Published in final edited form as:

J Pediatr Surg. 2014 March ; 49(3): 381–384. doi:10.1016/j.jpedsurg.2013.08.001.

Surgical site infections in infants admitted to the neonatal intensive care unit

Ilan Segal, MD^{1,2,3}, Christine Kang, BSc¹, Susan G. Albersheim, MD, PhD, FRCPC^{1,2,4}, Erik D. Skarsgard, MD, FRCSC^{1,2,5}, and Pascal M. Lavoie, MD, PhD, FRCPC^{1,2,4}

¹Children's & Women's Health Centre of British Columbia, Vancouver BC, Canada V6H 3N1

²Department of Pediatrics, University of British Columbia, 2329 West Mall Vancouver BC, V6T 1Z4

⁴Child & Family Research Institute, 950 west 28th Avenue, Vancouver BC V5Z4H4

⁵Department of Surgery, University of British Columbia, 2329 West Mall Vancouver BC, V6T 1Z4

Abstract

Background—Surgical interventions are common in infants admitted to the neonatal intensive care unit (NICU). Despite our awareness of the broad impact of surgical site infection (SSI), there is little data in neonates. Our objective was to determine the rate and clinical impact of SSI in infants admitted to the NICU.

Methods—Provincial population-based study of infants admitted to a tertiary care NICU. SSI, explicitly defined, was included if it occurred within 30 days of a skin/mucosal-breaking surgical intervention.

Results—Among 724 infants who underwent 1039 surgical interventions very low birth weight (VLBW) infants were over-represented. The overall SSI rate was 4.3 per 100 interventions [CI 95% 3.2 to 5.7], up to 19 per 100 dirty interventions (wound class 4) [CI 95% 4.0 to 46]. Rates were higher in infants following gastroschisis closure (13 per 100 infants [CI 95% 5.8 to 24]), whereas they were generally low following a ligation of a ductus arteriosus. Infants with SSI required longer hospitalization after adjusting for co-morbidities ($p < 0.001$).

Conclusions—Data from this relatively large contemporary study suggest that SSI rates in the NICU setting are more comparable to the pediatric age group. However, VLBW infants and those undergoing gastroschisis closure represent high risk groups.

Keywords

Surgical site infection; neonates; very low birth weight; gastroschisis

Address correspondence to: Dr. Pascal Lavoie, Child & Family Research Institute, 4th floor Translational Research Building, 950 West 28th Avenue, Vancouver BC V5Z 4H4. Tel.: (604) 875-2135. FAX: (604) 875-3106. plavoie@cw.bc.ca.

³Current address/affiliation: The Barzilai Medical Center Ashkelon; Ben Gurion University of the Negev; Hahistadrout St 2, Ashkelon 78278, Israel.

INTRODUCTION

Surgical Site Infection (SSI) constitutes a major post-operative complication resulting in serious morbidities and mortality in children and adults [1, 2]. In North America, one fourth of hospital-acquired infections are SSI, resulting in billions of dollars in hospitalization costs annually; therefore, major efforts are concentrated on prevention [3–5]. A considerable proportion of infants admitted to the neonatal intensive care unit (NICU) require surgical interventions. However, very little data are available on the impact of SSI in the neonatal age group.

Neonates are presumed to be at higher risk of SSI due to a greater immunological vulnerability and specific co-morbidities [6] including prematurity [2, 7] and prolonged parenteral nutrition dependence [8]. Also, neonates are commonly exposed to pre-operative antibiotics, raising additional concerns of microbial resistance [9]. Previous studies in the pediatric age group included a limited number of neonates and infants, and did not discriminate risk based on the type of surgical intervention [10]. Some studies excluded significant neonatal risk groups such as very low birth weight (VLBW) infants [11–13]. Finally, other neonatal studies were performed in an ambulatory care setting or in resource-limited countries [12, 14–19], which limits generalization of data to the neonatal intensive care setting where most high-risk interventions occur [10, 20]. Given the frequent occurrence of surgical interventions and serious clinical consequences of infection in neonates, and the lack of recent data reporting rates of SSI in this age group, we sought to determine the incidence and clinical impact of SSI in a population-based cohort of infants admitted to a large provincial tertiary care neonatal unit. Our data provide contemporary estimates of rates of SSI in the neonatal age group.

MATERIALS & METHODS

Study population

We retrospectively reviewed data from all infants admitted to the NICU at the Children's & Women's Health Centre of British Columbia (Vancouver, Canada) between January 2004 and December 2009. The study center is the main tertiary care neonatal referral center for the province of British Columbia (~7,500 births per year at this center, with a catchment area of ~44,000 births per year in the province according to 2011–2012 census data). Data for admitted patients were entered prospectively by trained database abstractors. The study was approved by the University of British Columbia Children's & Women's Clinical Research Ethics Board (certificate # H10-02409).

Inclusion criteria and case definitions

In a first-pass review, 238 infants were initially identified in our NICU database by screening for infants who either had a diagnosis of surgical infection and/or who received antibiotics for more than 5 days. To confirm data integrity within the entire dataset, we initially performed a random database abstraction (5% charts) against a medical chart review. In a second-pass review the medical chart of these infants was manually reviewed by two neonatologists (IS and PML) to determine whether they met a diagnosis of SSI, defined

based on Centers for Disease Control National Nosocomial Infections Surveillance System criteria combining subtypes (i.e. superficial, deep and organ/space), and within 30 days of the surgical intervention [21]. To exclude the small possibility that infants may have been missed due to an untreated SSI, or partially treated SSI, we also searched our database for infants with a diagnosis 'infection', who underwent a surgical procedure and reviewed the detailed hospitalization narrative for these infants. In addition, all cases of SSI were also consistent with diagnoses made by attending surgeons/neonatologists. Using this method, we established dataset accuracy (>99 %) over fields of interests. Infants who underwent an intervention requiring a surgical incision were included in the surgery group, whereas infants with non-incisional interventions (e.g. percutaneous, endoscopic and laser procedures) were excluded in our analysis. Surgical interventions were classified by body cavity (e.g. thoracic, abdominal) and wound class (1 to 4), as described [22], and whether antibiotics were used pre-, peri- or post-operatively. Wound classifications for surgical interventions were manually assigned by a pediatric surgeon (ES). Peri-operative antibiotic treatment of any duration was defined as antibiotics initiated within 24 hours of the surgical intervention, which also encompass traditionally defined prophylactic antibiotics (PA). In our centre, we routinely use 2% w/v chlorhexidine gluconate or 70% v/v isopropyl alcohol for disinfection of skin prior to a surgical procedure.

Data analysis and statistics

Data were analyzed on a per surgical intervention and per infant basis. Rates of SSI were reported with 95% confidence intervals using the exact method. Differences between groups were compared using chi-square, Student-t or Mann-Whitney U tests as indicated. Significant co-morbidities in univariate analyses were tested for association with SSI in separate models, by stepwise multiple regressions with an entry p value of 0.1, using SPSS for Windows v11.0.1. In multivariate models with SSI, a maximum of three independent variables were tested. Due to a high co-linearity, the influence of gestational age and birth weight were assessed separately. A threshold (p value) of 0.05 was considered significant, unless otherwise specified.

RESULTS

Clinical characteristics of study population

During the study period, 3907 neonates were admitted to our NICU. Of those, 724 (18.5%) underwent a total of 1039 surgical interventions (up to 11 surgical intervention per infant). The clinical characteristics of infants who required surgical interventions are presented in table 1. Although characteristics of infants who required surgical interventions, such as gestational age and birth weight, were representative of infants admitted to the NICU, infants of VLBW were significantly over-represented. Infants who required surgical intervention required mechanical ventilation for longer periods and had longer lengths of hospital stay (table 1). The all-cause mortality rate among infants who required surgical interventions was 8.0 % (CI 95% 6.1 to 10%).

Incidence of SSI

Among 1039 interventions, 45 were complicated with a SSI, for a rate of 4.3 SSI per 100 interventions (CI 95% 3.2 to 5.7). When examining SSI according to wound class, the rate of SSI was 3.1 per 100 clean interventions (Class 1; CI 95% 1.9 to 4.8; n = 611), 4.4 per 100 clean-contaminated/contaminated interventions (Class 2 and 3; CI 95% 2.6 to 6.8; n=412) and 19 SSI per 100 dirty interventions (Class 4; CI 95% 4.0 to 46; n=16). Among infants who required surgical interventions, 38 developed an SSI, for an overall rate of 5.3 SSI per 100 infants (CI 95% 3.7 to 7.1). Thirty-two infants developed one SSI, 5 developed two SSI and 1 developed three SSI. Blood cultures were positive in four of the 38 cases of infants with SSI (including three cases of coagulase-negative staphylococci and one enterobacter species).

When examining the type of surgical intervention, the majority of infants underwent abdominal (50%) or thoracic (27%) surgeries. The most common types of surgical intervention performed in our center were laparotomies for congenital or acquired bowel obstruction and surgical ligation of a patent ductus arteriosus (PDA). Among all types of interventions, laparotomies, which are usually considered contaminated or sometimes even dirty, when bowel perforation occurs, had an overall high rate of SSI of 6.2 per 100 infants per procedure (CI 95% 3.6 to 10). PDA ligation, generally considered a clean procedure, had the lowest SSI rate overall (table 2). Notably, 8 infants who underwent gastroschisis closure had a SSI, which is significantly higher (13 per 100 intervention [CI 95% 5.8 to 24]) than the overall SSI rate in infants who required a surgical intervention ($p = 0.045$).

Clinical predictors and outcomes of SSI

When examining clinical predictors, the timing of the first surgical intervention was a strong predictor of SSI. On the other hand, gestational age (including the proportion of infants of VLBW), birth weight, use of peri-operative antibiotics, the timing of surgery (in post-natal age) and wound Class were identical between infants with and without SSI (table 3). In addition, when analyzed on a per procedure basis, neither gestational age nor birth weight were significant predictors of SSI ($p > 0.2$).

When examining outcomes, infants with SSI were more likely to require further surgical interventions and required significantly longer hospitalization compared to those infants who did not develop SSI (table 4). On a per intervention analysis, both wound class (adjusted OR 18 CI 95% 10 to 25; $p < 0.001$) and the number of surgical intervention (adjusted OR 21 CI 95% 18 to 24; $p < 0.001$) were independent predictors of length of hospital stay when adjusted for gestational age, birth weight and type of surgery. Of 38 infants with SSI, one died of an unrelated cardiac complication. To determine whether SSI is an independent predictor of prolonged hospital stay, we used multivariate regression analyses. On a per infant analysis, the increment in duration of hospitalization in infants with SSI remained significant, after adjusting for either gestational age or birth weight, and the timing of the surgical intervention ($p < 0.001$).

DISCUSSION

This is the largest contemporary study reporting rates of SSI in infants admitted to the NICU. Davenport was the first to report SSI rates in 1094 infants born between 1975 and 1987 admitted to a neonatal surgical unit in England [12]. However, a major limitation of this earlier study is the inclusion of a very small number of preterm infants of lower gestational age (born <32 weeks; n = 68), which limits application of the data in a modern context of increased survival of VLBW infants [12]. According to our study, VLBW infants represent a significant proportion of infants who require surgical interventions and therefore, exclusion of these infants represents an important limitation of previous studies [11–13]. Furthermore although overall SSI rates were substantially higher in this earlier study (>16.6 %) compared to our data, these infants were managed before major improvements in neonatal and surgical care, which may have influenced the nature and/or risk of surgical interventions. Interestingly, the overall rate of SSI in the neonatal age group in our center is comparable to rates reported in the older pediatric age group [7, 10, 13, 20]. Taking into account that our study was performed in an intensive care setting, the SSI rate is considerably lower than might be expected [12, 23].

The size of and population-based nature of our study cohort allows us to make important observations regarding rates of SSI in subgroups of infants admitted to the NICU who require specific surgical interventions. Notably, we report a higher-than-expected incidence of SSI in infants with gastroschisis compared to other neonates admitted to the NICU. A recent report from the Canadian Pediatric Surgery Network: CAPSNet, reported a 8.2 % rate of SSI in infants with gastroschisis who underwent immediate closure (less than 6 hour after birth) versus a 21 % rate in infants in the delayed (>24 hour after birth) closure group [24]. However, due to the focus of this latter study on infants with gastroschisis, authors were unable to conclude whether this rate of SSI was high compared to a neonatal population. Overall, our findings provide an important validation of these previous findings and identify a particularly high risk group of SSI within the neonatal population. The finding of a reverse trend in SSI rate between infants with primary versus secondary closure, compared to the CAPSNet report is likely due to the small number of infants with gastroschisis in our study. Cowan et al. developed a Gastroschisis Prognostic Score to predict mortality and morbidities in infants with this condition; whether this score accurately predicts a high rate of SSI from gastroschisis repair requires further study [25]. Our observations also provides a basis for a re-classification of this type of wound (with corresponding clinical measures) based on a higher level of contamination [22].

Few studies have examined risk predictors of SSI in neonates undergoing surgical interventions. Neonates have distinct risk clinical characteristics, which may affect their susceptibility to SSI, including prematurity, a paucity of subcutaneous tissue and distinct, naive microbial colonization state [2]. In addition, the types of surgical interventions usually performed in neonates are also clearly distinct. More recently, Kessler reported a rate of post-operative sepsis of 6.9 % in a smaller cohort of infants of less than 6 months of age admitted to a tertiary care pediatric institution in Switzerland (n = 260) [19]. In this latter study a low gestation, certain types of surgeries as well as a prolonged operative time were associated with an increased rate of post-operative infection, although only the most severe

cases of sepsis were included [19]. Only a minority of infants with SSI presented a positive blood culture in our study, which emphasizes the importance of considering all infant with a clinical diagnosis of SSI regardless of blood culture results. When employing an inclusive definition of SSI regardless of the blood culture status, neither gestational age nor birth weight were significant predictors of SSI. On the other hand, a later timing of the first intervention was strongly associated with an SSI, which likely reflects a greater cumulative impact of co-morbidities associated with longer hospital stay rather than gestational maturity. The identification of specific neonatal risk groups for SSI represents an important step towards the development of targeted interventions.

Resource allocation is an important aspect in the management of health care. However, due to limited studies in neonates (referred to above), differences in population and clinical practices may limit interpretation of data. Gestational age and birth weight are important independent determinants of outcomes in neonates, although the impact of these covariates needs to be considered separately and was not reflected in our study [26]. Investigators from the Study on the Efficacy of Nosocomial Infection Control (SENIC) and the National Nosocomial Infection Surveillance produced scores for stratification of SSI risk, which resulted in a significant decrease in SSI rates in adults [27, 28]. Our findings of a longer duration of hospitalization in infants with SSI independent of gestational age and birth weight suggest an independent impact of SSI also in the neonatal age group. In that regard, similar scores adapted for the neonatal age group, may help predict resource allocation in the neonatal setting [29].

Our study has limitations. We were unable to compare outcomes based on the standard of practice for prophylactic antibiotics (PA) due to a lack of precision on the urgency of surgeries and lack of the data on the timing of peri-operative antibiotic administration. Ichikawa et al. showed that a peri-operative protocol involving, among other changes, a shorter, better timed administration of PA resulted in a significant reduction of SSI, which may indicate a potential benefit from PA in preventing SSI [11]. The lack of standard regarding the timing of pre-operative antibiotics may explain the lack of detectable association with SSI in our study. Second, although the use of a clinical definition has the advantage of more directly reflecting physicians' concern, it is possible that its interpretation is subject to observer bias, which may lead to an over-estimation of the rate of SSI. This is particularly relevant to infants with gastroschisis who can present with increased local inflammatory signs related to a tight abdominal closure. On the other hand, it is unlikely that infants with SSI were missed unless the infant was untreated. The absence of robust objective criteria (such as wound culture status) or even data indicating systemic responses to an SSI (changes in vital signs, temperature, blood glucose, acute phase proteins, etc.) limits a more precise ascertainment of the true incidence of SSI, which requires a carefully designed prospective study to confirm these relatively subjective observations.

In conclusion, a substantial proportion of infants who require neonatal intensive care undergo surgical interventions. In this age group, rates of SSI were lower than previously reported and more comparable to the pediatric age group despite distinct co-morbidities. VLBW infants as well as infants with gastroschisis represent particularly high risk groups when considered at the NICU population level. SSI are independently associated with

increased length of hospital stay in neonates. Further studies are warranted to confirm our findings prospectively and to define ways to improve peri-operative management of infants at highest risk of SSI.

Acknowledgments

Funding source: PML is supported by a Clinician-Scientist Award from the Child & Family Research Institute and a Career Investigator Award from the Michael Smith Foundation for Health Research. This work was funded by the Child & Family Research Institute and BC Women's Hospital Newborn Program.

We thank Peter Atkins for help with database access and data retrieval.

Abbreviations

CAPSNet	Canadian Pediatric Surgery Network
NICU	Neonatal intensive care unit
PA	Prophylactic antibiotics
PDA	patent ductus arteriosus
SSI	Surgical site infection
VLBW	Very low birth weight

References

1. Angus DC, Linde-Zwirble WT, Lidicker J, et al. Epidemiology of severe sepsis in the United States: analysis of incidence, outcome, and associated costs of care. *Crit Care Med*. 2001; 29:1303–1310. [PubMed: 11445675]
2. Raval MV, Dillon PW, Bruny JL, et al. Pediatric American College of Surgeons National Surgical Quality Improvement Program: feasibility of a novel, prospective assessment of surgical outcomes. *J Pediatr Surg*. 2011; 46:115–121. [PubMed: 21238651]
3. Sparling KW, Ryckman FC, Schoettker PJ, et al. Financial impact of failing to prevent surgical site infections. *Qual Manag Health Care*. 2007; 16:219–225. [PubMed: 17627217]
4. Fry DE. The economic costs of surgical site infection. *Surg Infect (Larchmt)*. 2002; 3(Suppl 1):S37–43. [PubMed: 12573038]
5. de Lissovoy G, Fraeman K, Hutchins V, et al. Surgical site infection: incidence and impact on hospital utilization and treatment costs. *Am J Infect Control*. 2009; 37:387–397. [PubMed: 19398246]
6. Bucher BT, Guth RM, Elward AM, et al. Risk factors and outcomes of surgical site infection in children. *J Am Coll Surg*. 2011; 212:1033–1038e1031. [PubMed: 21398150]
7. Kosloske AM. Surgical infections in children. *Curr Opin Pediatr*. 1994; 6:353–359. [PubMed: 8061746]
8. Cole CR, Hansen NI, Higgins RD, et al. Bloodstream infections in very low birth weight infants with intestinal failure. *J Pediatr*. 160:54–59e52.
9. Toltzis P, Dul MJ, Hoyer C, et al. The effect of antibiotic rotation on colonization with antibiotic-resistant bacilli in a neonatal intensive care unit. *Pediatrics*. 2002; 110:707–711. [PubMed: 12359783]
10. Horwitz JR, Chwals WJ, Doski JJ, et al. Pediatric wound infections: a prospective multicenter study. *Ann Surg*. 1998; 227:553–558. [PubMed: 9563545]

11. Ichikawa S, Ishihara M, Okazaki T, et al. Prospective study of antibiotic protocols for managing surgical site infections in children. *J Pediatr Surg.* 2007; 42:1002–1007. discussion 1007. [PubMed: 17560210]
12. Davenport M, Doig CM. Wound infection in pediatric surgery: a study in 1,094 neonates. *J Pediatr Surg.* 1993; 28:26–30. [PubMed: 8429466]
13. Davis SD, Sobocinski K, Hoffmann RG, et al. Postoperative wound infections in a children's hospital. *Pediatr Infect Dis.* 1984; 3:114–116. [PubMed: 6728700]
14. Wood JH, Nthumba PM, Stepita-Poenaru E, et al. Pediatric surgical site infection in the developing world: a Kenyan experience. *Pediatr Surg Int.* 2012; 28:523–527. [PubMed: 22297835]
15. Ameh EA, Mshelbwala PM, Nasir AA, et al. Surgical site infection in children: prospective analysis of the burden and risk factors in a sub-Saharan African setting. *Surg Infect (Larchmt).* 2009; 10:105–109. [PubMed: 18831682]
16. Giri BR, Pant HP, Shankar PR, et al. Surgical site infection and antibiotics use pattern in a tertiary care hospital in Nepal. *J Pak Med Assoc.* 2008; 58:148–151. [PubMed: 18517124]
17. Garcia HJ, Rodriguez-Medina X, Franco-Gutierrez M, et al. Risk factors for surgical site infections in newborns in a neonatal intensive care unit. *Rev Invest Clin.* 2005; 57:425–433. [PubMed: 16187703]
18. Eriksen HM, Chugulu S, Kondo S, et al. Surgical-site infections at Kilimanjaro Christian Medical Center. *J Hosp Infect.* 2003; 55:14–20. [PubMed: 14505604]
19. Kessler U, Ebnetter M, Zachariou Z, et al. Postoperative sepsis in infants below 6 months of age. *World J Pediatr.* 2009; 5:113–117. [PubMed: 19718532]
20. Duque-Estrada EO, Duarte MR, Rodrigues DM, et al. Wound infections in pediatric surgery: a study of 575 patients in a university hospital. *Pediatr Surg Int.* 2003; 19:436–438. [PubMed: 12883851]
21. Mangram AJ, Horan TC, Pearson ML, et al. Guideline for Prevention of Surgical Site Infection, 1999. Centers for Disease Control and Prevention (CDC) Hospital Infection Control Practices Advisory Committee. *Am J Infect Control.* 1999; 27:97–132. quiz 133–134; discussion 196. [PubMed: 10196487]
22. Vu LT, Nobuhara KK, Lee H, et al. Conflicts in wound classification of neonatal operations. *J Pediatr Surg.* 2009; 44:1206–1211. [PubMed: 19524742]
23. Bojdo A, Sawicka E, Zak K, et al. Risk factors of surgical site infection in newborn infants. *Med Wieku Rozwoj.* 2008; 12:771–777. [PubMed: 19305029]
24. Baird R, Puligandla P, Skarsgard E, et al. Infectious complications in the management of gastroschisis. *Pediatr Surg Int.* 2012; 28:399–404. [PubMed: 22159577]
25. Cowan KN, Puligandla PS, Laberge JM, et al. The gastroschisis prognostic score: reliable outcome prediction in gastroschisis. *J Pediatr Surg.* 2012; 47:1111–1117. [PubMed: 22703779]
26. Tyson JE, Parikh NA, Langer J, et al. Intensive care for extreme prematurity--moving beyond gestational age. *N Engl J Med.* 2008; 358:1672–1681. [PubMed: 18420500]
27. Haley RW, Culver DH, Morgan WM, et al. Identifying patients at high risk of surgical wound infection. A simple multivariate index of patient susceptibility and wound contamination. *Am J Epidemiol.* 1985; 121:206–215. [PubMed: 4014116]
28. Culver DH, Horan TC, Gaynes RP, et al. Surgical wound infection rates by wound class, operative procedure, and patient risk index. National Nosocomial Infections Surveillance System. *Am J Med.* 1991; 91:152S–157S. [PubMed: 1656747]
29. Casanova JF, Herruzo R, Diez J. Risk factors for surgical site infection in children. *Infect Control Hosp Epidemiol.* 2006; 27:709–715. [PubMed: 16807846]

Table 1

Clinical characteristics of infants who required a surgical intervention.

Clinical characteristics	Infants who required surgery n = 724	Entire NICU population n = 3907
Gestational age, wks (mean $\pm$ SD)	33 $\pm$ 5.8	34 $\pm$ 4.8
Birth weight, g (mean $\pm$ SD)	2154 $\pm$ 1155	2256 $\pm$ 1035
Infant of very low birth weight (%)	36	28
Day of life of surgery, (median [IQ])	12 [4 – 57]	N/A
Length of stay (median days [IQ])	26 [9 – 75]	8 [3 – 22]
Endotracheal ventilation days, (median [IQ])	4 [1 – 18]	0 [0 – 3]
Perioperative antibiotic use (%)	22	N/A

SD: standard deviation; IQ: interquartile range; N/A: Not applicable.

Table 2

Surgical site infections according to selected frequent interventions.

Type	Subtype	# infants/procedure	% infants*	SSI rate per 100 infants/procedure	
				Rate	95%CI
Central nervous system	V-P Shunt	24	3.1	4.2	0.1 to 21
Airway/ENT	TEF Repair	28	3.7	0	0 to 12
Chest	PDA ligation	173	23	0.6	0 to 3.2
	CDH Repair	36	4.7	5.6	0 to 18
Abdominal	Laparotomy with	165	22	7.9	4.3 to 13
	or without bowel resection	92	12	3.3	0.7 to 9.2
	Gastroschisis - primary closure	48	6.3	15	6 to 28
	- delayed closure	14	1.8	7.1	0.1 to 34
	G- tube insertion	59	7.7	5.1	1.1 to 14
Pelvic	Inguinal hernia repair	56	7.3	3.6	0.4 to 12
Other	CVL placement	68	8.9	0	0 to 5
Total number of procedures		763			

* Percentage total infants who underwent each procedure; ENT: Ear, nose & throat; PDA: Patent ductus arteriosus; V-P: Ventriculo-peritoneal; TEF: Tracheo-esophageal fistula; CDH: Congenital diaphragmatic hernia; CVL: central venous line.

Table 3

Clinical characteristics of infants with or without surgical site infections (SSI).

Clinical characteristic	SSI n = 38	No SSI n = 686	P value
Gestational age, wks (mean $\pm$ SD)	33 $\pm$ 5.8	33 $\pm$ 5.8	NS
Birth weight, g (mean $\pm$ SD)	2190 $\pm$ 1127	2152 $\pm$ 1158	NS
Infants of very low birth weight (%)	32	37	NS
Day of life of surgery, (median [IQ])	85 [5 – 120]	11 [4 – 52]	0.001
Peri-operative antibiotic use (%)	24	22	NS
Highest wound class (% [†])			
Clean (Class 1)	0	0.1	0.071 [*]
Clean-contaminated/contaminated (Class 2 and 3)	80	89	
Dirty (Class 4)	21	11	

NS: non-significant (p>0.2); IQ : interquartile range.

[†]When infants underwent a procedure, the highest wound class was considered;^{*} Comparing highest wound class in infants between two groups.

Table 4

Outcomes of infants with or without surgical site infections (SSI).

Outcomes	SSI n = 38	No SSI n = 686	P value
Length of stay (median days [IQ])	79 [34 – 131]	25 [9 – 70]	<0.001
Endotracheal ventilation days, (median [IQ])	7.5 [1 – 27]	4 [1 – 18]	0.189
Number of surgical intervention (median [IQ])	2 [1 – 4]	1 [1 – 2]	<0.001

NS: non-significant ($p>0.2$); IQ : interquartile range.