



## Effectiveness of Evidence-Based Guidelines on Catheter Associated Urinary Tract Infection Rate among Pediatric Intensive Care Children

<sup>1</sup>Omayma Mustafa Abu Samra & <sup>2</sup>Rehab Abd El Aziz El Sayed Abd El Aziz

<sup>(1,2)</sup> Pediatric Nursing Department, Faculty of Nursing, Mansoura University, Egypt.

Corresponding author E-mail ([rehababdelaizelsayed@yahoo.com](mailto:rehababdelaizelsayed@yahoo.com))

### ABSTRACT

**Background:** Urinary tract infection is the most common healthcare associated infection (HCAI) that usually results from prolonged use of urinary catheter that results in prolonged hospital stay. Prevention of catheter associated urinary tract infection (CAUTI) in pediatric patients regarded now as an important hospital policy worldwide. **Aim:** The aim of this study was examining the effectiveness of evidence-based guidelines on catheter associated urinary tract infection rate among pediatric intensive care children. **Design:** A quasi-experimental design was utilized. **Setting:** The study was conducted in acute care units (medical pediatric intensive care unit "PICU", surgical PICU and cardiac PICU) at Mansoura University Children's Hospital. **Subjects:** The subjects of the study included 84 nurses who are working at the above-mentioned study settings & 102 pediatric patients who are divided randomly into 2 identical groups, case & control groups, each group consists of (51) pediatric patients. **Tools:** I: A Structured self-administered questionnaire, II: evidence-based guidelines on Urinary catheter maintenance and removal observational checklists, III: A structured questionnaire of pediatric patients' health condition & IV: Catheter-associated urinary tract infection criteria checklist. **Results:** There was an improvement in the mean scores of nurses' total knowledge and practice with statistically significant difference ( $P < 0.001$ ) in the post intervention compared to pre intervention stage, additionally, the positive symptoms and signs suggesting CAUTI were more evident in control group compared to case group with significant difference ( $P < 0.05$  &  $P < 0.001$ ) post intervention. **Conclusion:** the implementation of evidence-based guidelines about CAUTI prevention for pediatric patients with urinary catheter has positive significant improvement on the prevention of CAUTI rate. **Recommendations:** there is a requisite to educate the pediatric nurse to avoid routinely use of urinary catheters and remove them when they are no longer required. The use of urinary catheter evidence-based guidelines checklists should be kept in the pediatric patient file and reviewed regularly by pediatric nurses.

**Keywords:** Children, Evidence-Based Guidelines, Pediatric Intensive Care Units, Rate, Urinary Catheter, Urinary Tract Infection

### INTRODUCTION

Urinary tract infection is the most common healthcare associated infections (HCAI) results from prolonged use of urinary catheter which leads to increasing the length of hospital stay. <sup>(1&2)</sup> Catheter associated urinary tract infection (CAUTI) is an infection of the urinary tract that affects pediatric patients who have an indwelling urinary catheter and

the risk of infection differs from three percent to ten percent each day the catheter is in place. <sup>(3, 4&5)</sup>

Center for Disease Control (CDC) reported that the common pathogens producing CAUTI were {Escherichia coli [21.4%], Enterococcus [14.9%], Candida [21.0%], Pseudomonas aeruginosa ([10.0%], Enterobacter and Staphylococcus [4.1%] and Klebsiella pneumonia [7.7%]}. Certain pathogens in urinary tract

infection (UTI) are transmitted from the perianal area flora, so, the usage of a urinary catheter may permit pathogens to come in the urinary tract, it's better to implement periurethral daily routine hygienic care especially during bathing. <sup>(6,7)</sup>

The clinical diagnosis of CAUTI in pediatric patients depends on symptoms such as fever, hypothermia, apnea & bradycardia in infant, nausea & vomiting, pain in the flank area, tenderness, hematuria, dysuria, pelvic pain, discomfort, frequent voiding, and lethargy with no other causes, as well as positive urine culture. <sup>(8,9)</sup>

Healthcare staffs are responsible for providing reassurance that the health care will be provided proficiently in order to avoid diseases related morbidity. Although several efforts have been issued to prevent CAUTI rate, the infection still continues to increase due to insufficient knowledge regarding basic practices about urinary catheter care particularly amongst nurses. <sup>(6&10)</sup> Healthcare organizations must incorporate the evidenced based guidelines into the nurses' daily practical activities to be able to prevent and manage CAUTI, as proper use of urinary catheter, appropriate catheter insertion, maintenance and satisfactory catheter removal once the indications ends up. <sup>(11)</sup>

The transmission of infection requires interaction of 3 agents " a reservoir, a susceptible host [comprising health care staff & visitors] and a mode of transmission. <sup>(12)</sup> The risk of HCAI increased due to exposure of pediatric patients to multiple invasive devices & procedures especially in Intensive Care Unit (ICU), increased patients' contact with health care staff, staying in the hospital for long time with space limitations. <sup>(13)</sup>

Prevention of CAUTI in pediatric patient is regarded currently as an essential hospitals policy

worldwide. Most studies have concentrated on ways of diminution and prevention of CAUTI, though effective preventive expectation tools are still lacking. <sup>(14)</sup> Evidence-based practice (EBP) regarding pediatric patients' safety is highly critical. The pediatric nurses should deliver evidence-based practices regarding care of urinary catheter and CAUTI prevention, that needs proper knowledge, practical skills in order to meet the standards of care. Nurse has a vital role in avoiding unnecessary insertion of urinary catheter, managing & reducing the duration of catheterization, maintaining a closed drainage system, emptying the collecting bag regularly, ensuring aseptic techniques during urinary catheterization and continually maintaining the drainage bag under the bladder level, the pediatric nurses should have adequate knowledge and skills regarding CAUTI prevention as well as performing efficient nursing care for their pediatric patients using such knowledge and EBP. <sup>(6 &15)</sup>

### **Significance of the study**

The CAUTI is considered a basic source of morbidity in hospitalized pediatric patients. Actually, CAUTI incidence in both intensive care unit and inpatient setting are similar for pediatric populations and adult. <sup>(16)</sup> Prevention of CAUTI in pediatric patients is nowadays regarded as an essential hospital policy worldwide. Application of a daily safety checklist about urinary catheter care in a pediatric intensive care unit (PICU) resulted in a significant reduction of CAUTI. <sup>(17)</sup> The pediatric nurses in PICU are responsible for implement of evidence-based guidelines during urinary catheters insertion, daily maintenance care, and proper well-timed catheter removal for pediatric patients. <sup>(18)</sup> Therefore, the implementation of evidence-based guidelines for pediatric patients with urinary catheter will reduce CAUTI rates among children in pediatric intensive care units.

## AIM OF THE STUDY

The aim of this study was, examine the effectiveness of evidence-based guidelines on catheter associated urinary tract infection rate among pediatric intensive care children.

## RESEARCH HYPOTHESES

- 1- The score of mean knowledge and practices of the pediatric nurses will be improved after implementation of evidence-based guidelines.
- 2- The incidence of catheter associated urinary tract infection will be reduced among pediatric patients in case group who received evidence-based guidelines.

## SUBJECTS AND METHODS

### Design

A quasi-experimental research design [pre-test / post-test] was utilized in this study.

### Setting

The study was conducted in acute care units (medical pediatric intensive care unit "PICU", surgical PICU and cardiac PICU) at Mansoura University Children's Hospital. Each PICU contains 10 beds. The acute care units were received pediatric patients with acute traumatic and non-traumatic disorders.

### Subjects

The subjects of the study included the following:

A convenience sample of all nurses (84) who are delivering the care at the previous mentioned study settings regardless their age, qualification and years of experience. As well as, the study included all pediatric patients (102), who were admitted to PICUs through the data collection period, they were divided randomly into 2 identical groups, both groups were exposed to the routine units care of the study settings, while the case group (51) who received evidence-based guidelines regarding CAUTI prevention, and the

control group (51) who received routine care only based on the policy of PICUs. The sample was chosen after fulfilling the inclusion criteria

### Inclusion criteria:

- Both gender.
- Pediatric patients aged from one month to twelve years.
- Pediatric patients who had an indwelling urinary catheter within the previous 48 hours.
- Pediatric patients who expected to have a urinary catheter for one week.

### Exclusion criteria:

- Pediatric patient with diagnosis of UTI at the admission time and those developed UTI in the first 2 days of urinary catheter insertion.
- Pediatric patient who have Immune-compromised disorders or taking immunosuppressive drugs.

### Tools of data collection

**Tool I: A Structured self-administered questionnaire, this tool was developed by the researchers after reviewing literatures related to the evidence-based practices for catheter-associated urinary tract infection prevention guidelines. (19 &20), it was included 2 parts:**

**Part 1:** It included socio-demographic characteristics of the pediatric nurses such as age, gender, educational level, experience years in PICU and previous attendance of courses or workshops regarding guidelines for prevention of CAUTI.

**Part 2:** It included nurses' knowledge about the guidelines for prevention of CAUTI, it was consisted of 54 questions to assess nurses' knowledge about guidelines for prevention of CAUTI, which divided to five parts, 1) Nurses' knowledge about urinary catheter, it's included definition, indications, types &

complications), it consisted of 4 multiple choice questions. 2) Nurses' knowledge about CAUTI and its prevention in PICU, it was composed of 6 multiple choice questions. 3) Nurses' knowledge about CAUTI prevention in PICU regarding urinary catheter insertion care guidelines, it was composed of 14 multiple choice questions. 4) Nurses' knowledge about CAUTI prevention in PICU regarding urinary catheter maintenance care guidelines, it was composed of 18 multiple choice questions. 5) Nurses' knowledge about CAUTI prevention in PICU regarding urinary catheter removal care guidelines, it was composed of 12 multiple choice questions.

**Scoring system:** The scoring system for nurses' knowledge was established, score (2) was given to the correct answer and score (1) for incomplete correct answer and unknown or incorrect answer was given score (zero). The total score was 108, the total score was computed out and converted into percentage and categorized into unsatisfactory knowledge if the percent score was < 65% and satisfactory knowledge if the percent score was  $\geq 65\%$ .<sup>(21)</sup>

#### **Tool II: Urinary catheter maintenance and removal evidence-based guidelines observational checklists**

Nurse practices of urinary catheter maintenance and removal care guidelines; it was adopted from.<sup>(20 &22)</sup>, it was used to assess nurses' actual practice of urinary catheter maintenance and removal care guidelines; it was consisted of 45 statements. Urinary catheter maintenance care guidelines composed of 23 steps related to routinely assess intermittent urinary catheterization (IUC) appropriateness, before IUC maintenance, maintenance evidence- based guidelines of IUC and urine specimen collection. Urinary catheter maintenance care guidelines composed of 10 steps, use proper hand hygiene and wearing gloves, appropriately secure catheters to avoid movement and urethral

traction, keep a sterile closed drainage system, keep good hygiene at the catheter-urethral interface, perineal care daily and after diaper change, keep unobstructed urine flow, removal when no longer required, maintain drainage bag under level of bladder at all times, don't change indwelling catheters or drainage bags at arbitrary fixed intervals and avoid touching base of the drainage spigot with the collecting container. Urinary catheter removal care evidence- based guidelines composed of 12 steps related to hand hygiene, catheter care, remove catheter securement, balloon deflation, perineal care, safe pediatric patient position, post-urinary catheter care and review fluid intake.

**Scoring system:** The scoring system for nurses' practice was established with score 0-2 (2 for done and 0 for not done). The total practice scores were 90, based on the total score; the nurses' performance consists of two categories; "incompetent performance for less than 80% and competent performance for more than & equal 80%".<sup>(23)</sup>

#### **Tool III: A Structured questionnaire of pediatric patients' health condition**

It was prepared by researchers after reviewing the relating literature.<sup>(18)</sup>, it was used to gather data about demographic characteristics and the medical condition of the studied pediatric patients which collected from pediatric patients' medical and nurses' sheets, it includes the following data: Age, gender, diagnosis, indication for insertion of urinary catheter and duration of urinary catheter.

#### **Tool IV: Catheter-associated urinary tract infection criteria checklist**

This tool was adopted from.<sup>(22, 24 &25)</sup>, It was including signs & symptoms of catheter-associated urinary tract infection for the diagnosis of CAUTI, the signs & symptoms of CAUTI in infants  $\leq 1$  year of age

include fever more than 38.0°C, hypothermia less than 36.0°C, hematuria, apnea, bradycardia, lethargy, offensive smelling urine, cloudy urine, vomiting, suprapubic tenderness and positive urine culture (a bacterium of  $\geq 10^5$  CFU/ml). As well as the signs & symptoms of CAUTI in children include fever, hematuria, urinary frequency, dysuria, abdominal pain, offensive smelling urine, cloudy urine, vomiting, tenderness, costovertebral angle pain or tenderness and positive urine culture (a bacterium of  $\geq 10^5$  CFU/ml).

### **Scoring system**

#### **1. Catheter-associated Urinary Tract Infection CAUTI in infant 1 year of age or less**

Pediatric patients must meet the following three criteria, 1- infant is  $\leq 1$  year of age with indwelling urinary catheter for 2 days, 2-Infant has at least *one* of the previously mentioned signs or symptoms and 3- Infant has a urine culture with no more than 2 species of organisms identified, at least 1 of which is a bacterium of  $\geq 10^5$  CFU/ml.

#### **2. Catheter-associated Urinary Tract Infection (CAUTI) in children**

Pediatric patients must meet the following three criteria, 1- Pediatric patients had an indwelling urinary catheter that had been in place for more than two consecutive days, 2-Pediatric patient has at least *one* of the previously mentioned signs or symptoms. 3- Pediatric patient has a urine culture with a bacterium of  $\geq 10^5$  CFU/ml.

### **Validity and reliability of tools**

Tools of the study were reviewed by a panel of three expertise in the pediatric nursing and urology before introduce it to the participants to ensure its validity and their comments were considered. The reliability of first tool was tested giving Cronbach's  $\alpha$

of 0.93 and third tool was tested giving Cronbach's  $\alpha$  of 0.88.

### **Ethical considerations**

Ethical agreement was obtained from Research Ethics Committee at the Faculty of Nursing-Mansoura University. An official permission was obtained from the director of hospital and the head of the PICUs after explaining the study aim, study tools, duration and the benefits of the study. An oral consent was obtained from the nurses as well as the mothers of pediatric patients after explaining the purpose, the benefits and the duration of the study. They were assured about the confidentiality of the collected data. The researchers informed the nurses and mothers about their right to withdraw from the study at any time and the mothers had the right to accept or reject participation of their children without interfering with the care provided to them.

### **Pilot study**

It was done on ten percent of the studied nurses and pediatric patients (n=9 nurses and 10 children) to evaluate the feasibility, applicability and clarity of the tools, some alterations were done. Nurses and children in the pilot were not included in the study.

### **Field of work**

Data collection of the present study was conducted over duration of seven months from first of June 2020 till the end of December 2020. The researchers were available in the study setting 3days per week from 9 A.m. to 12 p.m. Data collection was carried out through 4 stages {assessment, planning, implementation & evaluation}.

### **1-Assessment stage**

#### ***Studied nurses***

Assessment of socio-demographic data of the studied pediatric nurses and their knowledge level regarding CAUTI in PICUs, Urinary catheter insertion,

maintaining & removal care guidelines {pre- posttest} was performed using tool I. The questionnaire also included a checklist to assess their practice regarding maintaining & removal care guidelines for CAUTI prevention using tool II. The researchers were available to clarify and answer any question from the studied nurses. To assess the level of nurses' practice towards CAUTI prevention guidelines, the researchers explained to the nurses that they have to be observed while performing every step of CAUTI prevention guidelines; but the strict time wasn't stated to avoid data bias.

#### ***Pediatric patients***

- Assessment of demographic characteristics and health condition of the studied pediatric patients in the case and control groups.
- The assessment of CAUTI rate was performed using tool IV, the early assessment was performed by the researcher on the first day for pediatric patients who had urinary catheter to check that they didn't have CAUTI and free from exclusion criteria.

#### **2-The planning stage**

The researchers were designed the guidelines for prevention of CAUTI after reviewing literatures (**Centers for Disease Control and Prevention, 2015**)<sup>(22)</sup>, depending on the assessment needs of the studied pediatric nurses after reviewing specific related literatures and advanced evidence-based practice guidelines for CAUTI prevention, researchers were designed the educational booklet about evidence-based guidelines for prevention of CAUTI. The content was consisted of steps of urinary catheter insertion care guidelines, urinary catheter maintenance care guidelines and urinary catheter removal care guidelines.

#### **3-The implementation stage**

##### ***Studied nurses***

As regard to the implementation of the guidelines regarding prevention of CAUTI, it was planned to be given in 4 sessions "2 theoretical and 2 practical", the time for each session was 30 to 45 minutes. According to duties schedule of the study nurses in the morning shift and afternoon shift, the researchers divided them to small groups. Every one comprising 6-8 nurses to enable group discussion using teaching media such as poster, a video, power point presentations and educational booklet. Component of the urinary catheter maintenance care guidelines include : use proper hand hygiene ,wearing gloves, appropriately secure catheter to prevent movement and urethral traction, keep a sterile closed drainage system, keep good hygiene at the catheter-urethral interface, perineal care daily and after diaper change, maintain unobstructed urine flow, keep drainage bag under level of urinary bladder at all times, removal when no longer required, don't change urinary catheters or drainage bag at fixed intervals, and remove catheter when no longer needed. Component of the urinary catheter removal care guidelines include perform hand hygiene, catheter care with warm water and soap , remove catheter securement, balloon deflation (Don't use vigorous aspirate on to prevent lumen collapse), perineal care, reposition patient to safe comfortable position, post-catheter care, and reviewing fluid intake.

The researchers were implemented of CAUTI prevention evidence-based guidelines steps for pediatric patients in case group and the studied nurses were educated by the researchers' demonstration of the practical guidelines for prevention of CAUTI and re-demonstration of these guidelines by nurses to apply it throughout the routine care for pediatric patients in case group.

### *Pediatric patients*

#### **\*For pediatric patients in case group**

The researchers and nurses were implemented of CAUTI prevention evidence-based maintaining & removal care guidelines intervention steps for pediatric patients for 7 days (average duration of urinary catheter) or until urinary catheter removal.

Each pediatric patient was observed for signs and symptoms of CAUTI using catheter-associated urinary tract infection criteria checklist tool IV.

#### **\*For Pediatric patients in control group**

They were received routine care for urinary catheter care according to policy of PICUs.

#### **4- Evaluation stage.**

##### *Studied nurses*

Knowledge and practices of the studied nurses were evaluated by the researchers, pre and after implementation of CAUTI prevention evidence-based guidelines using the previous stated study tools (I& II).

##### *Pediatric patients*

- Evaluation of the health condition of the pediatric patients regarding CAUTI rate were done on seventh day using catheter-associated urinary tract infection criteria checklist tool to follow up CAUTI occurrence among pediatric patients in both groups.
- The urine specimen is sent to the laboratory for urine culture investigation for both groups.
- Comparison between the case and control group's outcome was performed to evaluate the effect of the evidence-based guidelines for prevention of CAUTI on occurrence of CAUTI among the studied pediatric patients using tool IV.

### **Statistical Analysis:**

The collected data were coded and transformed to the statistical package of social sciences (SPSS) version 20. Qualitative data was presented as number and percent. Quantitative data were described as mean (SD) or medians (Range). The Chi-Square and Monte Carlo tests were used for comparison between groups. Data were tested for normality by Kolmogorov-Smirnov test. Wilcoxon signed rank test was utilized for comparing between both groups mean ranks. All tests were performed at a level of significance (P-value) equal or less than 0.05 was considered to be statistically significant.

### **RESULTS:**

**Table (1):** Presented socio-demographic characteristics of studied pediatric nurses. The mean age of studied nurses was  $29.16 \pm 5.51$  years. Regarding gender (92.9%) of studied nurses were females. more than half (57.1%) of studied nurses had nursing technical Institute while less than half (42.9%) of them had a bachelor degree of nursing. More than one third (36.9%) of nurses had experience less than 5 years. In addition, the majority (83.3%) of them didn't receive any courses or workshops about CAUTI prevention guidelines.

**Table (2):** Showed distribution of studied nurses' knowledge categories score about urinary catheter and CAUTI prevention Guidelines in PICU before and after intervention with evidence-based guidelines. It was found that level of nurses' knowledge about CAUTI prevention guidelines in PICU was generally improved with highly statistically significant differences (P value  $< 0.001$ ) post intervention, regarding urinary catheter, CAUTI and its prevention in PICU, CAUTI prevention in PICU regarding urinary catheter insertion care guidelines, urinary catheter maintenance care guidelines and urinary catheter removal care guidelines.

**Figure (1):** Presented the total score of studied PICU nurses' knowledge level before and after intervention with evidence-based guidelines. It was showed that nurses' knowledge was generally improved with highly statistically significant differences (P value <0.001).

**Table (3):** Illustrated the distribution of the studied nurses' observed practices categories score about urinary catheter and CAUTI prevention in PICU before & after intervention with evidence-based guidelines. It was observed that level of nurses' practices about CAUTI prevention guidelines in PICU were improved with highly statistically significant differences (P value <0.001), regarding, urinary catheter maintenance care guidelines which includes (nurses practice about routinely assess of IUC appropriateness & care before IUC maintenance, urinary catheter maintenance care guidelines and urine specimen collection), and urinary catheter removal care guidelines.

**Figure (2):** Showed the total score of studied PICU nurses' observed practice level before and after intervention with evidence-based guidelines. It was observed that level of nurses' practices was improved with highly statistically significant differences (P value <0.001).

**Table (4):** Clarified the correlation between the total PICU nurses' knowledge and observed practices score before and after intervention with evidence-based guidelines. It was obvious that, there was a significant positive relation between total PICU nurses' knowledge and practices score pre and immediately post intervention with a highly statistically significant differences at  $p < 0.001$ .

**Table (5):** Showed the distribution of the socio-demographic characteristics and clinical data of pediatric patients in case and control groups, it is

obvious that, the mean age of children was ( $3.04 \pm 1.69$  &  $4.22 \pm 2.92$ ) respectively in case and control groups and more than two third of them (68.6% & 72.5%) respectively were boys in both groups. Regarding diagnosis, it was clear from this table that the majority (82.4% & 80.4 % respectively) of children in both groups had renal problems and about one third (29.4% & 35.3% respectively) of them in both groups have neurological problem. In relation to indication for insertion of urinary catheter, it was obvious that, about two thirds (58.8% & 68.6% respectively) of children in both groups had urinary catheter for intake & output calculation and about two thirds (58.8% & 66.7% respectively) of them in both groups had urinary catheter for duration  $\geq 7$  days with mean ( $5.47 \pm 2.08$  &  $5.39 \pm 2.33$  respectively) in both groups.

**Table (6):** Clarified the comparison of the symptoms and signs suggesting CAUTI in children in both case and control groups post intervention with evidence-based guidelines, it was clear from this table that positive symptoms and signs suggesting CAUTI were more evident in control group compared to less evident in case group with significant difference (P <0.05 & P <0.001), except in hematuria and cloudy urine in both groups with no-significant difference ( $p > 0.05$ ). Regarding urine culture, it was clear that one third (33.3%) of pediatric patient in case group had positive urine culture, versus to about two thirds (64.7%) in the control group. with significant difference (P <0.05) between both groups post intervention.

**Figure 3:** presents comparison between case and control groups regarding occurrence of clinical CAUTI post-intervention with evidence-based guidelines, it was obvious that more about two thirds (64.7%) of pediatric patient in control group had CAUTI compared with one third (33.3%) of pediatric patient in case



group had CAUTI, with significant difference ( $P < 0.05$ ) between both groups post intervention

**Table (7):** Showed correlation between the total post PICU nurses' knowledge and observed practices score about CAUTI and its prevention guidelines and occurrence of CAUTI in case group, it was clear that there was a negative significant correlation between nurses' observed practices score and presence of CAUTI in case group ( $P < 0.05$ ).

**Table (8):** Clarified association between clinical data of the studied pediatric patients and occurrence of CAUTI post – intervention with evidence- based guidelines, it was clear that there was a statistically significant difference with strong association between indication for insertion of urinary catheter including intake & output calculation, renal problems, and duration of urinary catheter and occurrence of CAUTI in Both groups ( $P < 0.05$ ) post intervention.

**Table (1): Distribution of Socio-Demographic Characteristics of the Studied Pediatric Nurses:**

Nurses' Socio-demographic characteristics		N=84	
		No.	%
Age	<20ys	5	6
	20-<30ys	41	48.8
	30-<40ys	38	45.2
	Mean ± SD =	29.16±5.51	
Gender	Male	6	7.1
	Female	78	92.9
Educational level	Nursing technical Institute	48	57.1
	Bachelor degree	36	42.9
Years of experience	<5ys	31	36.9
	5-<10ys	25	29.8
	10-<15ys	28	33.3
	Mean ± SD =	7.19±3.79	
Previous attendance of courses or workshops about CAUTI prevention guidelines	Yes	14	16.7
	No	70	83.3

**Answer Hypothesis one:**

The score of mean knowledge and practices of the pediatric nurses will be improved after implementation of evidence-based guidelines.

**Table (2): Distribution of the Studied Nurses' Knowledge Categories Score about Urinary Catheter and CAUTI Prevention Guidelines in PICU before and after Intervention with Evidence- based Guidelines**

Knowledge categories	Numbers of nurses = 84				Significance test	
	Pre-intervention No=84		Post-intervention No=84			
	No.	%	No.	%	Z	P
<b>Nurses' knowledge about urinary catheter</b>						
Unsatisfactory knowledge	68	81	2	2.4	7.92	0.000**
Satisfactory knowledge	16	19	82	97.6		
<b>Median (Range)</b>	3 (6)		7(3)			
<b>Nurses' knowledge about CAUTI and its prevention in PICU</b>						
Unsatisfactory knowledge	79	94	6	7.1	7.99	0.000**
Satisfactory knowledge	5	6	78	92.9		
<b>Median (Range)</b>	2(6)		7(4)			
<b>CAUTI prevention in PICU regarding urinary catheter insertion care guidelines</b>						
Unsatisfactory knowledge	78	92.9	1	1.2	7.91	0.000**
Satisfactory knowledge	6	7.1	83	98.8		
<b>Median (Range)</b>	7.5(13)		15(11)			
<b>CAUTI prevention in PICU regarding urinary catheter maintenance care guidelines</b>						
Unsatisfactory knowledge	65	77.4	2	2.4	7.90	0.000**
Satisfactory knowledge	19	22.6	82	97.6		
<b>Median (Range)</b>	8.5(16)		17(9)			
<b>CAUTI prevention in PICU regarding urinary catheter removal care guidelines</b>						
Unsatisfactory knowledge	69	82.1	1	1.2	7.69	0.000**
Satisfactory knowledge	15	17.9	83	98.8		
<b>Median (Range)</b>	5(12)		12(5)			
<b>Total Nurses' knowledge score</b>						
Unsatisfactory knowledge	80	95.2	1	1.2	7.96	0.000**
Satisfactory knowledge	4	4.8	83	98.8		
<b>Median (Range)</b>	26.5(40)		58(32)			

Unsatisfactory knowledge :< 75%, Satisfactory knowledge: ≥75%, Z: Wilcoxon signed rank test

(\*) Statistically significant at  $p \leq 0.05$ , (\*\*) Highly statistically significant  $P < 0.001$ .

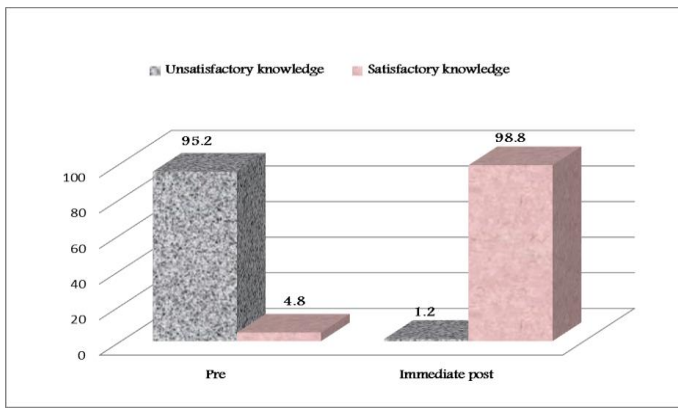


Figure (1): The Total Score of Studied PICU Nurses' Knowledge Level before and after Intervention with Evidence- based Guidelines (N=84)

Table (3): Distribution of the Studied Nurses' Observed Practices Categories Score about Urinary Catheter and CAUTI Prevention in PICU before and after Intervention with Evidence- based Guidelines

Practice categories	Numbers of nurses = 84					
	Pre-intervention N=84		Post-intervention N=84		Significance test	
	No.	%	No.	%	Z	P
<b>A- Routinely assess of IUC appropriateness &amp; care before IUC maintenance</b>						
Incompetent practice	64	76.2	1	1.2	7.77	0.000**
Competent practice	20	23.8	83	98.8		
<b>Median (Range)</b>	3(4)		6(2)			
<b>B-Maintenance evidence- based guidelines of IUC</b>						
Incompetent practice	63	75	1	1.2	7.72	0.000**
Competent practice	21	25	83	98.8		
<b>Median (Range)</b>	16(22)		30(14)			
<b>C- Urine specimen collection</b>						
Incompetent practice	58	69	2	2.4	7.71	0.000**
Competent practice	26	31	82	97.6		
<b>Median (Range)</b>	4(6)		8(4)			
<b>Total urinary catheter maintenance care evidence- based guidelines</b>						
Incompetent practice	79	94	2	2.4	7.67	0.000**
Competent practice	5	6	82	97.6		
<b>Median (Range)</b>	20(28)		38(15)			
<b>Total urinary catheter removal care evidence- based guidelines</b>						
Incompetent practice	61	72.6	2	2.4	7.72	0.000**
Competent practice	23	27.4	82	97.6		
<b>Median (Range)</b>	12(16)		24(12)			
<b>Total practice score</b>						
Incompetent practice	79	94	2	2.4	7.75	0.000**
Competent practice	5	6	82	97.6		
<b>Median (Range)</b>	33.5(42)		62(27)			

Incompetent practice : < 80%, Competent practice: ≥80%, Z: Wilcoxon signed rank test,

(\*) Statistically significant at  $p \leq 0.05$ , (\*\*) Highly statistically significant  $P < 0.001$ .

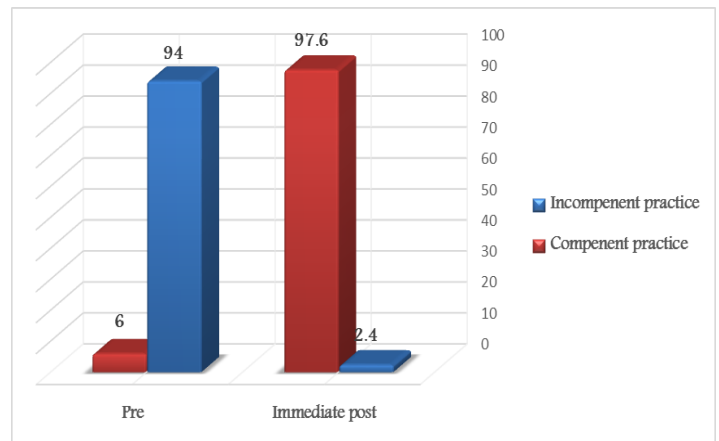


Figure (2): The Total Score of Studied PICU Nurses' Observed Practice Level Pre and Post- Intervention with Evidence- based Guidelines (N=84)

Table (4): Correlation Between the Total PICU Nurses' Knowledge and Observed Practice Score before and after Intervention with Evidence-based Guidelines

Item	Total nurses' knowledge score			
	Pre- intervention No=84		Immediate post intervention No=84	
	r	P	r	P
Total nurses' observed practice score	0.889	0.000**	0.703	0.000**

\*Correlation is significant at the  $\leq 0.05$  level.

\*\*Correlation is significant at the 0.01 level

Table(5): Distribution of the Socio-demographic Characteristics and Clinical Data of Pediatric Patients in Case and Control Groups (N= 102)

Items	Total number =102					
	Case N=(51)		Control N= (51)		Total N= (102)	
	No.	%	No.	%	No.	%
<b>Age</b>						
≤1y	7	13.7	7	13.7	14	13.7
1-<6ys	41	80.4	31	60.8	72	70.6
6 ≤12ys	3	5.9	13	25.5	16	15.7
<b>Mean ±SD</b>	3.04±1.69		4.22±2.92		3.63±2.44	
<b>Gender</b>						
Girl	16	31.4	14	27.5	30	29.4
Boy	35	68.6	37	72.5	72	70.6
<b>Diagnosis*</b>						
Cardiac problem	3	5.9	2	3.9	5	4.9
Respiratory problem	8	15.7	7	13.7	15	14.7
Neurological problem	15	29.4	18	35.3	33	32.4
CNS infection	7	13.7	8	15.7	15	14.7
Renal problems	42	82.4	41	80.4	83	81.4
Sepsis	3	5.9	4	7.8	7	6.9
<b>Indication for insertion of urinary catheter*</b>						
Intake &Output calculation	30	58.8	35	68.6	65	63.7

Urine retention	23	45.1	23	45.1	46	45.1
Post-Operative	18	35.3	17	33.3	35	34.3
Renal problems	17	33.3	22	43.1	39	38.2
<b>Duration of urinary catheter (Days)</b>						
1-3	12	23.6	16	31.4	28	27.5
4-6	9	17.6	1	1.9	10	9.8
≥ 7	30	<b>58.8</b>	34	<b>66.7</b>	64	62.7
<b>Mean ±SD</b>	<b>5.47±2.08</b>		<b>5.39±2.33</b>		5.43±2.20	

\*Multiple response questions

**Answer hypotheses two:**

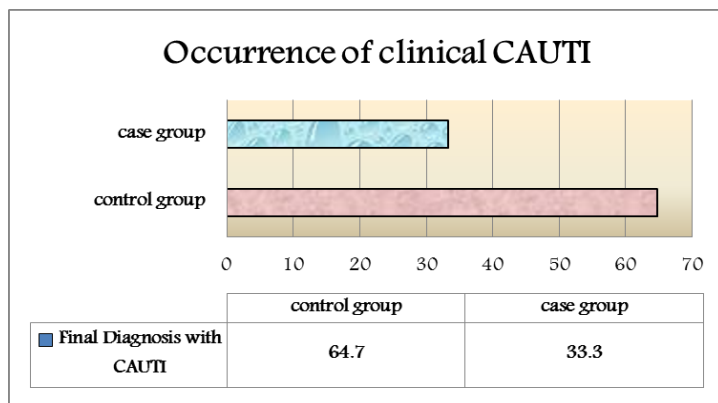
The incidence of catheter associated urinary tract infection will be reduced among pediatric patients in case group who received evidence-based guidelines.

**Table (6): Comparison of the Symptoms and Signs Suggesting CAUTI in Children in Both Case & Control Groups Post Intervention with Evidence-based Guidelines (N= 102)**

Symptoms & Signs of CAUTI*	Total number=102				Significance test (Chi square test)
	Case group N=(51)		Control group N=(51)		
	No.	%	No.	%	P-value
Fever (>38.0°C)	8	15.7	20	39.2	<b>0.014*</b>
Hematuria	13	25.5	11	21.6	0.641
urinary Frequency	15	29.4	28	54.9	<b>0.009*</b>
Dysuria	9	17.6	23	45.1	<b>0.003*</b>
Bradycardia	8	15.7	17	33.3	<b>0.038*</b>
Abdominal Pain	8	15.7	20	39.2	<b>0.008*</b>
Offensive smelling Urine	28	54.9	38	74.5	<b>0.038*</b>
Cloudy Urine	36	70.6	39	76.5	0.501
Vomiting	10	19.6	19	37.3	<b>0.048*</b>
Suprapubic or Costovertebral angle tenderness	13	25.5	31	60.8	<b>0.000**</b>
<b>Urine culture</b> -Positive (a bacterium of ≥10 <sup>5</sup> CFU/ml)	17	<b>33.3</b>	33	<b>64.7</b>	<b>0.002*</b>
	34	66.7	18	35.3	
-Negative					
<b>Occurrence of clinical CAUTI</b>	17	33.3	33	64.7	<b>0.002*</b>

\*Multiple response questions

(\*) Statistically significant at  $p \leq 0.05$ , (\*\*) Highly statistically significant  $P < 0.001$ .



**Figure (3): Comparison Between Case and Control Group Regarding Occurrence of Clinical CAUTI Post-Intervention with Evidence-based Guidelines**

**Table (7): Correlation Between the Total Post PICU Nurses' Knowledge and Observed Practices Score about CAUTI and its Prevention Guidelines and Occurrence of CAUTI in Case Group**

Items	N=84			
	Total nurses' knowledge score		Total nurses' observed practice score	
	r	P	r	P
Occurrence of CAUTI in Case group	-0.100	0.485	-0.286	<b>0.042*</b>

\*Correlation is significant at the  $\leq 0.05$  level.

**Table (8): Association Between Clinical Data of the Studied Pediatric Patients and Occurrence of CAUTI Post-Intervention with Evidence-based Guidelines (N= 102)**

Clinical data	Occurrence of CAUTI			
	Case N=(51)		Control N=( 51)	
	$\chi^2$	P	$\chi^2$	P
<b>Indication for insertion of urinary catheter</b>				
Intake &Output calculation	4.126	<b>0.042*</b>	2.914	<b>0.088*</b>
Urine retention	0.433	0.510	0.158	0.691
Post-Operative	0.688	0.407	0.176	0.674
Renal problems	13.26	<b>0.001*</b>	7.834	<b>0.005*</b>
<b>Duration of urinary catheter (Days)</b>	MC	<b>0.001*</b>	MC	<b>0.013*</b>

(\*) Statistically significant at  $p \leq 0.05$

$\chi^2$  = chi square, MC: Monte Carlo test.

**DISCUSSION**

The presence of a urinary catheter and the length of time a catheter left in place are the 2 most common significant risk factors for CAUTI. Unfortunately, adequate attention isn't paid to the need of inserting a

urinary catheter or to remove it when it's no longer required. Adverse effects associated with indwelling urinary catheters include increases in length of hospital stay (LOS), health care costs, morbidity and mortality in hospitalized pediatric patients. <sup>(25,26)</sup> The National Healthcare Safety Network revealed that pooled mean CAUTI rates were similar in children and adults, the national pooled mean for pediatric intensive care units (PICUs) was 2.5 infections per 1000 catheter-days. Daily infection control guidelines are simple and effective for decreasing CAUTI and enhancing pediatric patient outcomes. <sup>(16)</sup> So, this study was aimed to examine the effectiveness of evidence-based guidelines on catheter associated urinary tract infection rate among pediatric intensive care children.

The results of the present study revealed that the mean age of the studied pediatric nurses was  $29.16 \pm 5.51$ . This result was consistent with <sup>(27)</sup> who found that the mean age of nurses was  $30.20 \pm 4.763$ .

Regarding the gender, the majority of the studied pediatric nurses were females and more than one third of them had experience less than 5 years, finally, majority of them had not previous attendance of courses or workshops about CAUTI prevention guidelines. This finding was supported by <sup>(28)</sup> who found that the majority of nurses were females. Also, this result similar to finding of <sup>(29)</sup> who mentioned that the majority of participants were female nurses compared to males and about one third of them had experience less than 5 years, as well as the majority of respondents were not received any form of infection control training. In relation to the nurses' educational level, the result of this study showed that more than half of studied pediatric nurses had nursing technical Institute. These results were inconsistent with <sup>(30)</sup> who found the majority of nurses were bachelors' degree holder.

Regarding the nurses' knowledge categories score about urinary catheter and CAUTI prevention guidelines in PICU before and after intervention with evidence-based guidelines, the result of the present study showed that level of nurses' knowledge about CAUTI prevention guidelines in PICU was generally improved after intervention compared to pre intervention with highly statistically significant differences. This might be attributed to the effect of the intervention sessions implementation on improving the nurses' knowledge and awareness. The results were consistent with the results conducted by <sup>(31)</sup> who mentioned that nurses had insufficient knowledge level regarding urinary catheter care, the urinary catheterization, the use of drainage bags before interventions, which improved to an excellent level after intervention. Regarding proper techniques to insert the UC, results of this study revealed that all respondents were found to have good knowledge about CAUTI after implementation of evidence-based guidelines which consistent with <sup>(32)</sup> who found that nurses had a good knowledge about CAUTI after program implementation.

Concerning the nurses' observed practices categories score about urinary catheter and CAUTI prevention in PICU before and after intervention with evidence-based guidelines, the finding of this study was found that level of nurses' practices about CAUTI prevention in PICU were improved after intervention with highly statistically significant differences. This might be attributed to implementation of intervention with evidence-based guidelines about CAUTI prevention for nurses resulting in improving in their practice level. This result was supported by the study conducted by <sup>(33)</sup> who found that most of nurses were know basic CAUTI preventive measures after interventions, include proper indications, proper hand

washing before and after catheter insertion, wearing gloves and keep the catheter free from kinking and clean the perineal area daily to prevent CAUTI. Also, this result was congruent with <sup>(34)</sup> who mentioned that majority of all respondents know and have satisfactory practice level after intervention regarding effective measures to decrease CAUTI rates in intensive care units.

Regarding correlation between total PICU nurses' knowledge and observed practices score regarding urinary catheter and CAUTI and its prevention in PICU before and after intervention with evidence-based guidelines. The results of the current study were illustrated that, there was a significant positive correlation between total PICU nurses' knowledge score and practices score pre and immediately post intervention implementation with highly statistically significant differences. This could be due to the nurses' knowledge was increased and enhance their compliance after implementation of the educational intervention, thereby improve the nurses' practice level. This result finding was supported by <sup>(35)</sup> who found that there was an improvement in participants' clinical knowledge regarding CAUTI prevention and an improvement in proper Foley catheter maintenance practices with strong relationship between nurses' knowledge and practices. Also, these results congruent with <sup>(10)</sup> who stated that nurses need to be informed with advanced urinary catheter care guidelines in order to enhance their knowledge, practices and attitude related to urinary catheter care. On the other hand, these results were inconsistent with the study conducted by <sup>(36)</sup> who found that there wasn't significant relation between nurses' knowledge and practices about CAUTI prevention.

Regarding the socio-demographic characteristics and clinical data of pediatric patients in case and

control groups, the results of current study was revealed that, the mean age of children was ( $3.04 \pm 1.69$  &  $4.22 \pm 2.92$ ) respectively in both groups and more than two thirds of them were boys in both groups, also, the results of the current study showed that the mean of duration of urinary catheter were ( $5.47 \pm 2.08$  &  $5.39 \pm 2.33$  respectively) in both groups. This could be attributed to majority of pediatric patients in current study have renal problems in both groups and need for insertion of urinary catheter for intake & output calculation for more than one week. These findings were inconsistent with <sup>(37)</sup> who found that the minority of pediatric patients in PICU were boys and the median age was 11 months, as well as the median duration of urinary catheterization was seven days (range, 5-12 days), this long duration of urinary catheterization might be increased the risk of CAUTI by 5% every day at the PICU.

Concerning the diagnosis of pediatric patient, the present study was showed that, most of pediatric patients had renal problems in both groups and in relation to indication of urinary catheter insertion, about two thirds of them had urinary catheter for intake & output calculation. This could be due to the majority of pediatric patients who had renal problems may need insertion of urinary catheter for intake & output calculation. These results were congruent with <sup>(38)</sup> who found that the acute kidney injury being the greatest factor independently associated with CAUTIs among pediatric patients in cardiac ICU.

Regarding the comparison of the symptoms and signs suggesting CAUTI in children in both case and control groups post intervention with evidence-based guidelines. The current study findings were illustrated that the positive symptoms and signs suggesting CAUTI were highest percent in control group compared to lowest percent in case group with

significant difference. This could be due to positive effect of intervention with evidence- based guidelines on pediatric patients in case group which lead to decrease the CAUTI rate among pediatric patients in case group. These results were consistent with <sup>(39)</sup> who stated that, urinary tract infection was suspected when a pediatric patients had urinary catheter for more than two days with at least one of the following symptoms or signs [hyperthermia, hypothermia, bradycardia, apnea, vomiting, dysuria, lethargy and a positive urine culture with no more than two kinds of microorganisms].

Regarding urine culture, the results of current study were showed that one third of pediatric patients in case group had positive urine culture, versus to about two thirds in the control group, with significant difference, this could be reflect the effect of proper intervention on CAUTI rate among pediatric patients in case group, as well as the most common CAUTI criterion was positive urine culture. This finding was supported by <sup>(26)</sup> who found that the pediatric patients with CAUTI (51 child with CAUTI episodes) in his study had a microbiological diagnosis. Merely 46 patients had one organism was isolated from urine culture, while the remaining five patients had 2 organisms isolated. Also, these results were in line with <sup>(37)</sup> who mentioned that CAUTI was suspected when a pediatric patient had the urinary catheter for more two days with at least one of the next symptoms or signs [hyperthermia, hypothermia, dysuria, apnea, bradycardia, lethargy, vomiting, and a positive urine culture with no more than 2 kinds of microorganisms].

Regarding comparison between case and control groups regarding of occurrence of clinical CAUTI post intervention with evidence- based guidelines. The findings of current study found that two thirds of pediatric patients in control group had CAUTI

compared with one third of pediatric patients in case group had CAUTI. This could be due to the effect of evidence- based guidelines on the knowledge & practices of pediatric nurses, thereby they implement it for pediatric patients with urinary catheter in case group throughout the day resulting in reducing the rate of CAUTI. These results were congruent with <sup>(40)</sup> who found that CAUTI occurred in ten pediatric patients in PICU before bundle care and 6 patients after bundle implementation, there was a statistically significant difference between pre bundle and post bundle CAUTI rates. Also, these results supported by <sup>(41)</sup> who found that an early and continued improvement in CAUTI prevention principles compliance from minority to majority enhancement in pediatric cardiac ICU after intervention. These interventions revealed a decrease and then eradication of CAUTI. As well as <sup>(25)</sup> who concluded that, after the implementation of the pediatric CAUTI insertion and maintenance bundles care, CAUTI rates reduced among hospitalized children with indwelling urinary catheters after intervention.

Concerning correlation between the total post PICU nurses' knowledge, observed practices score about CAUTI and its prevention guidelines and occurrence of CAUTI in case group. The results of the current study revealed that, there was negative correlation between nurses' observed practices score and presence of CAUTI in case group, which mean that, when nurses' practice level was improved, the occurrence of CAUTI was reduced. This could be due to improvement of the nurses' performance level regarding CAUTI prevention guidelines, as continues implementation of these guidelines reducing the occurrence of CAUTI in case group. These findings were consistent with <sup>(42)</sup> who concluded that most of CAUTI was prevented when nurses had satisfactory preventive guidelines, these findings were supported by

<sup>(2)</sup> who found that preventive procedures such as removing the urinary catheter once it was not needed and accordingly lead to reduced rates of CAUTI. and accordingly lead to reduced rates of CAUTI.

In relation to association between clinical data of the studied pediatric patients and occurrence of CAUTI post intervention with evidence-based guidelines. The results of the current study showed that, there was a statistically significant difference with strong association between indication of urinary catheter insertion, including intake & output calculation, renal problems and duration of urinary catheter in both groups and presence of CAUTI. This means that the long duration of catheter more than 7 days permitting continuous entrance of microorganisms into the urethra and urinary bladder considered the main predisposing factors for occurrence of CAUTI, also, the pediatric patients with renal problems need intake & output calculation for long period to assess the renal function and health status of pediatric patients. These results were consisted with <sup>(43)</sup> who found that their strong association between the long period of urinary catheterization for "7-14 days" and high incidence of CAUTIs. Also, these results were supported by <sup>(44)</sup> who stated that short duration of catheterization has been associated with a 50% reduction in CAUTI in hospitals; these findings support the suggested study hypotheses.

### Conclusions

- The implementation of intervention with evidence-based guidelines about CAUTI prevention for pediatric patients have urinary catheter had positive significant enhancement on CAUTI prevention.
- There was significant reduction in CAUTI rates, through implementation of intervention with evidence-based guidelines about CAUTI prevention.

- Pediatric nurses' knowledge and practices relating CAUTI and its prevention in PICUs were improved after the implementation of the intervention with evidence-based guidelines immediately post intervention than pre implementation of the evidence-based guidelines that improve quality of nursing care provided for pediatric patients in PICUs.

### Recommendations

1. There is a requisite to educate the pediatric nurse to avoid routinely use of urinary catheters for pediatric patients and remove them when they are no longer required.
2. Use of evidence-based guidelines checklists for insertion, maintenance and removal of urinary catheter, should be kept in the pediatric patients file, that should be reviewed regularly by nurses.
3. Further researches are needed to be done on the other aspects of the infection prevention guidelines in different settings.

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### Conflict of Interests

The authors declare that there are no conflicts of interests.

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