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Effect of Pediatric Orthopedic Bundle guideline on Nurses' Performance Regarding Surgical Site Infections

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Abstract: **The occurrence of surgical site infections (SSIs) in orthopedic surgeries results in reduced quality of life, increased hospital length of stay, increased likelihood of mortality, higher change of readmissions and re-interventions. Aim of the study: to evaluate the effect of pediatric orthopedic bundle guidelines on nurses' performance regarding surgical site infections for children undergoing orthopedic surgeries. Design: A Quasi-experimental research design was (pre/post-test) utilized to conduct the current study. Settings: The study was conduct at orthopedic surgery departments at Benha University Hospital, Benha Health Insurance Hospital and Benha Teaching Hospital. Subjects: A convenient sample of all available nurses (124) working at the previously mentioned study settings regardless of their personal characteristics. Tools of data collection: Two tools were used; a structural interviewing questionnaire to collect personal data of the studied nurses and their knowledge regarding orthopedic surgeries, surgical site infections and bundle of nursing care to reduce surgical site infections. The second tool; Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection. Results: The study results showed that there was a highly statistical significant improvement in total nurses' performance after implementation of Pediatric Orthopedic Bundle guidelines. Moreover, there was a highly statistically significant relation in nurses' practice and their educational level, occupation, years of experience, and attendance of training courses. Conclusion: Based on the present study findings, it was concluded that there was unsatisfactory knowledge as well as an incompetent practice among nurses regarding surgical site infections before the orthopedic bundle guideline compared with after implementation, and there was an improvements in nurses' knowledge and performance regarding surgical site infections. Recommendations: The study recommended that implementing the Pediatric Orthopedic Bundle guidelines for staff nurses are important to improve care provided to children in orthopedic departments to reduce surgical site infection.**

Keywords: **Surgical Site Infection, Nurses' performance and Pediatric Orthopedic Bundle guidelines.**

1. INTRODUCTION

Surgical site infection (SSI) is a significant clinical problem that effect of health care outcomes globally, particularly in developing countries. This infection can have serious impacts including; prolonged hospital stay, reduced quality of life, increased mortality, additional cost for children and their families, and rising health care cost ***(Tanner, Dumvile, Norman & Fortnam*, 2016).** The World Health Organization (WHO) reported that the SSI incidence rate was higher for procedures in orthopedics (15.1%) and general surgery (14.1%). It has been reported that SSI incidence develops around 1 in 20 surgical children in hospitals ***(World Health Organization, 2016).***

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Surgical site infection has had a significant impact on children, in terms of increasing morbidity and mortality; and on hospitals, in terms of higher costs. It can lead to significantly impaired physical and mental capacity, and also decrease children quality of life. **(Smith and Dahlen, 2013)**. For example, functional disability, emotional stress and anxiety, and lower quality of life have been found among children with SSI .Surgery has become an important part of the health care systems across the world. It has been estimated that 312.9 million major surgical procedures are undertaken annually worldwide. **(Weiser et al., 2015)**

World Health Organization guidelines have put down a number of recommended best practices for preventing SSI, giving importance to the following six areas: hair removal with an electric clipper should be performed on the day of the operation immediately before the operation; preoperative showering with soap should be performed in the morning of the day of the operation; preoperative skin disinfection of children should be performed by applying an antiseptic solution; prophylactic antibiotics should be administered within one hour prior to incision; proper hand hygiene practices should be performed before and after any procedure; and the incision dressing should be done using an aseptic technique **(Ballard et al. 2012; and Bruny et al., 2013).**

Care bundles are a package of three to five evidence-based procedures that are consistently and effectively implemented together to improve care quality. Care bundles are broadly used in healthcare settings in order to prevent and manage various health conditions ***(Lavallee, Gray, Dumville, Russell, & Cullum, 2017).*** Evidences suggest that bundles of care are effective in reducing the incidence of SSIs in children. The implementation remains a challenge and the outcomes of bundles are largely associated with compliance rates in bundle implementation ***(Klinger et al., 2015 & Ryckmanet al., 2019).***

Nursing compliance with devolved guidelines is a challenge to efforts to prevent the complications of the SSI. Either due to shortage of knowledge or other causes, adherence to evidence-based practices is an identified issue that increased SSI's incidence ***(Flodgren et al., 2013).***

Nurses play a major comprehensive role and span of continuum performance care in preventing SSI. Therefore, they can modify SSI risk factors in their daily practice such as improper hand hygiene and skin preparation, in order to prevent SSI **(*Harrington, 2014*).** Many sets of guidelines in this area have been suggested in the past decade by the organizations working in the area of SSI prevention, such as the Center for Disease Control and Prevention, world Health Organization and the National Institute for Health and Clinical Excellence. However, adherence to the recommended best practices according to the guidelines for SSI prevention remains low among nurses ***(Demir, 2019).***

Significance of the study:

Surgical site infection (SSI) is one of the most common serious complications of surgical children after operation. Therefore, the current study will provide evidence for conducting studies and researches to improve nurses' knowledge and practice as regards surgical site infection for children undergoing orthopedic surgery. The contents of the pediatric orthopedic bundle guidelines in this study could be reflected in pediatric orthopedic nursing education and practice, and improve child outcomes.

Multiple studies have reported that proper practices for the prevention of infection among nurses have been affected by some barriers, such as knowledge, resources and SSI preventive guidelines. However, evidence in regard to nurses' practices for SSI prevention and its barriers and facilitators among nurses are very limited information. Therefore, the principal investigator was very interested to explore nurses' SSI prevention practices and its barriers **(Zingg et al., 2014).**

Aim of the study:-

The present study aimed to evaluate the effect of pediatric orthopedic bundle guidelines on nurses' performance regarding surgical site infections in orthopedic departments through:

1- Assessing nurses' performance regarding pediatric orthopedic bundle guidelines and surgical site infections.

2- Designing and implementing pediatric orthopedic bundle guidelines and surgical site infections.

3- Evaluating the effect of pediatric orthopedic bundle guidelines on nurses' performance regarding surgical site infections.

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Hypothesis:

The current study hypothesized that; nurses in the orthopedic departments exposed to pediatric orthopedic bundle guidelines, whom providing direct care for children with orthopedic surgery will show higher level of knowledge and competent practice after intervention than that before.

Operational definition

Pediatric Orthopedic Bundle:

It is the most appropriate intervention which is defined as a series of interventions related to care of SSI that when implemented together, will achieve better significantly outcomes than when implemented separately.

2. SUBJECTS AND METHODS

Research design:

A quasi-experimental design (pre/post-test) was utilized to attain of the present study. Quasi-experimental studies have been commonly accepted and used in the social sciences for several years. Quasi-experimental research shares similarities with the old-style experimental design or randomized controlled trial, but it exactly lacks the element of random assignment to treatment or control ***(Bärnighausen et al., 2017).***

Settings:

This study was carried out at orthopedic departments in Benha University Hospital, Benha Health Insurance Hospital and Benha Teaching Hospital affiliated to Egyptian Ministry of Health and Population. Orthopedic department in Benha University Hospital located in the 7th floor and contains six big rooms, one dressing room and one operating room. Orthopedic department in Benha Teaching Hospital located on the third floor and consists of one big room that contains eight beds. Orthopedic department at Benha Health Insurance Hospital located on the fifth floor and contains two big rooms, each room contains six beds.

Sample:

- A convenience sample of all available male and female nurses (124) who are working at the previously mentioned study settings were included in this study (50) nurse from Benha University Hospital, (32) from Benha Health Insurance Hospital and (42) nurse from Benha Teaching Hospital, regardless their educational level and years of experiences.

Tools of Data Collection:-

Three tools were utilized to collect data pertinent to the current study. The researchers developed them after reviewing related literature, periodicals, and scientific web sites. These tools were consisted of the following:

Tool (1) A structured Interviewing Questionnaire:

It was designed by the researchers in the light of relevant studies and researches ***(Hockenberry & Wilson, 2015).*** Each nurse interviewed individually for answering the structured interviewing questionnaire. It was written in an Arabic language and composed of three parts:

-The first part:

Personal data of the studied nurses as; age, gender, place of work, academic qualifications, years of experiences and attendance of any previous training courses regarding SSI.

-The second part:

Nurses' knowledge regarding surgical site infection. It included 13 MCQs regarding; definition of infection, definition of surgical site infection, most common causative organism, causes of SSI, prevention strategies for SSI, risk factors, early signs of SSI, late signs of SSI, time of dressing, strategies for controlling wound secretions and infection, complication, immediate intervention for SSI and prognosis of SSI.

The third part:

Nurses' knowledge regarding preventive bundled practice of pediatric orthopedic surgical site infection. It consisted of 10 multiple choice questions covering issues related to; bathing/ showering, hair removal, surgical antibiotic prophylaxis, nutrition, surgical hand scrub/ preparation, skin antiseptic preparation normothermia, drapes and gowns of the surgical field, use of gloves and post-operative wound dressing.

Scoring system for knowledge:

Nurses' knowledge was evaluated after completion of the structured interviewing questionnaire which their answers compared with a model key answer. The scoring system consisted of giving score (1) for the correct and complete answers, and (0) for the wrong, incomplete answers or don't know answers. The total score ranged from 0-23. Then, the total knowledge of nurses was categorized into the following:

- Satisfactory knowledge for 80% or more.
- Unsatisfactory knowledge for less than 80%.

Tool (2) Bundle for preventing surgical site infections:

It was adopted from ***World Health Organization (2009), and WHO (2018).*** It was used for assessing actual nurses' practices towards pediatric orthopedic preventive bundle guideline. It included three bundled practices as follow:

a. preoperative phase (10 items)

b. intraoperative phase (15 items)

c. postoperative phase. (5 items)

Scoring system of pediatric orthopedic preventive bundle guideline:

Total practice scores were (30 items). Each nurse observed during each procedure for three different times using nurses' observational checklists. The mean of the three observations calculated, and the mean was taken. Each correctly done step gave the score of (1) and (0) for each incorrectly done step or not done. The total scoring for practice classified as follows:

-Competent practice level: Equal to or more than 80%.

- Incompetent practice level: Less than 80%.

Preparatory phase:

This phase included reviewing related literatures, web sites, evidence-based articles, periodicals and different studies related to research problem, in order to collect tools of this study. This period extended from (February 2018 to April 2018). The researchers convince that items of the tools adequate presented what is hypothetical to be measured by a jury of three experts including; one orthopedic surgery professor, and two assistant professors of the pediatric nursing from the Ain Shams Faculty of Nursing and Benha faculty on nursing, to test the tool and guidelines' content validity .

Modifications made according to the experts' judgment on the transparency of sentences, appropriateness of the content, and categorization of items. The experts' agreed on the contents but suggested minor language changes that would make the information stronger and more precise. The recommended changes made. The internal consistency reliability of all items of the tools assessed using coefficient alpha. It was 0.86 for structured interviewed questionnaire and was 0.84 for nurses' practices observational checklists.

Designing Orthopedic Bundle Guidelines:

This was taken period of time from the end of April 2018 to May 2018. The researchers designed booklet concerning Orthopedic Bundle guideline for nurses working at orthopedic departments in Benha University Hospital, Benha Health Insurance Hospital and Benha Teaching Hospital affiliated to Egyptian Ministry of Health and Population.

Administrative Design:

An official permission for data collection was obtained from the hospital managers and head of orthopedic departments in the previously mentioned study settings through submission of official letters issued from the dean of Benha Faculty of Nursing. The title, aim and the expected outcomes of the study were illustrated as well as the main data items to be covered, and the study was carried out after gaining the necessary permissions. The study was carried out during the period from the beginning of July 2018 to the end of December 2018.

Ethical and legal considerations:

- The aim and the expected outcomes of the current study were explained to the managers and each nurse before implementation of orthopedic bundle guideline to gain their confidence and trust.
- An oral consent was obtained from each nurse before data collection.
- Data were collected and treated confidentially.
- Each nurse included in the current study has the right to withdraw at any time of the study without explanation of any rationale.

Pilot study:

A pilot study was carried out on 10% of the total sample size (approximately 12 nurses) over a period of one month (May 2018) to test clarity of the data collection tools, feasibility, objectivity and time needed for each data collection tool. Carrying out the pilot study gave the researchers experience to deal with the included subjects, and the data collection tools. Based on the results of the pilot study some modifications were done as; omission and addition of some items. The pilot study subjects were excluded from the actual study sample.

The field work:

The field work was started from the beginning of July 2018 to the end of December 2018 for data collection by the researchers. The researchers were available in the morning and afternoon shifts in the previously mentioned study settings by rotation for three days weekly to collect the data by using previously mentioned data collection tools.

The researchers interviewed each nurse, the aim of the study and expected outcomes were explained and the approval of them were taken to participate in the study prior to data collection, then the researchers assessed the nurses' knowledge and practice regarding caring of children under orthopedic procedures by using questionnaire and observational checklist as following: the structured interviewing questionnaire were administered by the researchers individually to all studied nurses to assess their knowledge about surgical site infection and preventive bundled practice of pediatric orthopedic surgical site infection. The average time needed for the completion of each interview for nurses was between 20 – 30 minutes. The researchers observed nurses' practice during caring of these children using Bundle for preventing surgical site infections. This period of pre-tests (knowledge and practice) took 12 weeks.

The implementation of Orthopedic Bundle Guidelines was achieved through 10 sessions at a period of 10 weeks. Each session started by a summary of the previous session, and objectives of the new session. Simple Arabic language was used to suits the nurses' educational level. Motivation and reinforcement were used during session in order to enhance motivation for participation in this study.

The total numbers of sessions were 10, in addition, one session for pre-test and another for post-test. It divided as follows: three sessions for knowledge, and seven sessions for the practice. The time of knowledge sessions ranged between 45 minutes to 6o minutes. The nurses divided into 12 groups, each group contains (8-12 nurses) to acquire the related information. Each nurse was supplemented with the Orthopedic Bundle Guidelines. The researchers continued to reinforce the gained information, answered any raised questions and gave feedback.

The duration of practice sessions ranged between 45 minutes to 60 minutes, and numbers of sessions were 7 sessions for each group (5-8 nurses) in the form of demonstration and re-demonstration for each group of the studied nurses.

Teaching methods were lectures, group discussion, brain storming, demonstration and re-demonstration. Media utilized were handouts, colored posters, videos presentation and data show presentation.

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Evaluation phase:

After implementation of orthopedic bundle guidelines, the researchers administer the post tests to assess nurses' knowledge and practice using the same form of Pre-test; this helped to evaluate the effect of implemented orthopedic bundle guidelines. This was done immediately after the intervention. This phase took about 12 weeks.

Statistical design

The collected data was reviewed, organized, categorized and tabulated for computer entry. Data entry and analysis was done through SPSS 20 statistical software package. Quantitative data was presented by mean, standard deviation and T-test was used for comparison between two means. Qualitative data was presented in the form of numbers and percentage. It was analyzed in the form of chi square, fisher exact test and Test of significance was set as P value is ≤ 0.05, indicates statistical significant and P is ≤ 0.001, indicates highly statistical significant.

3. RESULTS

Table (1) shows the personal characteristics of the studied nurses; it was observed that, the mean age of them were 32 ± 2.3 years. Majority of nurses are females and exactly two fifth of them were working at Benha University hospital. In relation to nurses' education, 79.0% of them have diploma in nursing, while 11.3% of them have Bachelor degree in nursing and the remaining (9.7%) of nurses graduated from technical institute of nursing. Also, it is noticed that, half of nurses (51.6 %) have years of experiences ranges from 1 to less than 10 years, and 93.5% of them not attended any previous training courses regarding surgical site infection care bundle.

Table (2) clarifies that; the majority of nurses had unsatisfactory knowledge in pre orthopedic bundle guidelines implementation regarding definition, most common causative organism, causes, prevention strategies, risk factors, signs, time of dressing, strategies for controlling wound secretions and infection, complication, immediate intervention and prognosis compared with post orthopedic bundle guidelines implementation. There is a highly statistical significant difference between nurses' knowledge scores in all items pre and post implementation (P<0.001).

Table (3) reveals that; nurses had satisfactory answers in post orthopedic bundle guidelines implementation regarding all items of bundle compared with pre orthopedic bundle guidelines implementation. There is a highly statistical significant difference between nurses' knowledge scores in all items pre and post implementation (P<0.001).

Table (4) shows number and percentage distribution of the studied nurses' total practices score regarding pediatric orthopedic bundle guidelines pre/post implementation; it was observed that, all studies nurses having competent practice post implementation regarding surgical hand scrub/ preparation, skin antiseptic preparation, normothermia and use of gloves respectively compared with pre implementation. This table also clarify that, nurses had competent practice in post orthopedic bundle guidelines implementation regarding all items of bundle compared with pre orthopedic bundle guidelines implementation. There is a highly statistically significant difference between nurses' practice scores in all items pre and post implementation (P<0.001).

Table (5) displays number and percentage distribution of the studied nurses' practices total scores regarding Bundle for preventing surgical site infections pre/post implementation; the total scores of nurses' practice were incompetent pre implementation. However, post implementation was competent practice. There was highly statistical significance difference (p value is 0.000).

Table (6) shows number and percentage distribution of the studied nurses' total scores of their knowledge and practice regarding pediatric orthopedic bundle guidelines pre/post implementation; the total scores of nurses' knowledge were unsatisfactory with percentage 95.2% pre implementation. However, post implementation was satisfactory with percentage 96.8%. Regarding their practices' total scores, there were 80.6% were competent post implementation compared with 6.4 pre implementation.

Table (7) shows highly statistically significance relations between studied nurses' knowledge and practice post orthopedic bundle guidelines implementation and their ages, educational level and years of experiences, contrariwise, there was no statistical significance between gender and their knowledge and practice

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Table (8) demonstrates relation between studied nurses' knowledge and practices regarding orthopedic bundle guidelines implementation, it was shown that there were a highly statistical significance relation between them pre and post-implementation.

Table (1): Number and percentage distribution of nurses' personal characteristics (N=124).

Characteristics	Study sample n=124	
	No	%
Age in years		
- 20 - < 30	42	33.9
- 30 - < 40	74	59.7
- ≥ 40	8	6.4
Mean ±SD: 32 ± 2.3		
Gender:		
- Male	6	4.8
- Female	118	95.2
Place of work		
- Benha University Hospital	50	40.3
- Benha Health Insurance Hospital	32	25.8
- Benha Teaching Hospital	42	33.9
Qualifications		
- Diploma in nursing	98	79.0
- Technical institute of nursing	12	9.7
- Bachelor degree	14	11.3
Years of experience		
- <1	18	14.5
- 1 < 10	64	51.6
- ≥ 10	42	33.9
Attendance of any previous training courses		
- yes	8	6.5
- No	116	93.5

Table (2): Number and percentage distribution of the studied nurses' knowledge regarding surgical site infection pre/post pediatric orthopedic bundle guidelines implementation (n=124)

Items of Knowledge	Pre-test (124)				Post-test (124)				x^2	P value
	Satisfactory		Unsatisfactory		Satisfactory		Unsatisfactory			
	No	%	No	%	No	%	No	%		
Definition of infection	14	11.3	110	88.7	120	96.8	4	6.4	31.41	0.001**
Definition of surgical site infection	2	1.6	122	98.4	124	100.0	0	0.0	37.19	0.000**
Most common causative organism for surgical infection	6	4.8	118	95.2	116	93.6	8	12.8	40.09	0.001**
Causes of SSI	0	0.0	124	100.0	118	95.2	6	9.6	35.08	0.001**
Prevention strategies for SSI	0	0.0	124	100.0	116	93.6	8	12.8	33.74	0.001**
Risk factors for surgical infection	0	0.0	124	100.0	124	100.0	0	0.0	41.16	0.000**
Early signs of SSI	14	11.3	110	88.7	120	96.8	4	6.4	32.55	0.001**

Late signs of SSI	8	6.4	116	93.6	124	100.0	0	0.0	27.95	0.000**
Time of dressing	4	3.2	120	96.8	124	100.0	0	0.0	31.24	0.000**
Strategies for controlling wound secretions and infection	16	12.9	108	87.1	118	95.2	6	9.6	30.98	0.005*
Complication of SSI	0	0.0	124	100.0	120	96.8	4	6.4	31.75	0.001**
Immediate intervention for SSI	6	4.8	118	95.2	110	88.7	14	22.6	29.85	0.05**
Prognosis of SSI	8	6.4	116	93.6	116	93.6	8	12.8	42.85	0.001**
Total	**5.8**	**4.7**	**118.2**	**95.3**	**119.3**	**96.2**	**4.7**	**3.8**	**37.28**	**0.001****

A highly statistical significant difference ($P \leq 0.001$)

Table (3): Number and percentage distribution of the studied nurses' knowledge regarding items of pediatric orthopedic bundle guidelines pre/post implementation (n=124)

Items of Knowledge	Pre-test (124)				Post-test (124)				x^2	P value
	Satisfactory		Unsatisfactory		Satisfactory		Unsatisfactory			
	No	%	No	%	No	%	No	%		
Bathing/ showering	6	4.8	118	95.2	116	93.6	8	12.8	40.09	0.001**
Hair removal	0	0.0	124	100.0	118	95.2	6	9.6	35.08	0.001**
Surgical antibiotic prophylaxis	0	0.0	124	100.0	116	93.6	8	12.8	33.74	0.001**
Nutrition	0	0.0	124	100.0	124	100.0	0	0.0	41.16	0.000**
Surgical hand scrub/ preparation	14	11.3	110	88.7	120	96.8	4	6.4	32.55	0.001**
Skin antiseptic preparation	8	6.4	116	93.6	124	100.0	0	0.0	27.95	0.000**
Normothermia	4	3.2	120	96.8	124	100.0	0	0.0	31.24	0.000**
Drapes and gowns of the surgical field	16	12.9	108	87.1	118	95.2	6	9.6	30.98	0.005*
Use of gloves	6	4.8	118	95.2	110	88.7	14	22.6	29.85	0.05**
Post-operative wound dressing	8	6.4	116	93.6	116	93.6	8	12.8	42.85	0.001**
Total	**5.5**	**4.4**	**118.5**	**95.6**	**119.0**	**96.0**	**5**	**4.0**	**74.8**	**0.001****

A highly statistical significant difference ($P \leq 0.001$)

Table (4): Number and percentage distribution of the studied nurses' total practices score regarding pediatric orthopedic bundle guidelines pre/post implementation (n=124)

Items of practice	Pre-test (124)				Post-test (124)				x^2	P value
	Competent		Incompetent		Competent		Incompetent			
	No	%	No	%	No	%	No	%		
Bathing/ showering	16	12.9	108	87.1	120	96.8	4	6.4	40.09	0.001**
Hair removal	8	6.4	116	93.6	110	88.7	14	22.6	35.08	0.001**
Surgical antibiotic prophylaxis	6	4.8	118	95.2	116	93.6	8	12.8	33.74	0.001**
Nutrition	14	11.3	110	88.7	116	93.6	8	12.8	41.16	0.000**
Surgical hand scrub/ preparation	14	11.3	110	88.7	124	100.0	0	0.0	32.55	0.001**
Skin antiseptic preparation	8	6.4	116	93.6	124	100.0	0	0.0	27.95	0.000**
Normothermia	4	3.2	120	96.8	124	100.0	0	0.0	31.24	0.000**

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Drapes and gowns of surgical field	16	12.9	108	87.1	118	95.2	6	9.6	30.98	0.001*
Use of gloves	22	17.7	102	82.3	124	100.0	0	0.0	29.85	0.05**
Post-operative wound dressing	14	22.6	110	88.7	116	93.6	8	12.8	42.85	0.001**
Total	**5.5**	**4.4**	**118.5**	**95.6**	**119.0**	**96.0**	**5**	**4.0**	**74.8**	**0.001****

P Value ≤ 0.05 Statistical significant differences (S); P value ≤ 0.01 high Statistical significant differences (HS).

Table (5): Number and percentage distribution of the studied nurses' practices total scores regarding Bundle for preventing surgical site infections pre/post implementation (n=124)

Items		Pre-test (124)		Post-test (124)		x^2	P value
		No	%	No	%		
- Preoperative phase	Competent	6	4.8	110	88.7	58.72	0.000**
	Incompetent	118	95.2	14	11.3		
- Intraoperative phase	Competent	8	6.4	100	80.6	61.48	0.000**
	Incompetent	116	93.6	24	19.4		
- Postoperative phase	Competent	16	12.9	120	96.8	62.09	0.000**
	Incompetent	108	87.1	4	3.2		

P Value ≤ 0.05 Statistical significant differences (S); P value ≤ 0.01 high Statistical significant differences (HS).

Table (6): Number and percentage distribution of the studied nurses' total scores of their knowledge and practice regarding pediatric orthopedic bundle guidelines pre/post implementation (n=124)

Items		Pre-test (124)		Post-test (124)		x^2	P value
		No	%	No	%		
Knowledge	**Satisfactory**	6	4.8	120	96.8	28.78	0.000**
	Unsatisfactory	118	95.2	4	3.2		
Practice	**Competent**	8	6.4	100	80.6	64.48	0.000**
	Incompetent	116	93.6	24	19.4		

P Value ≤ 0.05 Statistical significant differences (S); P value ≤ 0.01 high Statistical significant differences (HS).

Table (7): Relation between studied nurses' knowledge and practices and their personal characteristics post orthopedic bundle guidelines implementation (n: 124)

personal characteristics	Knowledge		ANOVA		Practice	ANOVA	
	N0: 124	Mean±SD	F/T test	P value	Mean±SD	F/T test	P value
Age in years							
20 - < 30	42	72.61±6.85	F test 4.42	0.001	80.44±2.34	F test 0.452	0.001**
30 - < 40	74	58.85±7.08			90.81±3.28		
≥ 40	8	49.09± 4.66			89.22± 1.86		
Gender:							
Male	6	48.82±6.58	T test	0.058	98.55+9.28	T test	0. 062

Female	118	44.38± 5.56	4.62		89.32+ 3.62	0.732	
Qualifications							
Diploma in nursing	98	42.48±2.18	F test 4.43	0.00	86.14±4.12	F test 0.738	0.000**
Technical institute	12	48.45±1.68			92.61±3.48		
Bachelor degree	14	52.36± 2.34			94.62± 2.62		
Years of experience							
<1year	18	46.36±4.32	F test 2.94	0.00	80.72±3.39	F test 0.842	0.000**
1- < 10 years	64	42.44±1.48			92.38±3.46		
≥ 10 years	42	39.84± 2.33			93.72± 2.88		

Table (8): Relation between studied nurses' knowledge and practices regarding orthopedic bundle guidelines pre/post implementation (n: 124)

Items	Pre-test (124)		Post-test (124)	
	r	p	r	p
Knowledge	0.664	0.000**	0.872	0.000**
Practice	0.724	0.000**	0.978	0.000**

P Value ≤ 0.05 Statistical significant differences (S);

P value ≤ 0.01 high Statistical significant differences (HS).

4. DISCUSSION

Surgical Site Infection (SSI) for orthopedic surgery is a clinical problem that occurs in orthopedic department for children undergoing orthopedic surgery. It represents an acquired health problem among hospitalized orthopedic children especially at the post-operative period. The interaction of practice standardization, adherence to bundle components and the specific bundle components, result in the lowest SSI rates **(Bader & Kadhim, 2017).** Therefore, the aim of the present study was to evaluate the effect of pediatric orthopedic bundle guidelines on nurses' performance regarding surgical site infections. This aim was achieved throughout the study findings and the research hypothesis was accepted.

Regarding personal characteristics of the studied nurses, the findings of the current study revealed that, the majority of nurses were females and their mean age were 32 ± 2.3 years. The majority of them were females that might be due to the higher proportion of the nurses in Egypt were females and may also be related to the nursing study in the Egyptian Universities was limited for females only till fifteen years ago. These findings were agreed with ***Venkatramana Jayadevan and Jayakumay,* (2018)** in a study about "Opinion and practice of gloving among orthopedic nurse in a university teaching hospital" who reported that the majority of nurses in orthopedic wards were females, with age group was 25-30 years but these findings were disagreed with **Haleim, *Ibraheim and Tahlawy*, (2017)** in a study about " Surgical site infection and associated risk factors in Egyptian orthopedic patients " who indicated that the majority of the nurse staff in orthopedic were males with mean age was 35 years.

On concerning qualifications of studied nurses, the present study revealed that the majority of studied nurses had diploma in nursing. This finding were disagreed with ***Aiken Clarke, Sloane, Lake, and Cheney,* (2018)** in a study about "Effect of hospital care environment on patient mortality and nurse out comes ", who showed that the higher percentage of the educational level were institute graduate. And these findings were also differed with the results of **Khan, (2016)** in a study about "Antiseptics, iodine, povidone iodine and traumatic wound cleansing" that showed that the majority graduate in orthopedic ward had bachelor degree of science in nursing.

Regarding years of experiences for studied nurses, the current study finding revealed that, slightly more than half of studied nurses had 1 to less than 10 years of experiences. This finding was supported by ***Agrawal*, Jain, *and Raza*, (2018)** in a study about " Pathogenic bacteria in an orthopedic hospital in India" who reported that the years of experience in orthopedic departments, most of them had 1-5 years of experience in orthopedic departments and this finding comes in agreement with **Venkatramana et al., (2018)** who reported that the majority of the orthopedic nurse staff had experience less than 5 years in orthopedic departments.

As regard attendance of training courses of studied nurses, the result of the current study clarified that the most of them not attended any previous training courses regarding surgical site infection care bundle. From researchers' points of view this could be due to that all orthopedic nursing staff in orthopedic departments should identify factors affecting on the performance that causes failure in orthopedic nurses' practice. All orthopedic nurses who have a clinical responsibility for caring of orthopedic children must include wound infection prevention and control through developing training sessions for hand washing, aseptic technique and clean equipment, wound dressing and wound infection control. This finding was disagreed with **Bader & Kadhim, (2017)** in a study about " Evaluation of nurses' practices toward orthopedic wound infection " who indicated that more than half of the study sample had sharing in training sessions and the majority of them had numbers of training sessions to be involved three training sessions and more.

Regarding nurses' knowledge about SSI, the present study showed that the majority of studied nurses had unsatisfactory knowledge in pre orthopedic bundle guidelines implementation regarding definition, most common causative organism, causes, prevention strategies, risk factors, signs, time of dressing, strategies for controlling wound secretions and infection, complication, immediate intervention and prognosis compared with post orthopedic bundle guidelines implementation. From researchers' points of view this could be due to lack program or intervention guideline set in place of orthopedic departments so, the desire to enhance or at least refresh their knowledge to increased awareness of the surgical site infection care bundle and its importance among the orthopedic children's is needed. This finding was supported by ***Brisibe***, ***Ordinioha and Gbeneolol,*** **(2014)** in a study about "Knowledge, attitude, and infection control practices of two tertiary hospitals in Port-Harcourt, Nigeria" who indicated that more than half of the nurses working in the two referral hospitals demonstrated inadequate knowledge regarding prevention of surgical site infections.

On the same line, the present study revealed that there is a highly statistical significant difference between nurses' knowledge scores in all items pre and post implementation. This might be due to the fact that updating nurses' knowledge about prevention of surgical site infection could have changed the old nurses' knowledge and could have resulted in good score on knowledge items. Therefore, since the knowledge-based questions were designed based on up-to-date guidelines, Moreover, since the surgical site infection prevention and children safety national guideline detailed information and evidence-based recommendations about prevention of surgical site infection care bundle, nurses who have taken this training could have better knowledge regarding prevention of SSIs. This finding was agreed with ***Fry and Fry, (2017)*** in a study about "Surgical site infection: the host factor" who reported that, knowledge about prevention of surgical site infection was significantly associated with ever taking training on surgical site infection prevention methods.

The present study revealed that the majority of nurses had satisfactory knowledge in post orthopedic bundle guidelines implementation regarding all items of bundle compared with pre orthopedic bundle guidelines implementation .This might be due to the bundle guideline had an impact on orthopedic nurse who works in orthopedic ward of children and they should be reinforced and engaged in guideline. This finding was disagreed with ***Teshager, Engeda, and Worku., (2015)*** in a study conducted in Ethiopia about "Knowledge, Practice, and Associated Factors towards Prevention of Surgical Site Infection among Nurses Working in Amhara Regional State Referral Hospitals" who reported that, many nurses had insufficient knowledge regarding the prevention of SSI. These findings were also disagreed with ***Famakinwa , Bello, , Oyeniran, , Okhiah, and Nwadke*** **(2014)** in a study carried out on Nigeria about "Knowledge and practice of post-operative wound infection prevention among nurses in the surgical unit of a teaching hospital in Nigeria " who reported that, the majority of nurses had inadequate knowledge of surgical site infection prevention. This lack of knowledge is likely to be due to the subsequent factors mentioned by the interviewed nurses' as; insufficient up-to-date in-service training and education programs; lack of proper education policies and planning; lack of up-to-date guidelines.

On the same line, the present study revealed that there is a highly statistical significant difference between nurses' knowledge scores in all items pre and post implementation. This might be due to the effectiveness of orthopedic bundle guidelines on the knowledge scores of the orthopedic nurse that there was significant. This finding was supported by ***Leaper Tanner, Kiernan, Assadian, and Edmiston*** **(2014)** in a study about "Surgical site infection: compliance with guidelines and care bundles" who reported that, the orthopedic bundle guideline identified that hair removal, antibiotic prophylaxis, maintenance of normothermia and perioperative skin preparation were among the key areas for implementation of evidence-based interventions recommendations were high impact intervention for surgical site infection.

The present study revealed that the all studies nurses' total practices score regarding pediatric orthopedic bundle guidelines having competent practice post implementation regarding surgical hand scrub/ preparation, skin antiseptic preparation, normothermia and use of gloves respectively compared with pre implementation. From researchers' points of view the hand antisepsis was superior to hand washing, hand antisepsis and antimicrobial as a corner stone of infection control to reduce cross-contamination in orthopedic ward. While the effect of antiseptic hand rub is to inhibit flora on the skin. It was explained in standard precautions for wound infection in orthopedic ward by Centers for Disease Control (CDC), and the orthopedic nurse who works in orthopedic ward should be reinforced and engaged in training sessions which provide more explanation about the benefits of washing hand practice with chemical solutions. This finding was supported by ***Hurst, (2016)*** in a study about " Infection control: Double gloving in the OR" Who reported that it is suitable to wash hands before wearing gloves and change gloves between each child contact and encouraged hand wash after gloves removal. Wearing sterile gloves during providing of care or wound dressing for orthopedic children's were significant and good practice.

On the same line, the present study revealed that the nurses had competent practice in post orthopedic bundle guidelines implementation regarding all items of bundle compared with pre orthopedic bundle guidelines implementation. There is a highly statistically significant difference between nurses' practice scores in all items pre and post implementation ($P<0.001$). This result may be reflected the positive consequence of the orthopedic bundle guidelines for the prevention of surgical site infection. The vital role of nurses was passionate to acquire more knowledge and practices about how to prevent surgical site infection in orthopedic departments. These findings were agreed with ***Shah and Muhammad, (2017)***, in a study about "The practice of nursing care for prevention surgical site infection among orthopedic nurses in Private Tertiary Care Hospital" who reported that there was a highly statistically significant improvement in the total nurses' practice post orthopedic bundle guidelines implementation. These findings are supporting the research hypothesis.

Apparently, the current study findings showed that highly statistically significance relations between studied nurses' knowledge and practice post orthopedic bundle guidelines implementation and their ages, educational level and years of experience. This might be due to the reflection of positive outcome of the orthopedic bundle guideline on nurses' knowledge and practices, which were eager to know about how to prevent surgical site infection in orthopedic departments. On the other hand, the immediately post- orthopedic bundle guideline was improved consistently. It was reflected an improvement in nurse's performance as regards orthopedic bundle guideline as a result of an effective orthopedic bundle of these best practices and clinical interventions at orthopedic departments, knowledge and performance background. These findings come along with ***Robert, (2016)*** in a study about "Universal precaution: improving the knowledge of trained nurses " who stated that the previous orthopedic bundle guideline training a significant effect on practice and knowledge of surgical wound infection of universal precautions and methods of safe disposal were significantly higher among previously trained nurses compared with untrained nurses. And were significant associations between nurses' practice and their levels of education as the graduate orthopedic nurses have scored better than diploma nurses.

Finally, the present study finding revealed that relation between studied nurses' knowledge and practices regarding orthopedic bundle guidelines implementation, it was shown that there were a highly statistical significance relation between them pre and post implementation. The current study cleared a positive significant statistical relationship between knowledge and practice of orthopedic bundle guideline on nurses' performance regarding surgical site infections. This finding was agreed with ***El-Sol and Badawy, (2017)*** in a study about "The effect of a designed teaching module regarding the prevention of surgical site infection on orthopedic nurses' knowledge and practice " who reported that, the application of bundle approaches and continuous training guideline are considered for improvement of nurses' performance and decrease the gap between their knowledge and actual performance. Additionally, the enhancement of the total nurses' practice and authenticity to the prevention of orthopedic surgical site infection were anticipated.

5. CONCLUSION

Based on the present study findings, it concluded that there was unsatisfactory knowledge as well as an incompetent practice among nurses regarding surgical site infections before the orthopedic bundle guideline compared with after implementation. The research hypothesis was supported, and the orthopedic bundle guideline achieved significant improvements in nurses' knowledge and performance regarding surgical site infections

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6. RECOMMENDATIONS

Based on the findings of the current study, the following recommendations were suggested:

1. Special training sessions should be designated and presented to all orthopedic nurses that include specific education concerning hand washing, application of principles of aseptic technique during sterilization and disinfection procedures.

2. Training session should be applied as regular refresher courses to nurses on the orthopedic departments which including the updated knowledge and procedures about wound infection control.

3. Pediatric Orthopedic Bundle guideline regarding management of children with orthopedic surgeries should be reviewed and available in the form of printed booklets on orthopedic departments in both Arabic and English language.

4. Further studies are needed to apply the pediatric orthopedic bundle guideline with larger sample size and evaluate its impact on nurses' performance regarding caring for of children with orthopedic surgery.

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