for the development of a wound infection. The overal incidence of wound infections among 974 children who had undergone the operation was 3.9%. Factors found to be significantly associated with a post-operative wound infection were age of patient ($p<0.05$) and the amount of contamination during the operation time ($p<0.05$). There was no significant difference in sex and season of operation. The result of this study demonstrated that wound infection in children is similar to adults, however, in neonates, it is more than adults that is related to the physiologic status.

Key words: Wound infection, child, surgery, physiologic status, center study

INTRODUCTION

Surgical Site Infections (SSI) are the second most common nosocomial infection (Haley *et al*., 1985) and in some reports it is the first ethiology (Townsend *et al*., 2004). SSIs are associated with considerable morbidity and occasional lethality, substantial healthcare costs, patient inconvenience and dissatisfaction. Despite numerous publications on the incidence rate and risk factors for SSI in adults, there have been few reports in the English literatures concering neonates and children. These studies have reported varying overall wound infection rates, ranging from 2.5% (Bhattacharyya and Kosloske, 1990) to 20% (Doig and Wilkinson, 1976). This study was performed to determine the frequency of post-operative SSI in neonates, infants and children in single center provided by one pediatric surgeon and also to identify the risk factors associated with SSI in these patients.

MATERIALS AND METHODS

In our study, all patients (neonates, infants, children) who were undergoing an operation, required a skin incision on the pediatric surgical ward during a 4.5 year period (from September 2002 through March 2007). They were prospectively followed for the development of a wound infection.

Clinical variables and data collected included age, sex, weight, diagnosis and the class of operation determined by wound contamination. All the patients were operated by one surgeon with similar techniques and materials. Each patient was followed for at least 30 days post surgery and examined by one surgeon. Out patient surgery such as circumcision, meatotomy, drainage of cutaneous abscesses and ICU procedures such as cut down venotomy, were excluded from this study. Patients were also excluded for death during or before the month after the opreation with another ethiology.

By definition, according to the Center for Disease Control and Prevention (CDC), SSIs are infections of the tissues, organs, or spaces exposed by surgeons during the performance of an invasive procedure. An incisional SSI occurs when a surgical wound drains the purulent material or if the surgeon determines it to be infected and hence, opens it (Brunicardi *et al*., 2005). SSI may be superficial or deep (Horan *et al*., 1992). Superficial infection is an infection that occurs at the incision site within 30 days after surgery. The surgery involves only the skin and subcutaneous tissues with at least one of

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the followings: Purulent drainage from the incision; isolation of an organism from a culture of fluid from the superficial incision; incisional pain, swelling or redness and the wound was opened. Diagnostic criterion for a deep SSI was an infection within 30 days after surgery. If the infection occurs within a year, it may be due to an implant left in the surgical site, which consists of deep soft tissues, such as facial and muscle layers and at least one of the followings: purulent drainage from the deep incision, the spontaneously dehised incision, an abscess involving the deep incision and the diagnosis of a deep incisional SSI made by the surgeon.

All surgical incisions were classified according to the definitions proposed by Altemeier *et al.* (1984) as: clean, clean-contaminated, contaminated and dirty/ infected.

Statistical analysis was conducted with a statistical program of SPASS-11 and discrete variables were analyzed with Chi Square test. The p value below 0.05 was considered significant.

RESULTS

During a 4.5-year period, the total of patients that underwent operations and completed follow-ups were 976. Thirty-eight patients (3.9%) developed post-operative wound infection. There were 722 boys (74%) and 254 girls (26%). Incidence of SSI among boys was 24 (3.3%) and girls 14 (5.5%). There was no significant difference in sex. There were 184 neonates (= 30 days old) (18.8%), 403 infants (41.3%) and 38 children older than 2 years (39.8%). SSIs were significantly linked to the age ($p<0.05$). The younger the neonates are, the more the infection occured. SSIs were found in 20 neonates (10.8%), 10 infants (2.48%) and 8 children who were older than 2 years (2%).

The most commonly performed procedures were inguinal herniorrhaphy (n = 274), digestive tract anomalies and emergency operations, such as intestinal obstruction and atresia (n = 239). Table 1 gives a complete list of the most commonly performed operations. SSIs were significantly high in emergency operations, especially in Gastnointestinal system ($p<0.05$). It is clear that most of the patients were in neonatal group.

SSIs were significantly associated with the degree of wound contamination ($p<0.05$) (Table 2). The infection rate elevated as wound contamination increased from clean (1.77%) to clean-contaminated (3.84%), from clean-contaminated to contaminated (7.4%) and from contaminated to dirty or infected wounds (16.9%). The factors irrelevant to cause an increase in wound infection, was the season of operation.Wound infection in all of the elective operations, occured after discharge and was detected by a surgeon in the clinic.

Table 1: Operative procedures

Procedure	Number (976)
Inguinal hernia or hydrocele	274
Gastrointestinal emergency operations	239
Urogenital anomaly	184
Appendectomy	93
Closure of colostomy	38
Cleft lip or palate	34
Others	114

Table 2: Wound class and infection rate

Wound class	Number of patients	SSI number (%)
Clean	564	10 (1.7)
Clean-contaminated	260	10 (3.8)
Contaminated	81	6 (7.4)
Dirty	71	12 (16.9)

DISCUSSION

SSI is a signifcant nosocomial infection that causes multiple problems to both patients and surgeons. For these reasons, there have been numerous publications on the incidence and risk factors of SSI, but nearly all of these reports are about adults and our study is the largest review thus far, in general pediatric surgery, that is, single-center in which all operations were performed by one surgeon. Our overall post-operative wound infection rate was 3.9%, that is similar to Davis *et al.* (1984) and Sharma's and Sharma's (1986) findings. The overall incidence of wound infections in a report containing nearly 63,000 adult patients by Cruse and Foord (1980), was 4.7% among similar studies that were limited to a pediatric group. Our incidence of SSI was more than 2.5% which is reported by Bhattacharyya and Kosloske (1990). We excluded all patients having day surgery and operations performed in the ICU. On the other hand, we closed all wounds (even dirty ones) primarily, therfore. it was difficult to compare these reports. Our diagnostic criteria of wound infections were considered clinicaly, by a surgeon who used current standardized CDC definitions of SSI, that included not only infections of the skin and subcutaneous, but also the deep layers (Geoffery *et al.*, 1990).

All of our patients were followed up for one month after their operation by a surgeon. They were examined at least 7-10 days after discharge in the clinic and then followed by telephone as needed. Olson and Lee (1990) in a 10-year report with nearly 41,000 patients, found that 19.5% of wound infections were diagnosed after discharge.

The results of our study suggest that SSI in children is related to factors such as age of patients and contamination at the time of operation. The role of wound contamination has been documented in many reports, however, it should be noted that the age factor is contraversial (Horwitz *et al*., 1998). The distribution of wound infections in clean and clean-contaminated cases, closely paralleled the data from most reports (Bhattacharyya and Kosloske, 1990; Olson and Lee, 1990). However, our results in dirty or infected cases is different from that of Horwitz *et al*. (1998). It is important to know that we routinely closed all these wounds. As a result, the incidence of SSI increased considerably..

Our emergency cases were in neonatal group, specially in the alimentary trait system. The incidence of SSI was the highest in this group which may be due to the emergency situation and physiologic problems of patients. As has been shown in some reports, gastrointestinal operations and emergency situations may be a risk factor for SSI (Bhattacharyya and Kosloske, 1990; Sharma's and Sharma's, 1986).

As a whole, neonates, especially premature infants, show increased suseptibility to bacterial infections and sepsis. This pre-dispostion is closely linked to intrinsic deficiencies in the neonatal host defense apparatus (Sharma's and Sharma's, 1986; Wright *et al*., 1975; Grosfeld *et al*., 2005). Perhaps, one of the most importamt factors in neonates is their relative inability to significantly increase the levels of circulating neutrophils. Infact, experimental data from neonatal rats suggest that their neutrophil storage pool is only 20-30% of that in adults (Grosfeld *et al*., 2006). Wright *et al*. (1975) reported that the mean bactericidal activity (percentage of organisms killed after 2 h) of leukocytes from stressed newborns, was significantly less than that of the combined well infant and adult control group. On the other hand, the effects of gestational age and birthweight on the concentration of IgG at birth, were highly interdependent and significant (Conway *et al*., 1985).

Although, the use of pre-operative antibiotic and culture results are of epidomiologic interest, they rarely serve to direct therapy, because antibiotics are not routinely withheld until results appear. Standard therapy for SSI consists solely of incision and drainage without additional antibiotics.

One of the most importamt limitations of our study was the patient's follow- up, which is a common problem. Weigelt *et al*. (1992) stated that follow-ups, varies from less than 50% in trauma patients to about 95% in transplant patients. We excluded the patients who didn`t return to the center for their follow-up visit. This may influence our results.

Because the study was carried out in a single center with only one surgeon to perform all the direct examinations of any suspicious wound, our report may have a positive point.

CONCLUSION

To conclude, the overall SSI rate in children is similar to adults, but it is higher in neonates. Furthermore, contamination of wounds has a very importamt role in wound infection. It appears that many efforts are necessary in pediatric surgery to help reduce the costs of healthcare associated with post- operative wound infection, especially with neonatal intensive care unit patients. Post-operative wound infections in many of patients were detected after discharge and as Burns and Dippe (1982), Reimer *et al*. (1987) and Weigelt *et al*. (1992) have shown, post-operative wound infection surveillance must be pursued even after discharge.

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