Risk Factors of Surgical Site Infection among Infants: Descriptive Study

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Abstract
Background: Surgical Site Infections (SSIs) are among causes of infants increased duration of hospitalization and post-operative death. **Aim:** To assess the risk factors of SSIs among infants. **Subjects and Methods:** A descriptive research design was used in the present study to assess the occurrence of SSIs and to detect their risk factors among infants admitted in pediatric surgery unit at Assiut university children hospital and subsequent outpatient clinic and home follow up. Two tools were used, a structured interview sheet to assess socio-demographic data and the possible risk factors for SSIs and observational check list were used to assess the SSIs occurrence. **Results:** It was found that 15.3% of the operated infants developed SSIs. Infant with history of nutritional diseases or on artificial feeding, infants who didn't take bath before operation and infants who were nursed without hand wash or with the use of unsterile equipments had more SSIs. **Conclusion:** incidence of SSIs was considered high in infants who had the following risk factors: History of nutritional diseases, infectious diseases, unclean operation, formula feeding, emergency surgery, defect in hand washing and sterilization, using unsterile equipment and antiseptic solution before dressing. **Recommendations**: The pediatric surgeons and nurses should pay a more perioperative attention to prevent risk factors of SSI among infants.

Key wards: SSIs &Wound Infection.

Introduction
Common complications of surgery among infants are surgical wound infections (SSIs) that significantly increase the costs of treatment and the morbidity of infants. Period of stay post-operatively in hospital is increased by SSIs **(Centers for Disease Control & Prevention, 2016).**

The **Association of Surgical Wound Infection (2014)** classified SSI as follows; deep incisional SSIs which is defined as infection involving deep tissues, such as facial and muscle layers; infection involving both superficial and deep incision sites. The second type of SSI is superficial incisional SSI that means infection involves only skin and subcutaneous tissue of incision. The third type of SSI is an organ/space that's means infection involves any part of the anatomy in organs and spaces other than the incision. Fifty percent of SSIs are superficial incisional SSI.

Risk factors of pediatric SSIs differ according to infection- prevention practices including type of surgical practice, sterilization and barriers, effectiveness of perioperative nursing management, use of antimicrobial prophylaxis, age, sex, length of preoperative hospitalization, and site of operation, the presence of any disease or hidden infection. Some strategies can reduce pediatric wound infection as infant's immunity and exclusive breast feeding **(Laura et al., 2016).**

Clinical Picture of SSI include; edema, induration, change in wound or discharge odor, erythema and warmth of the periwound tissues, increasing or purulent discharge, and increased wound pain **(Rosenberger & Sawyer, 2014).**

The severity of SSIs appears within 30 days post-operatively and mostly between the 5th and 10th postoperative day and if infection affected the deeper tissues last for occur several months postoperatively (**Anderson, 2011).**

Rates of infants' SSIs globally reach to 4.4%. Complete SSI rate was 18.7% and 40% of SSI were superficial, about ten percent were deep, and more than quarter were organ/space infections **(Porras et al., 2009).**

At Africa SSI occurred among 23.6% (40 boys/36 girls). The middle age was 9 months (range, 2 days-12 years) for the individuals who had SSI and 15 months (extend, 1 day-13 years) for the infants who did not. The death rate of children with SSI was 10.5%, with six of the eight deaths related specifically to the SSI, compared with a death rate of 4.1% in infants without SSI ($p < 0.05$) **(James et al., 2012).**

Poor wound healing was found in (45.5%) of infants related to inadequate dietary management of pediatric surgical at Alexandria at Egypt (**Elbanna et al., 2010).**

Sacrococcygeal teratoma complications in **upper Egypt by Osman & Ibrahim (2012)** who reported that the follow-up period ranged from 3 months to 10 years, wound infection occurred in four cases (9.7%), and diarrhea in two cases (4.8%).

Wounds require different treatment strategies and dressings through the stages of wound healing. Nurses need to be aware that wound management carries with it significant liability and orders for all wound care products and treatments should be documented **(Sangrasi et al., 2008).**

Nurses must work to apply evidence-based practices in surgical settings. Nurses must provide counseling and education during the initial preoperative visit, especially related to glucose control in infants with diabetes. Encourage infants and their families to report any signs of infections as rashes, breaks in skin integrity, and new-onset respiratory infections before surgery **(Association of periOperative Registered Nurses, 2014).**

Nurses have a serious perioperative role to help decreasing SSIs among infants by applying nursing care from admission to discharge and follow-up to provide parents with accurate information regarding the type of laboratory and surgical procedure, type of operation (emergency/elective) and type of anesthesia **(Magill et al., 2014).**

Significance of the study

During the researcher's work in the pediatric surgical unit at Assiut University children Hospital I observed that the occurrence of SSI was considered high in infants with poor literature sources to explain the predisposing factors to these conditions. So, this study was conducted to assess the risk factors and calculate the incidence of SSIs among infants.

Aim of the study

This study aimed to assess the risk factors of SSIs among infants in pediatric surgery unit at Assiut University Children Hospital.

Research Questions

What are the risk factors of SSIs among infants in pediatric surgery department at Assiut University Children Hospital?

Subjects and Methods

The purpose of this part is to discuss the research methodology and procedures.

Research design

A descriptive research design was utilized in this study.

Setting

The present study was carried out in pediatric surgery unit and follow-up at out-patient clinic at Assiut University Children Hospital or at home if the family can't attend to hospital.

Subjects

A convenience sample of this study comprised of 131 infants at the first 30 days post-operatively, with inpatient assessment by the researchers, and subsequent outpatient clinics follow up at Assiut University Children Hospital during one year period from January to December 2015, were selected from the previously mentioned settings who fulfill the following criteria

- The infants' age ranged from one to twelve months.
- Infants were free from any associated disease.

Tools of the study

Two tools were used to collect the necessary data: a structured interview sheet to study the possible risk factors for SSIs among operated infants and observational check-list were used to assess the wound condition and the SSIs occurrence.

Tools

Two tools were used in this study.

Tool I: Structured interview sheet for infants

It was developed by the researcher after reviewing of literature and consists of two parts

Part one: Demographic and clinical data about infants and their parent such as gender, sex, residence, social level, level of parents' education and job of the parents.

Part two: Data about possible risk factors for SSIs among studied infants: such as; type of feeding (artificial or breast milk), type of operation, length of stay pre-operative and postoperative hospitalization, use of antibiotics, location of operation, the presence of a coexisting disease or remote infection, period postoperative and type and number of dressings.

Tool II: (Observation Check list)

This tool vised to assess the wound characteristics. It is a designed observation checklist form was developed by **Bailey et al., (1992)** to assess the wound characteristics of the study subjects. This tool was used on the 3rd postoperative day.

Scoring system for this tool includes the following elements; grade 0 for normal healing, grade 1 for normal healing with mild bruising or erythema, grade II for erythema plus other signs of inflammation, grade III for clear or haemoserious discharge, grade IV for pus and grade V for deep or sever wound infection with or without tissue breakdown; haematoma requiring aspiration.

Method

Preparatory phase

- Tools of the study were developed by the researcher after reviewing of literature.

Pilot study

- A pilot study was carried out before starting data collection on ten infants chosen randomly who were excluded from the sample, this taken to test the clearness, applicability of tools and to estimate the time required to fill the questionnaire, with the pilot study, the essential adaptation in the sheet was done.

Validity: The validity of tool I was tested for its content, and clarity of the questions by 5 experts in

both pediatric nursing and pediatric surgery fields. Tool II is valid and reliable (Wilson et al., 1998).

Reliability: internal consistency was estimated by Alpa Cronbachs test for tool I and its value was R=0.89.2 and R=0.92.1 for tool II.

Administrative Design

- An official letter approval was obtained from the dean of faculty of Nursing; Assiut University to the director of Assiut University children Hospital and to the director of Pediatric Surgery Unit.
- This letter includes a permission to carry out the study and explain the purpose and nature of the study.

Ethical considerations

The purpose of this study was explained for the parent of the studied infants that accompany their children at pediatric surgery units. Parents have ethical rights to participate or refuse participation in the study. Written consent was acquired from the parents of the studied infants, learned them that the information obtained would be private and used only for the aim of the study.

II-Data collection:

Field of Work

Data were collected in the period from first of January 2015 to the end of the December of the same year.

The study was carried out in three visits

Visit 1: By interview parent immediately postoperative to collect demographic and clinical data about infants and their parents and interview sheet about possible risk factors for SSIs among infants.

Visit 2: Observation checklist using Southampton scoring system (Bailey et al., 1992) to evaluate wound condition to assess the wound characteristics of the study subject. This tool was first used after the 3rd postoperative day.

Visit 3: Observation checklist using Southampton scoring system to evaluate wound status to judge the wound signs of the study subjects after the 7th postoperative day and reevaluated after about 15, 21 and 30 days postoperatively.

Analysis of data

Collected data were revised and coded for computerized data entry. Package of social science (SPSS) version was used in this study. Descriptive statistics as; (frequency, percentage, mean, and standard deviation), Z-test were calculated. P-values were revised as statistically significant when less than 0.05.

Results

Our study included demographic and clinical data about infants and their parent and risk factors for SSIs among studied infants

Table (1): Incidence of post-operative SSIs among infants in Assiut University Children Hospital (No.=131).

Items	No.	%	P-value	X^2
Non infected cases	111	84.7		
Infected cases	20	15.3	**<0.001****	**61.83**
Total	131	100		

****** *Highly statistically significant difference (p<0.01).*

Table (2): Relationship between personal data and presence of SSIs among infants in Assiut University Children Hospital.

Items	Non-Infected cases		Infected cases		P-value
	No.(no=111)	%	No. (no=20)	%	
Age by months					
> 4	26	23.4	2	10	0.176
4-	39	35.1	7	35	
6-	17	15.3	7	35	
8-	16	14.4	1	5	
10-12 months	13	11.7	3	15	
Gender					
Male	83	74.7	12	60	0.173
Female	28	25.3	8	40	
Residence					
Urban	60	54.0	9	45	0.455
Rural	51	46.0	11	55	
Birth order					
1st	8	7.2	5	25	0.005**
2nd	60	54.1	4	20	
3rd or more	43	38.7	11	55	
Mother education					
Educated	48	43.2	9	45	0.884
Illiterate	63	56.8	11	55	
Father education					
Educated	78	70.3	8	40	0.008**
Illiterate	33	29.7	12	60	
Mother job					
Working	37	33.3	11	55	0.064
Housewife	74	66.6	9	45	
Father job					
Governmental	67	60.4	12	60	0.975
Not governmental	44	39.6	8	40	

****** *Highly statistically significant difference (p<0.01).*

Table (3): Relationship between studied infants history, diagnosis and type of operation and presence of SSIs in Assiut University Children Hospital.

Items	Non- infected cases		Infected cases		P-value
	No. (no=111)	%	No. (no=20)	%	
History of medical diseases	48	43.2	13	65	0.072
History of nutritional disease	18	16.2	15	75	<0.001**
History of infectious diseases	17	15.3	16	80	<0.001**
History of abscess	6	5.4	17	85	<0.001**
Types of feeding					
Breast feeding	23	20.7	1	5	0.002**
Artificial feeding	7	6.3	6	30	
Parenteral feeding	38	34.2	2	10	
Breast feeding + parenteral feeding	26	23.4	6	30	
Parenteral feeding + adult food	17	15.3	5	25	
Diagnosis					0.177
Congenital	73	65.8	10	50	
Acquired	38	34.2	10	50	
Types of operation					<0.001**
Emergency surgery	10	9.0	14	70	
Elective surgery	101	91.0	6	30	

******** *Highly statistically significant difference (p<0.01).*

Table (4): Relationship between length of hospital stay pre/post-operative and development of SSIs, in Assiut University Children Hospital.

Items	Non- infected cases		Infected cases		P-value
	No. (no=111)	%	No.(no=20)	%	
Length of hospital stay preoperative					<0.001**
1-5 days	83	74.77	6	30.00	
6-10 days	16	14.41	5	25.00	
11-15 days	8	7.21	3	15.00	
>15 days	4	3.60	6	30.00	
Mean ± SD	5.3+±3.2		10.9±5.1		0.001**
Range	1-17		2-17		
Length of hospital stay postoperative					0.020*
1-5 days	62	55.86	7	35.00	
6-10 days	33	29.73	6	30.00	
11-15 days	8	7.21	1	5.00	
>15 days	8	7.21	6	30.00	
Mean ± SD	6.9±4.3		10.6±3.6		0.041*
Range	1-20		1-20		

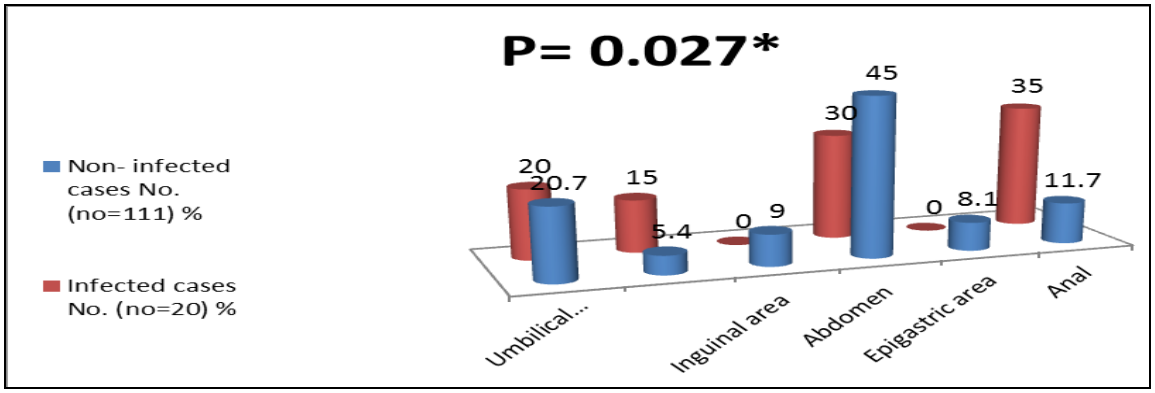
** Statistically significant difference (p<0.05)*

******** *Highly statistically significant difference (p<0.01).*

Table (5): Relationship between infection-prevention practices and development of SSIs, in Assiut University Children Hospital.

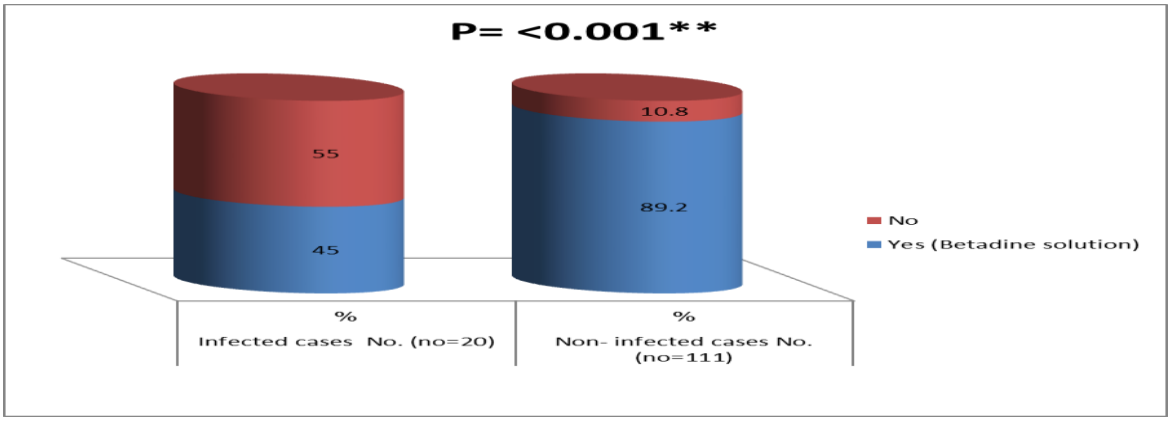
Items	Non- infected cases		Infected cases		P-value
	No. (no=111)	%	No. (no=20)	%	
Antibiotic drugs					
Amikin (Amikacin)	12	10.8	5	25	0.198
Augmentin	42	37.8	4	20	
Rocephin	20	18.0	5	25	
Unasyn	37	33.3	6	30	
Bathing	88	79.3	6	30	<0.001**
Washing hands before dressing	93	83.8	8	40	<0.001**
Using sterile equipment during dressing	93	83.8	8	40	<0.001**
Using of antibiotic ointment during dressing					
Fucidin	36	32.4	4	20	<0.001**
Garamycin	68	61.3	3	15	
Tetracycline	7	6.3	13	65	

*** Highly statistically significant difference (p<0.01).*



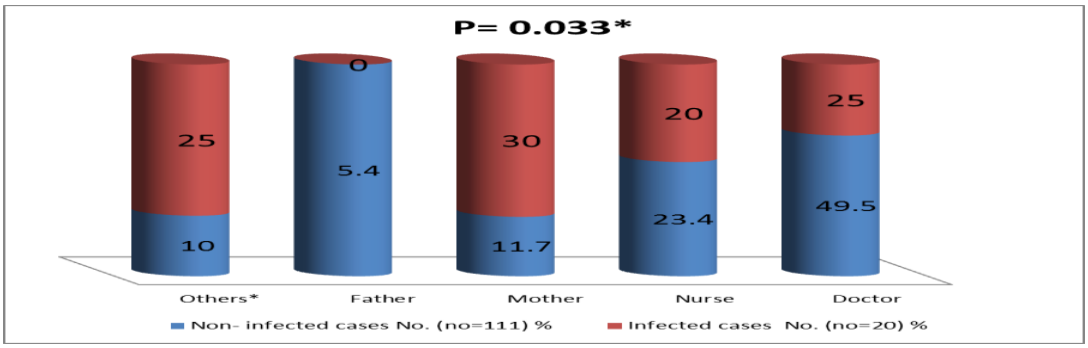
** Statistically significant difference (p<0.05)*

Fig. (1): Relationship between operation sites and development of SSIs, in Assiut University Children Hospital.



*** Highly statistically significant difference (p<0.01).*

Fig. (2): Relationship between using antiseptic solution during dressing and development of SSIs, in Assiut University Children Hospital.



** *Highly statistically significant difference (p<0.01)*

Fig. (3): **Relationship between people performed wound dressing and development of surgical site infection, in Assiut University Children Hospital.**

Table (1): Represents the incidence of SSIs post-operative. It was found that 15.3% of the infants developed SSIs.

Table (2): Shows that 35.1% of the non-infected cases aged 4-6 months and 35% of the infected cases in the same age. Regarding to gender, 60% of the infected cases were male. Regarding residence, it was observed that 55% of the infected cases were from rural area. In referral to birth order of the infant of those who had infected wound, it was found that 55% of them were the third or more.

Table (3): Reveals that 65% of infected cases had history of medical diseases and 43.2% of those who hadn't SSIs had history of medical diseases. 75% of the infected infants group had nutritional diseases, while only 16.2% of the non-infected cases had history of nutritional diseases. Regarding history of abscess, the majority (85%) of infected cases had history of abscess. According to diagnosis, 65.8% of the non-infected cases had congenital disease. Moreover, 34.2% of the infants who didn't develop wound infection were on parenteral feeding. In contrast, 30% of infants with infected wound were taken artificial feeding.

Table (4): Presents relationship between length of hospital stay pre/post-operative and development of SSIs. Significant difference was found between length of hospital stay pre/post-operative and development of SSIs. It was observed that the lowest percent (3.60% and 7.21% respectively) among non-infected infants who stay in hospital more than 15 days however, 30% of infected infants stay in hospital more than 15 days.

Table (5): Illustrates relationship between development of SSIs and wound caring methods, it was observed that 37.8% of non-infected infants were given Augmentin and 30% of the infected cases were given Unasyn as antibiotic drug. Moreover, bathing of the infant before operation was recorded in 79.3% of the non-infected cases, compared with 70% of the infants who non-bath developed surgical wound infection. However, lack of hand wash and not using of sterile equipments were recorded in (60% and 75% respectively) of the infected cases.

Fig. (1): Shows that 45.0% of infants who had undergone abdominal surgery didn't had wound infection, in contrast, 35% of those who had undergone anal surgery developed SSIs.

Fig. (2): Reveals that not using of any antiseptic solution during wound dressing was present in 55% of those infants who developed SSIs.

Fig. (3): Shows that 25% of wound dressings which were performed by physicians develop infection, while 30% of wound dressed by the mother had SSIs.

Discussion

The second most common problem occurring for hospitalized infants after surgery are surgical wound infections and is one of the most common surgical complications. The incidence of SSI differs largely from one country to another according to the factors of occurrence.

Current study represents the incidence of surgical wound infection among infants during the first 30 days post-operatively was 15.3% of operated infants according to table 1. This result consider a high incidence of pediatric community compared to previous results of studies at developing countries as the prospective study by **James et al., (2012)** to determine the incidence of SSIs among infants at an academic children's hospital in rural sub-Saharan Africa and to identify potentially risk factors among 1,008 surgical admissions to Bethany Kids Kijabe Hospital (Kijabe, Kenya) who was reported that the SSIs occurred in only 6.8% of included infants. This result may be referred to defect in applying antiseptic technics during wound care in hospital and in home.

The Present study found that the infants with medical illness and nutritional diseases show more SSI incidence than those without according to table 3.

Our study agree with **National Collaborating Centre for Women's & Children's Health (2008**) in that the risk factor for SSI incidence was low immunity of the patients (for example, diabetes, malnutrition, or immunosuppressive therapy with radiotherapy, chemotherapy or steroids) or local immune response (for example, foreign bodies, chronic illness and malnutrition).

Result of current study illustrates relationship between development of surgical wound infections and infants caring methods, it was observed that 70% of the infants who non-bath developed surgical wound infection. However, didn't wash hands and didn't using of sterile equipment were recorded in (60% and 75% respectively) of the infected cases.

In agree with our study Deverick et al., (2014) reported that the defect in promotion of operating room practices, surgical technique, instrument sterilization methods and the highest efforts of infection prevention strategies, SSI considered a major cause of hospital-acquired infections and rates are increasing even in hospitals with the high standard protocols for preoperative preparation and modern facilities.

Our results revealed that SSI differs according to type of the operation: about two thirds of the infected cases had emergency surgery as shown in Table 3. Infants with emergency surgeries are at a higher perioperative risk for SSI because of the infected operation. Most of the emergency surgeries are carried out beyond normal duty working hours and inadequate preoperative preparation might be a possible explanation for the higher incidence of SSI.

Wilbert (2015) was agreement with present studies who accounted that the rate of SSI in emergency operations was more than in elective one (8.4% compare 2.5%, respectively) and added the surgical techniques don't take into consideration the standard before surgical procedure (eg. sufficient skin cleaning).

The length of infants stays post-operatively at hospital by days shows that the Mean ± SD of non-infected cases were 6.9±4.3 in contrast of infected cases were10.6±3.6 in our study. These results may be related to long of period of exposure to acquired hospital infection.

According to **Sherrod & Rocque (2017)** the average period of hospitalization was 26.1 days (range from, 8 to 127 days) in infants with SSI and 18.0 days (range, 1-99 days) in those without SSI.

Out of the included infants that only 5% of the infants who develop wound infection were feed by breast milk in contrast, 30% of infants with infected wound were taken artificial feeding. our data suggest that correlated with the risk of SSI and that relevant preventive measures should be implemented to reduce the incidence of SSI especially the breast feeding for infants to increase body immunity and its defense against microorganism.

Our study results agree with **Ahmed et al., (2013)** who reported that the majority of formula feeding neonates' wounds was inflamed, while less than one third of breast milk feeding neonates' wounds were inflamed one week post-operatively. On the other hand 38% of formula fed neonates' wounds were inflamed, while only 8% of breast milk feeding neonates' wounds was inflamed after one week.

Conclusion

In the light of the present study findings, it can be concluded that the overall hospital incidence of surgical wound infection among infants in surgical department and outpatient clinic during first postoperative month at Assiut University Children Hospital, Egypt was 15.3%. It is considered a high prevalence of infected surgical site among pediatric patients. The most common risk factors of surgical wound infection were history of nutritional diseases, infectious disease, abscess, artificial feeding, emergency surgery, not washing hands before dressing, using unsterile equipment during dressing, abdominal operations and not using antiseptic solution during dressing.

Recommendations

- Further studies are needed to assess the risk factors of surgical wound infection among infants and training courses must be given to on large number of population among different pediatric surgical department and pediatric surgical outpatient clinic during follow-up.
- An exploration of high incidence of surgical wound infection recommended that the physicians and pediatric surgical nurses should give health education about infection- prevention practices to decrease SSIs risk factors among infant as; type of surgical practice, sterilization and barriers, effectiveness of perioperative nursing management, using of antimicrobial prophylaxis, age, sex, length of preoperative hospitalization, and location of operation, the presence of any disease or hidden infection, the use of perioperative antibiotics drugs or exclusive breast feeding**.** Therefore, SSI prevention strategies should focus on improving the perioperative nutritional status of infants' to improve the outcomes for infants.
- Highly importance strengthens the management of emergency operations to decrease SSI incidences. Also, the post-operatively hospital period should be as short as possible and the one-day surgery

protocol should be applied to all minor and intermediate procedures to help in decreasing SSI.

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