Assessment of Risk Factors Associated with Surgical Site Infections in the Infancy Period

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Abstract

Background: Several factors pose a risk for developing surgical site infection including preoperative, operative and postoperative events. **Aim:** Assess the risk factors associated with surgical site infections in the infancy period. **Design:** An exploratory descriptive research design. **Setting:** In-patient pediatric surgical department and out-patient clinic at Cairo-University Specialized Pediatric Hospital. **Sample:** A purposive sample of 60 newborn and infants. **Tools:** Three tools were used structured interview questionnaire, surgical site infections assessment rating scale and neonatal infant pain scale. **Results:** Less than three fifths of children aged <6 month, most of children had congenital anomalies, majority of them had emergency operation, less than three quarters of them had operation in the abdomen, vast majority of them had preoperative hospitalization, less than three quarters had more than 2 hours operation period, less than half of them had the first dressing after 24 and 48 hours respectively. Vast majority of them had one dressing per day, more than half of children had mild level of surgical site infection, while one third had moderate level and more than one tenth had severe level of infection. **Conclusion:** Preoperative hospitalization, daily dressing after operation, emergency surgery, diagnosis as congenital anomalies malformation, abdominal site of operation and more than two hours duration of operation are the risk factors associated with surgical site infections in the infancy period**. Recommendations:** Early management of children with congenital anomalies in the infancy period is essential.

Keywords: Infancy period, Risk factors, Surgical site infections.

Introduction

Surgical Site Infections (SSIs) are infections that happen postoperatively in the area of the body where the surgery took place. SSIs can be superficial and include the skin only, or more serious, and comprise other tissues, organs, or implanted material. SSIs are among the most common nosocomial infections and are an important cause of morbidity and mortality, in neonates and infant's costs associated with chronic wound care can substantially increase the burden on the health care system ***(Catania et al., 2019).***

In a study previously done in Egypt in two different governorate which revealed that the overall incidence rates of SSIs among pediatric patients that measured were 22.6% and 25.8% respectively in the general pediatric surgical department at Tanta University and in orthopedic pediatric surgeries at Cairo-University hospital ***(Wahdan et al., 2021)***. In developing countries, such as India, Pakistan, Nepal, Turkey and Iran, the incidence of SSIs is higher ranging from 5.5% to 25%. SSIs are among the most common hospital acquired diseases and are an important cause of morbidity and mortality in all patients, including neonates and infants. In developed countries, such as USA, the United Kingdom (UK), and Sweden have the lower incidence of SSIs ranging from 2% to 6.4% (***Haque et al., 2021).***

Risk factors of pediatric SSIs differ according to infection-prevention practices including the type of surgical practice, sterilization, and barriers, the effectiveness of perioperative nursing management, use of antimicrobial prophylaxis, age, sex, length of preoperative hospitalization, site of operation and the presence of any disease or hidden infection ***(Ahmed et al., 2017).*** Many factors specific to neonates, including multiple co-morbidities, type of surgery, immunologic immaturity, prematurity, chronic illness and increased length of stay in intensive care units, place this population at increased risk for SSIs development ***(Bartz-Kurycki et al., 2018).*** Some strategies can reduce pediatric wound infection as infant's immunity and exclusive breastfeeding ***(Ahmed et al., 2017).***

Other factors associated with surgical infections are prolonged preoperative hospital stay, nasal staph aureus colonization, perioperative blood transfusions, infection remote to the surgical site and immunosuppression. Neonates represent a particular at-risk population as they fall into many of the categories with high risk of surgical infection. Their humoral and cellular immunity is immature and their surgical pathology often requires extended hospital stays, the need for indwelling catheters and prolonged parenteral nutrition - all of which increase their risk of infection ***(Shankar et al., 2020).***

The symptoms of a surgical site infection typically appear 5 to 7 days post-procedure, however can develop up to 3 weeks after. The common clinical features of surgical site infections include; spreading erythema, localized pain, pus or discharge from the wound and persistent pyrexia. In certain cases, superficial or even complete wound dehiscence can occur secondary to SSIs developing. Most SSIs are superficial; however, some can result in extensive wound breakdown; fortunately, the need for debridement is not common ***(Bath, 2022).***

Postoperative wound infection causes delayed healing of incision and poor wound healing, which not only adversely affects the effect of operation but also prolongs the course of treatment, affects the functional recovery of patients, and increases the economic and psychological burden of their parents. It will adversely affect the quality of life of children in the future. Severe wound infection can cause systemic infection and multiple organ dysfunctions, resulting in septic shock and even life-threatening ***(Christopher & Kyle, 2021).***

Significance of the study

In spite of advances that have been made in infection control practices, including improved operating room ventilation, sterilization methods, barriers, surgical technique, and availability of antimicrobial prophylaxis. SSIs remain a substantial cause of morbidity, prolonged hospitalization, and death. SSIs are associated with a mortality rate of 3%, and 75% of SSIs associated deaths are directly attributable to the SSIs. SSIs are the most costly healthcare-associated infection type and are associated with nearly 1 million additional inpatient days annually ***(Centers for Disease Control & Prevention (CDC), 2021).***

The predisposing factors for SSIs constitute a set of risk factors that can be intrinsic or extrinsic. The intrinsic factors consist of life habits, basic or associated pathologies; the extrinsic ones refer to the assistance procedures and surgical techniques adopted. The importance of the identification of these factors by the health team is given by the fact that most of the extrinsic factors can be avoided by actions of care, which are of entire responsibility of the care team that assists the patient ***(Silva, et al., 2022).***

Nurses play an important role to help in decrease SSIs incidence among infants by applying nursing care to pediatric patients from admission to discharge and follow-up as provide parents with accurate information regarding the type of laboratory and surgical procedure, type of operation (emergency/elective) type of anesthesia. Nurses have a distinctive chance to lessen the probability of hospital acquired infections. They can assist patients in their recovery and reduce the complications associated with infection ***(Sadia et al., 2017).***

Aim of the study

This study aimed to assess of risk factors associated with surgical site infections in the infancy period.

Research questions

What are the risk factors associated with surgical site infections in the infancy period?

Methodology

Design: An exploratory descriptive research.

Setting

This study was conducted at the in-patient pediatric surgical department situated in the fourth floor and out-patient clinic in the first floor at Cairo-University Specialized Pediatric Hospital (CUSPH), the hospital consists of 6 floors for different specialties and services of children, all services introduced for free.

Sample

A purposive sample was used to achieve the aim of this study. A purposive sample consisted of 60 newborn and infants was selected from above settings who fulfilling the following inclusion criteria:

Inclusion criteria

- Children from birth to twelve months of age.
- Surgical site infection cases.
- After 72 hours of operation.

Tools for data collection

The data were collected through using the following three tools:

Tool (I): Structured Interview Questionnaire:

This tool was developed by the researcher to assess personal data, past and present medical history and consist of 2 parts.

Part 1: Personal data of child and his/her family including child code, age, gender, birth and current weight, gestational age, residence, level of parents' education and mother work, health promotion activities include immunization status, type of feeding (artificial or breast milk, and/or complementary feeding).

Part 2: Past and present medical history of child condition including; diagnosis (acquired or congenital, emergency), date of operation, type of operation, site of operation, pre-operative, and postoperative hospitalization, use of antibiotics, the presence of a coexisting disease or infection, time of first dressing, number of dressings.

Tool (II): Surgical Site Infections Assessment Rating Scale:

It was developed by the researchers after review of recent literature ***(CDC, 2022 & Hockenberry et al., 2021)*** to assess surgical site infections postoperatively through 10 items including 1. Involved skin layers includes (superficial skin only, tissues under skin, organs), 2. Spreading redness includes (in the spot of the wound, all wound edges, around the wound), 3. Swelling and tenderness includes (swelled and minor tender, tender, very tender), 4. Pain (assessed through neonatal infant pain scale), 5. Fever includes (37.5-38, 38-39, above 39), 6. Exudate viscosity includes (thick, slimy and gooey, watery), 7. Exudate odour includes (unpleasant smell, bad odour, offensive odour), 8. Presence of pimple (present in part of the wound, majority of the wound, all of the wound), 9. Red streak runs from the wound includes (from part of the wound, around the wound, spreading away from the wound), 10. Child appear sick includes (fatigue and nausea, drowsy and less attentive, very sick and not doing well). Each item in this tool has characteristics rated from mild, moderate, to severe.

Scoring system:

The tool consists of 10 items rated according to severity of wound infection manifestations as (1) for mild, (2) for moderate, and (3) for severe surgical site infections. The total score of scale divided into mild infection scored from (1-10), moderate infection scored from (11-20), severe infection scored from (21-30).

Tool (III): Neonatal Infant Pain Scale (NIPS):

It was adopted from ***Hockenberry et al., (2017***), to assess infant pain.

Scoring system:

Neonatal Infant Pain Scale (NIPS) is a pain assessment tool which encompasses of six parameters (facial expression, cry, breathing patterns, arms, legs, and state of arousal) each parameter was scored, facial expression from (0-1), cry from (0-2), breathing patterns from (0-1), arms from (0-1), legs from (0-1), state of arousal from (0-1). A child rates their pain on scale of 0 to 7, zero means “no pain”, from 1 to 2 “mild pain”, 3 to 4 “moderate pain” and from 5 to 7“severe pain”.

Tools validity

Surgical site infections assessment rating scale (Tool II) was ascertained by panel of three experts in the field of pediatric nursing and pediatric surgery who was reviewed the content of the tools for comprehensiveness, accuracy, clarity, relevance and minor modifications were done accordingly. Content validity of neonatal infant pain scale was assured because it is standardized tool.

Tool reliability

Tool II surgical site infections assessment rating scale reliability was 0.918 assessed by Cronbach’s Alpha test, and standardized reliability of NIPS was 0.88.

Ethical considerations

An official permission to conduct the proposed study would be obtained from the scientific research ethics committee of the Faculty of Nursing-Helwan University. Also, an official permission was obtained from the directors of CUSPH before starting the study. Participation of parents in the study is voluntary and asked to sign the informed consent after explaining the purpose of the study and their right to withdraw from the study at any time and assure the parents about confidentiality and uses of the information.

Pilot study: The pilot study was carried out on 6 children (10%) of the sample to examine the clarity, applicability, feasibility and relevance of the tools. The children who were included in the pilot study were not excluded where no major modification was done after conducting the pilot study.

Field work:

After gaining the research committee acceptance and official permissions of directors of study settings, the researcher introduce himself to the children' parents to explain the purpose of the study, to gain parents' cooperation and then informed consent was attained. Parents and their children's personal data were assessed as well as the child medical history from the parents and child's sheet, also assessment of preoperative, operative and postoperative events was carried-out for inpatient children. But children in outpatient all data needed is gained from the parents, while surgical site infections assessment rating scale is assessed through direct observation for the child wound in either inpatient or outpatient. Also, assessment of pain through neonatal infant pain scale was done during wound assessment. Data collection started from August, 2022 to January, 2023.

Statistical design

The collected data were, organized, categorized, tabulated and statistically analyzed using the statistical package of social science (SPSS version 24). Frequency distribution was used to describe the qualitative data; mean and standard deviation were used to describe the quantitative data. Pearson correlation coefficient (r) was used for measuring the correlation between numerical variables. Qualitative categorical variables were compared using chi-square test. Statistical significance was considered at p-value <0.05.

Results

Table (1) showed that, less than three fifths (56.7%) of children in the infancy period aged <6 month with X̄±SD= 6.71±1.21, less than two thirds (65.0%) of children were males and more than half (55.0%) their weight were at birth >2.5Kg with X̄±SD= 2.88±1.91. Less than three quarters (70.0%) of infant weight was 8-12Kg with X̄±SD= 8.67±2.25, the mean length of infant was X̄±SD= 58.90±1.21. Regarding body mass index there were more than two fifth (43.3%) of infant was under weight, majority (93.3%) of children were term weeks of gestation and less than three fifths (56.7%) of children live in rural areas.

Table (2) illustrated that, more than two thirds 68.8% of children in the infancy period aged <6 month had mild surgical site infection; while 100% of children aged ≥6 month had severe infection. Also, 40% of children their weight was 5-8kg had moderate infection, while more than two third (68.8%) of children their weight was 8-12Kg had mild infection, while all (100%) of them had severe infection. 62.5% of them they were underweight ≤18.4 body mass index had mild infection, while 75% and 62.5% of children their normal weight was 18-24.9 body mass index had moderate and severe infection, there 62.5% and 65.5% of them there was feed through breastfeeding had mild and moderate infection, while 50% of them there was feed through artificial feeding had moderate surgical site infection, 50% of children there were feed through complementary feeding had severe infection. All these differences were statistically significant.

Table (3) indicated that vast majority (95.0% and 93.3%) of children in the infancy period had not history of medical diseases and infection respectively, most (80%) of children had congenital anomalies and less than two fifths (38.4%) of them had Hirschsprung's disease, majority (90%) of children had emergency operation, and less than three quarters (73.4%) had operation in the abdomen. Moreover, less than three quarters (73.3%) had more than 2 hours operation period with X̄±SD= 2.71±3.27, vast majority (95%) of children had one dressing per day, less than half (46.7% and 45.0%) had the first dressing after 24 and 48 hours respectively.

Table (4) displayed that, there was all (100%) of the children in the infancy period had moderate and severe surgical site infection development were congenital anomalies, all (100%) of them had severe infection were emergency operation. Furthermore, 100% and 62.5% of them had moderate and mild infection their operation at abdomen. Also, all (100%) of them had moderate infection their duration of operation was >2 hours. As well as, all (100%) of them had severe infection were one dressing per day and more than three fifths (62.5%) of them had mild infection were dressing after 24 hours of operation. All these differences were statistically significant.

Table (5) showed that slightly more than two thirds (66.7%) had mild skin infection, less than half (48.3%) had moderate spreading redness, less than two thirds (65.0%) had mild swelling and tenderness, 58.3% had moderate pain, 51.7% and 36.7% respectively had mild and moderate fever, more than three quarters (76.7%) had mild exudate viscosity, less than three quarters (73.3%) had mild exudate odour and most of children (80.0%) had mild presence of pimple, 53.3% of children had mild red streak runs from the wound, 71.7% of children had mild degree regarding child appear sick.

Table (6) revealed that more than half (53.4%) of children in the infancy period had mild level of surgical site infection, while one third than (33.3%) of children had moderate level and more than one tenth (13.3%) of children had severe level of infection.

Table (7) showed that there was highly significant strong correlation between diagnosis, type of operation, number of dressings, postoperative hospitalization period, pre-operative used of antibiotics, site of operation at infant's body and infection development. Also, there was significant moderate correlation between duration of operation, time of the first dressing, pre-operative hospitalization period and infection development.

Table (1): Frequency distribution of children in the infancy period according to their personal characteristics (n=60)

Item	No	%
Age by months		
<6 month	34	56.7
≥6 month	26	43.3
$\bar{X}$ ± SD	6.71 ± 1.21	
Gender		
Male	39	65.0
Female	21	35.0
Child weight at birth		
≤2.5Kg	27	45.0
>2.5Kg	33	55.0
$\bar{X}$ ± SD	2.88 ± 1.91	
Current child weight by kg		
5<8 Kg	18	30.0
8≤12 Kg	42	70.0
$\bar{X}$ ± SD	8.67 ± 2.25	
Length of child by cm		
49-65 cm	30	50.0
≥65 cm	30	50.0
$\bar{X}$ ± SD	58.90 ± 1.21	
BMI		
≤18.4 (Underweight)	26	43.3
18.-24.9 (Normal)	30	50.0
25.0-39.9 (Overweight)	4	6.7
≥ 40.0 (Obese)	0	0.0
$\bar{X}$ ± SD	18.61 ± 1.21	
Gestational age		
Pre term	2	3.3
Term	56	93.4
Post term	2	3.3
Residence		
Urban	26	43.3
Rural	34	56.7

Table (2): Relationship between personal characteristics of children and levels of surgical site infection (n=60)

Item	**Mild** (n=32)		**Moderate** (n=20)		**Severe** (n=8)		**X^2**	**p- value**
	No	**%**	**No**	**%**	**No**	**%**		
Age								
<6 month	22	68.8	12	60.0	0	0.0	2.1476	.011*
≥6 month	10	31.2	8	40.0	8	100.0		
Current child weight								
5-8<Kg	10	31.2	8	40.0	0	0.0	2.910	.011*
8-12Kg	22	68.8	12	60.0	8	100.0		
BMI								
≤18.4 (Underweight)	20	62.5	5	25.0	1	12.5	1.902	.0001**
18.-24.9 (Normal)	10	31.2	15	75.0	5	62.5		
25.0-39.9 (Overweight)	2	6.3	0	0.0	2	25.0		
Types of feeding								

Breastfeeding	20	62.5	13	65.0	0	0.0	2.013	.014*
Artificial feeding	10	31.2	10	50.0	4	0.0		
Complementary feeding	2	6.3	10	50.0	8	100.0		
Gender								
Male	30	93.7	9	45.0	0	0.0	6.129	.415
Female	2	6.3	11	55.0	8	100.0		
Length of child								
49-<65 cm	15	46.9	15	75.0	0	0.0	.204	.114
≥65 cm	17	53.1	5	25.0	8	100.0		
Gestational age								
Pre term	2	6.3	0	0.0	0	0.0	.729	.899
Term	30	93.7	18	90.0	8	100.0		
Post term	0		2	10.0	0	0.0		
Residence								
Urban	10	31.2	16	80.0	0	0.0	2.683	.298
Rural	22	68.8	4	20.0	8	100.0		
Child weight at birth								
<2.5 kg	20	62.5	7	35.0	0	0.0	.916	354
> 2.5 kg	12	37.5	13	65.0	8	100.0		

Table (3): Frequency distribution of medical history and operation data of children in the infancy period (n=60)

Items	No	%
Medical diseases		
Yes	3	5.0
No	57	95.0
Types of medical diseases		
Convulsion	2	3.4
Jaundice	1	1.6
Presence of infection		
Yes	4	6.7
No	56	93.3
Types of infection		
Sepsis	2	3.3
Appendicitis	2	3.3
Diagnosis		
Congenital	48	80
Emergency	12	20
Types of congenital anomalies		
Hirschsprung disease	23	38.4
Anorectal malformation	15	25.0
Biliary atresia	10	16.7
Types of emergency diagnoses		
Intestinal obstruction	10	16.7
Gastroschisis	1	1.6
Brain abscess	1	1.6
Type of operation		
Emergency	54	90.0
Elective	6	10.0
Site of operation at infant's body*		
Abdomen	44	73.4
Buttocks	38	63.3
Head	1	1.6
Duration of operation		
≤2hrs	16	26.7
>2 hrs.	44	73.3
$\bar{X}\pm SD$ 2.71 ± 3.27		
Number of Dressings		
1 per day	57	95.0

2 per day	3	5.0
Time of the first dressing		
After 24hrs	28	46.7
After 48hrs	27	45.0
After 72 hrs.	5	8.3

Table (4): Relation between children in the infancy period past and present medical data and operation data and surgical site infection development (n=60)

Items	Mild (n=32)		Moderate (n=20)		Severe (n=8)		X^2	p- value
	No	%	No	%	No	%		
Medical diseases								
Yes	0	0.0	3	15.0	0	0.0	4.183	.266
No	32	100.0	17	85.0	8	100.0		
Presence of infection								
Yes	4	12.5	0	0.0	0	0.0	3.93	.123
No	28	87.5	20	100.0	8	100.0		
Diagnosis								
Acquired	2	6.3	0	0.0	0	0.0	.914	.003**
Congenital	30	93.7	20	100.0	8	100.0		
Type of operation								
Emergency	29	90.6	17	85.0	8	100.0	2.712	0001**
Elective	3	9.4	3	15.0	0	0.0		
Site of operation at infant's body								
Abdomen	20	62.5	20	100.0	4	50.0	1.934	.006**
Buttocks	12	37.5	0	0.0	3	37.5		
Head	0	0.0	0	0.0	1	125		
Duration of operation								
≤2hrs	10	31.3	0	0.0	6	75.0	.351	.014*
>2 hrs.	22	68.7	20	100.0	2	25.0		
Number of dressings								
1 per day	30	93.7	19	95.0	8	100.0	2.923	0001**
2 per days	2	6.3	1	5.0	0	0.0		
Time of the first dressing								
After 24hrs	20	62.5	5	25.0	3	37.5	3.934	.049*
After 48hrs	12	37.5	10	50.0	5	62.5		
After 72 hrs.	0	0.0	5	25.0	0	0.0		

(*) Statistically significant at $p<0.05$. (**) highly statistically significant at $p<0.001$

Table (5): Frequency distribution of children in the infancy period according to surgical site infections development postoperatively (n=60)

Item	Mild		Moderate		Severe	
	No	%	No	%	No	%
1. Involved Skin layers	40	66.7	20	33.3	0	0.0
2. Spreading redness	20	33.3	29	48.3	11	18.3
3. Swelling and tenderness	39	65.0	14	23.3	7	11.7
4. Pain (neonatal infant pain scale)	23	38.0	35	58.3	2	3.3
5. Fever	31	51.7	22	36.7	7	11.7
6. Exudate viscosity	46	76.7	9	15.0	5	8.3
7. Exudate odour	44	73.3	7	11.7	9	15.0
8. Presence of pimple	48	80.0	9	15.0	3	5.0

9. Red streak runs from the wound	32	53.3	23	38.3	5	8.3
10. Child appear sick	43	71.7	14	23.3	3	5.0

Table (6): Frequency distribution of total levels of surgical site infections among children in the infancy period (n=60)

Total levels of surgical site infections	No	%
Mild (0-10)	**32**	**53.4**
Moderate (11-20)	**20**	**33.3**
Severe (21-30)	**8**	**13.3**

Table (7): Correlation between surgical site infection development and operation, post operative dressing data, pre and postoperative data of children hospitalization

Studied variables	Surgical site infection development	
	Pearson correlation coefficient (r)	p- value
Diagnosis	.784	**.0001****
Medical diseases	.213	.266
Presence of a coexisting disease or infection	.33	.123
Type of operation	.712	**0001****
Number of Dressings	.923	**0001****
Postoperative hospitalization period	.823	**.0001****
Pre-operative used of antibiotics	.712	**.0001****
Site of operation at infant's body	.834	**.0006****
Duration of operation	.451	**.014***
Time of the first dressing	.532	**.049***
Pre-operative hospitalization period	.487	**.043***
Post-operative used of antibiotics	.012	.451
Total infant pain	.106	.919

(*) Statistically significant at p<0.05. (**) highly statistically significant at p<0.001

Discussion

The current study results revealed that less than three fifths of children in the infancy period aged <6 months. These findings in agreed with ***Pough et al., (2020)*** in a study entitled "Evaluation of pediatric surgical site infections associated with colorectal surgeries at an academic children's hospital" who reported that more than half of children age was 4 months. Also supported by ***Kumba, (2021)*** in a study entitled "Postoperative outcome in non-preterm infants under one year old in non-cardiac surgery" who found that the majority of the infant aged <6 months.

Also, ***Ozgor et al., (2019)*** in a study entitled "Factors affecting infectious complications following flexible ureterorenoscopy" who reported that, previous studies found that younger age was associated with higher incidence of postoperative infectious complications. While this study result in the same line with ***Collaborative, (2020)*** in a study entitled "Surgical site infection after gastrointestinal surgery in children: an international, multicenter, prospective cohort study" who showed that low percentage of them their age was <1month. From the researcher point of view this might be related to the children in the infancy period is at increased risk for infection because their immune defenses are not completely developed yet.

The present study results showed that, there was more than two thirds of children in the infancy period aged <6 month had mild surgical site infection, while all of children aged ≥6 month had severe infection. There were statistically significant differences. The results of the current study in the same line with ***Wabada et al., (2017)*** in a study entitled "Risk factors for surgical site infections in childhood" who found that there was statistically significant relation between surgical site infection development and neonates ≤30 days and Infants >30 days but ≤1yr.

The present study findings showed that less than two thirds of children were males. These results of current study in the same line with ***Catania et al., (2019)*** who found that less than two thirds of children were males had SSIs. While these results were contrasted with ***Elshami et al., (2020)*** in a study entitled "Determinants of surgeons' adherence to preventive intraoperative measures of surgical site infection in Gaza Strip hospitals" who found that more than half of the study sample were females.

The results of this study illustrated that more than half of children in the infancy period their weight at birth >2.5Kg with $\bar{X}$±SD= 2.88±1.91. Less than three quarters their current child weight was 8-12Kg with $\bar{X}$±SD= 8.67±2.25. These results of current study conversely with ***Inoue et al., (2018)*** in a study entitled "Contaminated or dirty wound operations and methicillin-resistant staphylococcus aureus (MRSA) colonization during hospitalization may be risk factors for surgical site infection in neonatal surgical patients" who revealed that mean birth body weight was 2.5 kg (range 0.5–5.0 kg) while mean body weight at surgery was 2.5 kg (range 0.5–4.5 kg). Also, these results were contrasted with ***Yang et al., (2021)*** in study entitled "Surgical site infection after delayed sternal closure in neonates with congenital heart disease retrospective case-control" who showed that less than one half of the neonates had surgical site infection their current weight was 2.5 ≤ 3 kg.

The findings of this study illustrated that more than two fifths of children were classified as underweight according to calculation of body mass index with $\bar{X}$±SD= 18.61±1.21. These results in the same line with ***Wabada et al., (2017)*** who found that less than one half of children had low body mass index ≤18. There was significant strong correlation between low body mass index and surgical site infection development. Also, there was significant moderate correlation between current weight and infection development. These results were supported with ***Wabada et al., (2017)*** who found that low body mass index was found to correlate with the development of SSIs. The result of this study illustrated that vast majority of children were full term. These results in the same line with ***Yang et al., (2021)*** who found that two thirds of the neonates were full term.

The current study results revealed that less than three fifths of children live in rural area. This result in the same line with ***Ahmed et al., (2013)*** in a study entitled "Impact of breast feeding versus formula feeding on surgical wound healing in infants during the first three months of age" who showed that highly percentage of infants living in rural areas, while less than two thirds of them were live in urban areas. Also, this result was supported by ***Sattar et al., (2019)*** studied entitled "Frequency of post-operative surgical site infections in a tertiary care hospital in Abbottabad, Pakistan" who found that less than two thirds of the children belonging to rural areas and less than two fifths of them belonging to urban areas. From the researcher point of view this might be related to the Cairo-University specialized pediatric hospital serve all cases all over Egypt including rural areas.

The results of these study illustrated that vast majority of children in the infancy period had no history of medical diseases and infection respectively. Regarding the current diagnosis most of children had congenital anomalies and less than two fifths of children had Hirschsprung's disease. These results were contrasted with ***Ahmed et al., (2017)*** who revealed that less than two thirds of infected cases had history of medical diseases, and disagreed with ***Yang et al., (2021)*** who showed that less than one quarter of children had congenital anomalies. From the researcher point of view the cause of congenital anomalies might be related to consanguinity marriage which is common in rural communities.

The current study results demonstrated that, majority of children had emergency operation, and less than three quarters had operation in the abdomen. These results in the same line with ***Wabada et al., (2017)*** regarding predisposing factors of SSIs, there was high rates (less than two thirds) of infection in emergency operations, less than one half of those children who had emergency exploratory laparotomy developed SSIs.

These results in the same line with ***Pough et al., (2020)*** who found that the children had operation in the abdomen included colorectal resection, exploratory laparotomy, and small bowel resection, most of patients required multiple surgery types during their procedures. Moreover, ***Canadian Nosocomial Infection Surveillance Program, (2020)*** recommended that the site of operation the patient undergoes greatly influences the risk of SSIs, and many studies have investigated the incidence of SSIs in specific subcategories of surgery.

The findings of this study demonstrated that there was statistically significant strong correlation between surgical site infection development among children in the infancy period and abdominal site of operation. The current study results were supported with ***Stanger et al., (2014)*** in a study entitled "Practice variation in gastroschisis: factors influencing closure technique" who found that site of surgery was significantly associated with an increased risk of SSIs. Also, these results were supported by ***Wabada et al., (2017)*** who found that nature of surgery operation were done on emergency basis like exploratory laparotomy for various indications was associated with the development of SSIs. From researcher point of view majority of children had emergency operation which might make them risky for developing SSIs.

The current study result demonstrated that, less than three quarters of children had >2hrs. operation period. The study result was supported by ***Imran & Ali, (2020)*** investigate "Surgical site infections in pediatric population-an experience at a tertiary care hospital" who demonstrated that more than two fifths of children had >2hrs. operation duration, and agree with ***Gilje et al., (2017)*** in a study entitled "Surgical site infections in neonates are independently associated with longer hospitalizations" who showed that majority of neonates their length of operation was more than 1 hr.

The current study results demonstrated that there was statistically significant correlation between surgical site infection development at children in the infancy period and duration of operation. The study results were supported by ***Imran & Ali, (2020)*** who demonstrated that duration of operation was one of the main factors strongly associated with development of SSIs. Also, in the same line with ***Gilje et al., (2017)*** who illustrated that length duration of surgery was significantly associated with SSIs.

The current study results demonstrated that all children who had moderate surgical site infection the duration of operation of them was >2 hours. These study results were supported with ***Yamamichi et al., (2022)*** who showed that the incidence of SSIs was higher in patients who had prolonged operations more than 2 hrs.

The current study results reveled that less than half of children had the first dressing after 24 hrs. followed by after 48 hrs. As regard, ***National Healthcare Safety Network, Centers for Disease Control and Prevention, (2022)*** in a study entitled "Surgical site infection event" who recommended that based on the best practice and on the major postoperative care bundles, the wound dressing is routinely kept in place undisturbed for 48 hrs. after surgery unless leakage occurs, as this is the time required to restore the continuity of the skin.

The current study results reveled that there was less than two third of children who had mild infection time of first dressing was after 24 hrs. The current study results were contrasted with systemic review done by ***Toon, et al., (2015)*** in a study entitled "Early versus delayed dressing removal after primary closure of clean and clean-contaminated surgical wounds" who conducted there were no statistically significant differences between the early dressing removal group and delayed dressing removal group in the proportion of people who developed surgical site infection.

The results of these study showed that there were significant strong and moderate correlation between surgical site infection development and preoperative using of antibiotics, preoperative hospitalization period, postoperative hospitalization period. These study results were supported with ***Yamamichi et al., (2022)*** who showed that the incidence of SSIs was significantly associated in neonate who had long-term hospitalization, long-term antibiotic administration. These results of current study were contrasted with ***Catania et al., (2019)*** who found that preoperative antibiotic use was not significantly associated with development of SSIs. From the researcher point of view, length stay of children at hospital pre and postoperative might be factor of surgical site infection development.

The current study results showed that slightly more than two thirds had mild skin infection (superficial skin infection), less than half had moderate spreading redness, less than two thirds had mild swelling and tenderness, more than three quarters had mild exudate viscosity, less than three quarters had mild exudate odour and less than three quarters of children had mild degree regarding child appear sick. The study results in accordance with ***Wabada et al., (2017)*** who showed that about less than one third of children had superficial skin infection, minority of them had localized swelling and tenderness at incision site and purulent discharge from the wound respectively.

The current study findings in the same line with ***Aballah et al., (2019)*** in a study entitled "Effect of breast feeding versus formula feeding on surgical wound healing among infants during the first six months of age" who showed that more than half had spreading redness, more than one fifth had swelling, less than one third of them had exudate odour and minority of them had secretion from wound. The study results were contrasted with ***Imran & Ali, (2020)*** who showed that more than one third had superficial skin infection, more than half of infants had deep incisional infection. So, the deep incisional infection was the most common of surgical site infection.

As regard total levels of surgical site infections among children in the infancy period, the results of this study revealed that more than one half of children in the infancy period had mild level of surgical site infection, while one third had moderate level and less than one quarter had severe level of infection. The study results were supported by ***Wabada et al., (2017)*** who found that there were about two thirds of children had mild surgical site infection, while less than one third of them had moderate infection and minority of them had severe infection.

This study findings in the same line with ***James et al., (2012)*** in a study entitled " Pediatric surgical site infection in the developing world: a Kenyan experience" who showed more than two thirds of children had mild surgical site infection, while less than one third of them had moderate infection and minority of them had severe infection. Also, ***Imran and Ali, (2020)*** reported that neonates and infants have different percentages of infection rates, more than one third of neonates and infants had mild surgical site infection, while less than two thirds of them had moderate infection. From the researcher point of view development of surgical site infection of children in the infancy period might be related most of children had congenital anomalies and need to multiple surgeries. These circumstances that might be causing surgical site infection in the infancy period.

Conclusion

Preoperative hospitalization, daily dressing after operation, emergency surgery, diagnosis as congenital anomalies malformation, abdominal site of operation and more than two hours duration of operation are the risk factors associated with surgical site infections in the infancy period.

Recommendations

- Early management of children with congenital anomalies in infancy period is essential.
- Apply concept of the family cantered care for the parent of children had congenital anomalies.
- Dissemination of research results.
- Replication of the study in large numbers of children in the same age.

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