

# Impact of Educational Guidelines about Prevention of Pressure Injuries among Infants in Intensive Care Unit

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## Abstract

Most pressure injuries are preventable. Nurses have an essential role in their prevention, but they need to acquire related evidence-based knowledge and skills. The study aim was to evaluate the effectiveness of educational guidelines for pediatric nurses on the prevention of pressure injury among infants in intensive care unit (ICU). The study was carried out in the pediatric intensive care unit (PICU) at El-Monira Pediatric Hospital, affiliated to Cairo University hospitals using quasi-experimental one-group design with pre-post evaluation. It involved 50 pediatric nurses and 50 infants under their care. Infants were 1-12 months old, newly admitted in PICU, and connected to a mechanical ventilator. A self-administered questionnaire was used for nurse's knowledge, an observation checklist for practice, and the Glamorgan Pressure Injury Risk Assessment Scale. The researcher developed the educational guidelines based on assessment information and pertinent literature, and implemented it in small group sessions, and its effects evaluated immediately after, and one-month later. Two-thirds of the infants (64%) were not at risk of pressure injury at the admission and first follow-up days. This was reduced to 56% on day 4. Nurses' knowledge was deficient in all aspects. In total, only one (2.0%) nurse had satisfactory knowledge before the intervention; this increased to 92.0% at the post-intervention phase, and 78% at follow-up ( $p < 0.001$ ). Moreover, none of the nurses had had adequate total practice before the intervention; this rose to 74.0% at the post-intervention and follow-up phases ( $p < 0.001$ ). In multivariate analysis, the intervention was a significant positive predictor of nurses' knowledge and practice scores. A higher admission risk score was a protective factor with Odds Ratio (OR) 0.87 for the incidence of pressure injuries, while a higher injury risk score on day 3 was a significant risk factor with OR 1.20. Thus, nurses in PICUs can gain evidence-based knowledge and skills related to pressure injury prevention through simple educational guidelines associated with practical training.

**Keywords:** Educational guidelines; Pressure injuries; Pediatric Intensive Care Unit;

## Introduction

A pressure injury (PI) is localized damage to skin and underlying soft tissues due to intense and/or prolonged pressure or pressure with shear [1]. The term was introduced by the National Pressure Injury Advisory Panel 2016 [2] to replace pressure ulcer. They are mostly related to medical devices or immobility pressure [3]. Pressure injuries are classified according to the extent and depth of skin and soft tissue damage [4].

Pressure injuries are less studied in infants and children. Their skin is exponentially vulnerable to damage because of the immature collagen structures within the epidermis [5]. The reported incidence in critically ill infants and children is 26.7% to 27.0% [6, 7]. Thus, PICUs have the highest rates of pressure injuries, and these usually occur within 2 days of admission. The greatest risk factors in PICUs include assisted ventilation, four or more days of PICU stay, weight loss, immobility, and nutritional deficits. However, although a number of risk factors were identified in pediatric population, no true risk factors that can be modified or reduced were put in evidence [8].

Most pressure injuries are preventable. Effective preventive

measures involve padding and careful positioning and fixation of medical devices attached to patient, along with regular full skin assessment, in addition to the use of pressure relieving devices [2], and management of the pertinent risk factors as poor skin condition and poor nutritional status [9, 10]. Nevertheless, the implementation of preventive nursing interventions for pressure ulcers in infants and children needs improvement, and more research is needed in this area [11, 12].

Although the prevention of pressure injury is a multidisciplinary approach, nurses have an essential role in it through regular and thorough assessment and continuous patient care [13, 14]. This necessitates that nurses acquire related evidence-based knowledge and skills. Thus, nurse need training in related evidence-based practices through evidence-linked educational programs focused on the pediatric population [15, 16]. This study is an attempt to provide such training to intensive care pediatric nurses in the study setting.

## Aim of the study

The study aim was to evaluate the effectiveness of educational guidelines for pediatric nurses on the prevention of pressure inju-

ry among infants in intensive care unit (ICU). It was hypothesized that the knowledge practice of the pediatric nurses who receive the educational guidelines will demonstrate significant improvements at the post- intervention and follow-up phases. This will have a positive impact on the incidence of pressure injury among infants under their care.

## **Subjects and Methods**

### **Research design and setting**

A quasi-experimental one-group design with pre-post evaluation was used in this study, which was carried out in the pediatric intensive care unit (PICU) at El-Monira Pediatric Hospital, affiliated to Cairo University hospitals. It is the largest hospital for children in Egypt, and it provides its services free of charge.

### **Subjects**

A non-probability purposive sample of 50 pediatric nurses and 50 infants in the study setting were included in the study sample. The only inclusion criterion for nurses was providing direct care to the infants. Those who had previously attended similar educational guidelines were excluded. The inclusion criteria for infants were being 1-12 months old, newly admitted in PICU, and connected to a mechanical ventilator. The sample size was calculated to demonstrate an expected improvement in nurses' percentages of satisfactory knowledge or adequate performance from 50% before the intervention to 80% after the intervention at 95% level of confidence and 80% study power using the Open Epi software package, with compensation for 10% dropout.

### **Data collection tools**

The researcher used a self-administered questionnaire for nurse's knowledge, an observation checklist for practice, and the pressure injury assessment scale. The knowledge questionnaire was developed by the researcher based on relevant literature [2]. It included questions about pressure injury definition, causes, symptoms, signs, prevention, sites, phases, phase 1, complications, and foot protection. It was appended with a section for nurse's personal data such as age, gender, qualification, and years of experience. For scoring, a correct response was scored 1 and the incorrect zero. For each area of knowledge, the scores of the items were summed-up and the total divided by the number of the items, giving a mean score for the part. These scores were converted into percent scores. Knowledge was considered satisfactory if the percent score was 60% or more and unsatisfactory if less than 60%.

The observation checklist for skin care practice was adopted from Wilson and Hockenberry [17]. It consists of 20 steps such as keeping skin free of moisture, providing daily cleaning, reducing skin friction, etc. Each step was to be checked as "done" or "not done," scored one and zero respectively. The scores of the 20 steps were summed-up and converted into a percent score. The nurse was considered as having adequate skin care practice if the

total was 60% or higher and inadequate if less than 60%. The tool also had infant's identification data such as age, gender, as well as nurse's identification data.

The Glamorgan Pressure Injury Risk Assessment Scale was developed by Willock et al to predict the risk for pressure injury development [18]. The scale assesses two risk factors, namely mobility (0-20 points) and equipment (15 points). The total score is categorized by risk level as following: 0-<10 indicates not at risk, 10-<15 at risk, 15-<20 high risk, 20+ very high risk. The tool was appended with a section for infant's data such as age, gender, consciousness level, as well as the number of days in the PICU and on mechanical ventilation.

### **Tools validity**

The tools were thoroughly reviewed by two experts in pediatric nursing and one in pediatric medicine for face and content validation. As per their opinions, no modifications were required. The Glamorgan scale has been previously shown to have high validity and reliability [19, 20].

### **Pilot Study**

A pilot study was carried out on 5 nurses and 5 infants representing 10% of the total sample to test the study tools in terms of clarity, applicability and time required to be filled out. Since no modifications were required, these subjects were included in the main study sample.

### **Procedure**

Upon obtaining official permissions, the study was implemented in assessment, planning, implementation, and evaluation phases.

### **Assessment phase**

The researcher met with the pediatric nurses and infants' parents for a clear and simple explanation of the aim and nature of the study. Those who gave their consent and fulfilled the eligibility criteria were recruited in the study sample. For the nurses, they were handed the knowledge questionnaire and instructed in how to fill it. It took around 30 minutes to complete the questionnaire and this constituted the knowledge pretest. Then, each nurse was observed by the researcher while providing care for the infant. This was done using the observation checklist, and the technique of participant observation to preclude any observer bias.

### **Planning phase**

During this phase, the researcher developed the educational guidelines based on assessment information and pertinent literature [2]. An illustrated booklet was prepared in simple Arabic language covering knowledge about the definition of pressure injury, its causes, manifestations, phases, complications, preventive measures and nursing care.

**Implementation phase**

The guidelines were explained to nurses in small group (around seven nurses) sessions. This took about one-hour. They were provided with the booklet and guidelines and given the opportunity to study and assimilate the guidelines. The researcher explained the steps of skin care to participants using demonstration re-demonstration using a small doll. This was repeated out by each nurse individually on the doll, with feedback about her/his practice.

**Evaluation phase**

The effect of the guidelines on nurses’ knowledge and practice was assessed immediately after the implementation phase (post-intervention test), as well as one-month later (follow-up test). These were done using the knowledge questionnaire and the observation checklist. Moreover, the infants were assessed four times using the Glamorgan assessment scale. This was done four times after implementation of the guidelines: upon admission, and at the first and second days after admission, and the fourth time before discharge. The fieldwork was carried out from the beginning of January to the end of May 2016.

**Ethical considerations**

Ethical approval of the study protocol was obtained from the research ethics committee of the Faculty of Nursing, Cairo University. Informed consents were signed by nurses and parents after being informed about their rights to refuse and/or withdraw at any time without providing a reason and without any effect on the infant routine care. Participants were reassured that their information would remain confidential. Permission was obtained by the researcher from the author to use the Adapted Glamorgan pressure injury risk assessment scale.

**Statistical analysis**

Data entry and statistical analysis were done using SPSS 20.0 statistical software package. Descriptive statistics included frequencies and percentages for qualitative variables, and means and standard deviations and medians for quantitative ones. In order to identify the independent predictors of nurses’ knowledge and performance scores, multiple linear regression analysis was used and analysis of variance for the full regression models was done. To identify the independent predictors of the risk of pressure injury, multiple logistic regression analysis was used.

**Results**

The sample of nurses had their age ranging between 26 and 39, with median 30.5 years, with a majority of females (84.0%), with diploma degree (84.0%) as illustrated in Table 1. Their experience ranged between 2 and 15 years, with median 10.0 years.

As for infants, Table 2 shows that their age ranged between one and eight months, median 1.0 month, with slightly more males (58%). Their duration of ICU stay ranged between 5 and

**Table 1:** Socio-demographic characteristics of nurses in the study sample (n=50)

Characteristic of nurses	Frequency	Percent
<b>Age:</b>		
<30	17	34.0
30+	33	66.0
Range	26.0-39.0	
Mean±SD	31.2±3.4	
Median	30.5	
<b>Gender:</b>		
Male	8	16.0
Female	42	84.0
<b>Nursing qualification:</b>		
Diploma	42	84.0
Bachelor	8	16.0
<b>Experience years:</b>		
<10	23	46.0
10+	27	54.0
Range	2.0-15.0	
Mean±SD	8.9±3.2	
Median	10	

30 days, median 12.5, and their duration on mechanical ventilator ranged between 2 and 30 days, median 7.0. Only 30.0% of them were fully conscious. At the end of follow-up, the incidence of pressure injury was 12.0% among them.

Table 3 demonstrates that approximately two-thirds of the infants (64%) were not at risk of pressure injury at the admission and first follow-up days. This was reduced to 56% on day 4. On the other hand, around one-fourth (24%) were at very high risk from admission to day 4. The mean risk score rose from 10.6±17.2 on admission to 13.1±16.1 at the end of follow-up.

Concerning nurses’ knowledge of pressure injury, Table 4 indicates its deficiency in all aspects. This was particularly evident regarding prevention (4%), symptoms (8%), definition (10%), and causes (12%). At the post-intervention phase, there were statistically significant improvements in almost all areas of knowledge, reaching 96% for the definition. On the other hand, the knowledge of phase 1 had a significant decline. The table shows slight declines in most areas at the follow-up phase, although the percentages of satisfactory knowledge remained significantly higher compared with the pre-intervention figures. The only exceptions were related to knowledge of the phases and phase I. In total, only one (2.0%) of the nurses had satisfactory knowledge before the intervention; this increased to 92.0% at the post-intervention phase, and 78% at follow-up after one month of intervention (p < 0.001).

**Table 2:** Personal and health characteristics and ulcer incidence among infants in the study sample (n=50)

Characteristics of infants	Frequency	Percent
<b>Age (months):</b>		
<1	28	56.0
1+	22	44.0
Range	1-8	
Mean±SD	1.1±1.4	
Median	1.0	
<b>Gender:</b>		
Male	29	58.0
Female	21	42.0
<b>Stay in ICU (days):</b>		
<15	28	56.0
15+	22	44.0
Range	5-30	
Mean±SD	14.0±5.5	
Median	12.5	
<b>Days on ventilator:</b>		
<7	23	46.0
7+	27	54.0
Range	2-30	
Mean±SD	7.7±5.8	
Median	7.0	
<b>Consciousness:</b>		
Full	15	30.0
Semi-conscious	16	32.0
Unconscious	19	38.0
Have pressure ulcers on day 4	6	12.0

As shown in Table 5, nurses' practice of pressure injury preventive care was very deficient before the intervention. Thus, none of them had adequate practice of providing daily cleansing of the infants' eyes and oral areas, and only one (2%) had adequate practice of cleansing diaper area, using non-irritant tape, and assessing skin underlying electrodes/probes. The post-intervention phase showed statistically significant improvements in all practice steps, ranging between 74% for keeping skin free of excess moisture as urine, and 96% for the step of changing child position every 2 hours. At the follow up phase, there were some declines in some steps, while other steps continued to improve as for the use of minimum tape and adhesive in cannula care. Nonetheless, all practice steps remained significantly better compared with pre-intervention practice. Overall, none of the nurses had had adequate total practice before the intervention; this rose to 74.0% at the post-intervention and follow-up phases (p< 0.001).

**Table 3:** Pressure ulcer risk among infants throughout follow-up (n=50)

Glamorgan risk categories	Admission		Day1		Day2		Day4	
	No.	%	No.	%	No.	%	No.	%
<b>0 (not at risk)</b>	32	64.0	32	64.0	30	60.0	28	56.0
<b>10 + (at risk)</b>	5	10.0	5	10.0	6	12.0	9	18.0
<b>15 + (high risk)</b>	1	2.0	1	2.0	2	4.0	1	2.0
<b>20+ (very high risk)</b>	12	24.0	12	24.0	12	24.0	12	24.0
<b>Range</b>	0-61		0-61		0-63		0-63	
<b>Mean±SD</b>	10.6±17.2		10.8±17.1		12.4±16.3		13.1±16.1	
<b>Median</b>	0.0		0.0		4.0		5.0	

In multivariate analysis (Table 6), the intervention was the only statistically significant positive predictor of nurses' knowledge scores, and it explained 67% of the improvement in this score. As for the performance scores, the table illustrates that the intervention was its main independent positive predictor, in addition to the knowledge score. On the other hand, the nurse female gender and the days the infant spends on mechanical ventilators were negative predictors. The model explains 76% of the improvement of the performance score. None of the other nurse or infant characteristics had a significant influence on nurses' knowledge or performance score.

As regards the factors influencing the incidence of pressure injuries among infants, Table 7 indicates that the higher admission risk score was a protective factor with Odds Ratio (OR) 0.87. Conversely, the increase of nurse age and the higher injury risk score on day 3 were significant risk factors with ORs 1.25 and 1.20 respectively.

## Discussion

The study findings indicate deficient knowledge and inadequate practice related to pressure injury prevention among pediatric nurses in PICUs of the study settings. The implementation of educational guidelines to these nurses proved to be effective in improving their knowledge and practice, with a positive impact on the incidence of pressure injury among infants. This leads to acceptance of the set research hypotheses.

According to the present study results, only one of the fifty nurses in the study sample had satisfactory knowledge of pressure injury and related preventive care before implementation of the of educational guidelines. This could be attributed to lack of preparation of these nurses, given that the majority of them were only holding a diploma degree in nursing. Moreover, their

**Table 4:** Knowledge of pressure ulcers among nurses in the study sample throughout the study

Correct knowledge of pressure ulcer	Time						X <sup>2</sup> (p-value) Pre-post	X <sup>2</sup> (p-value) Pre-FU
	Pre (n-50)		Post (n-50)		FU (n-50)			
	No.	%	No.	%	No.	%		
<b>Definition</b>	5	10.0	48	96.0	35	70.0	74.23 <0.001*	37.50 <0.001*
<b>Causes</b>	6	12.0	46	92.0	39	78.0	64.10 <0.001*	44.00 <0.001*
<b>Symptoms</b>	4	8.0	34	68.0	22	44.0	38.20 <0.001*	16.84 <0.001*
<b>Signs</b>	44	22.0	22	44.0	29	58.0	5.47 0.02*	13.50 <0.001*
<b>Prevention</b>	2	4.0	44	88.0	41	82.0	71.01 <0.001*	62.06 <0.001*
<b>Sites</b>	21	42.0	47	94.0	42	84.0	31.07 <0.001*	18.92 <0.001*
<b>Phases</b>	27	54.0	35	70.0	24	48.0	2.72 0.1	0.36 0.55
<b>Phase 1</b>	31	62.0	21	42.0	17	34.0	4.01 0.045*	7.85 0.005*
<b>Complications</b>	21	42.0	42	84.0	39	78.0	18.92 <0.001*	13.50 <0.001*
<b>Foot protection</b>	21	42.0	42	84.0	41	82.0	18.92 <0.001*	16.98 <0.001*
<b>Total:</b>								
<b>Satisfactory (60%+)</b>	1	2.0	46	92.0	39	78.0	81.29	60.17
<b>Unsatisfactory (&lt;60%+)</b>	49	98.0	4	8.0	11	22.0	<0.001*	<0.001*

**Table 5:** Nurses' practice of pressure ulcer preventive care throughout the study

Practice steps	Time						X <sup>2</sup> (p-value) Pre-post	X <sup>2</sup> (p-value) Pre-FU
	Pre (n-50)		Post (n-50)		FU (n-50)			
	No.	%	No.	%	No.	%		
Keep skin free of excess moisture as urine	2	4.0	37	74.0	39	78.0	51.49 <0.001*	56.59 <0.001*
Keep skin free of excess moisture as fecal	3	6.0	38	76.0	39	78.0	50.64 <0.001*	53.2 <0.001*
Keep skin free of excess moisture as drainage	5	10.0	38	76.0	39	78.0	44.43 <0.001*	46.92 <0.001*
Cleans skin with non-irritant soap	6	12.0	42	84.0	39	78.0	51.92 <0.001*	44.00 <0.001*
Rinse well with plain warm water	5	10.0	40	80.6	39	78.0	49.49 <0.001*	46.92 <0.001*
Provide daily cleansing of eyes	0	0.0	39	78.0	37	74.0	63.93 <0.001*	58.73 <0.001*
Provide daily cleansing of oral areas	0	0.0	39	78.0	37	74.0	63.93 <0.001*	58.73 <0.001*
Provide daily cleansing of diaper area	1	2.0	41	82.0	37	74.0	65.68 <0.001*	55.01 <0.001*
Apply nonalcoholic moisturizing agents	4	8.0	42	84.0	40	80.0	58.13 <0.001*	52.60 <0.001*
Use minimum tape and adhesive in cannula care	2	4.0	43	86.0	45	90.0	67.92 <0.001*	74.23 <0.001*
Use nonirritant tape	1	2.0	43	86.0	43	86.0	71.59 <0.001*	71.59 <0.001*
Fix tape in correct comfortable way	3	6.0	46	92.0	41	82.0	73.99 <0.001*	58.60 <0.001*
Alternate electrode/probe placement sites	2	4.0	45	90.0	43	86.0	4.23 <0.001*	67.92 <0.001*
Assess underlying skin every 8 to 24 hours	1	2.0	46	92.0	44	88.0	81.29 <0.001*	74.71 <0.001*
Eliminate pressure secondary to medical devices as oxygen devices	3	6.0	46	92.0	43	86.0	73.99 <0.001*	64.41 <0.001*



Reduce friction by keeping skin dry	6	12.0	45	90.0	44	88.0	60.86 <0.001*	57.76 <0.001*
Use soft smooth clothes and linens	5	10.0	46	92.0	45	90.0	67.27 <0.001*	64.00 <0.001*
Use draw sheet to move child in bed to reduce friction and sharing injuries	4	8.0	46	92.0	45	90.0	70.56 <0.001*	67.27 <0.001*
Make sure fingers/toes are visible when limb is used for IV/arterial line	9	18.0	47	94.0	45	90.0	58.6 <0.001*	52.17 <0.001*
Change child position every 2 hours	22	44.0	48	96.0	48	96.0	32.19 <0.001*	32.19 <0.001*
<b>Total:</b>								
Adequate (60%+)	0	0.0	37	74.0	37	74.0	58.73	58.73
Inadequate (<60%+)	50	100.0	13	26.0	13	26.0	<0.001*	<0.001*

(\* Statistically significant at p<0.05)

**Table 6:** Best fitting multiple linear regression model for the knowledge and practice scores

	Unstandardized Coefficients		Standardized Coefficients	t-test	p-value	95% Confidence Interval for B	
	B	Std. Error				Upper	Lower
<b>Knowledge score</b>							
Constant	29.80	1.93		15.431	<0.001	25.98	33.62
Intervention	41.20	2.37	0.82	17.419	<0.001	36.53	45.87
r-square=0.67      Model ANOVA: F=303.43, p<0.001 Variables entered and excluded: age, gender, qualification, experience							
<b>Practice score</b>							
Constant	26.56	10.24		2.594	0.01	6.32	46.8
Nurse female gender	-10.89	4.65	-0.10	-2.343	0.02	-20.08	-1.70
Intervention	65.93	6.31	0.74	10.445	<0.001	53.45	78.4
Knowledge score	0.25	0.13	0.14	1.954	0.053	0.00	0.49
Days on ventilator	-0.70	0.30	-0.10	-2.38	0.019	-1.29	-0.12
r-square=0.76      Model ANOVA: F=115.24, p<0.001 Variables entered and excluded: nurse age, qualification, experience, infant age, gender, ICU days							

**Table 7:** Best fitting multiple logistic regression model for the occurrence of ulcer

	Wald	Df	P	OR	95.0% CI for OR	
					Upper	Lower
Constant	13.384	1	0.000	0.00		
Nurse age	7.203	1	0.007	1.25	1.06	1.47
Admission risk score	4.477	1	0.034	0.87	0.76	0.99
Risk score day 3	6.870	1	0.009	1.20	1.05	1.37

Nagelkerke R Square: 0.29  
Hosmer and Lemeshow Test: p=0.18  
Omnibus Tests of Model Coefficients: p<0.001

median age was around thirty years, which means that than one decade has passed since their graduation, a too long period to recall the knowledge acquired during their study years. The finding is in agreement with the results of a study conducted in one of the largest health insurance hospital in Alexandria, where nurses' knowledge was below the minimum acceptable level [21].

The implementation of the educational guidelines to the nurses in the present study led to significant improvements in their knowledge, and the majority of them had satisfactory knowledge after receiving the guidelines. Moreover, the nurses' knowledge level was retained at one-month follow-up, although with some slight declines, which indicates that the educational guidelines have a long lasting effect on nurses' knowledge. The positive effect of the guidelines on nurses' knowledge scores was further confirmed in multivariate analysis, which revealed that the study intervention was the only significant independent positive predictor of this score. In congruence with this finding, in a study of the effect of educational guidelines on the prevention of skin breakdown in PICUS at al-Jouf City in Saudi Arabia, reported significant improvement in nurses' related knowledge after implementation of the educational intervention [22]. On the same line, similar lack of knowledge about prevention of pressure injuries was reported in previous studies [23, 24].

Meanwhile, the results of the current study could not reveal significant improvements in nurses' knowledge of the phases of pressure injuries after implementation of the educational interventions. This could be due to that the nurse could not easily assimilate to staging system of pressure injuries due to its difficulty of application [25]. This could be an issue that needs to be re-addressed in the educational guidelines so that this area could be more simplified to participating nurses.

The present study results have also demonstrated that nurses' practice of preventive skin care before the intervention was no better, or even worse than their knowledge. Thus, none of them had adequate total practice at the pretest, with many of the steps observed to be performed by a small minority of them. Such deficient practice could be attributed to their lack of knowledge. In fact, the multivariate analysis of the present study revealed that the knowledge score was a positive independent predictor of the nurses' practice score. Thus, improving nurses' knowledge would certainly have a positive impact on their practice. In congruence with this, highlighted that improving nurses' knowledge concerning proper assessment of infants at high risk of pressure ulcers can lead to better pressure injury prevention care [26].

After receiving the educational guidelines, the majority of the nurses in the current study demonstrated adequate practice of preventive skin care. Furthermore, this adequate practice continued at almost the same level at the one-month follow-up. Such immediate and long-term improvements are undoubtedly related to the implementation of the educational guidelines as revealed in the multivariate analysis of the current study. This positive im-

pact could be attributed to the process of training of the nurses in applying the guidelines, which was mainly hands-on with rehearsal and individualized coaching. A similar success of an educational intervention based on the Pediatric Skin Integrity Practice Guideline for Institutional Use in improving nursing care and decreasing pressure injuries among infants in PICUs was reported by Kiss and Heiler [27]. On the same line, [22] demonstrated significant improvements in nurses' performance after an educational intervention in Saudi Arabia. Moreover, [16] showed that the implementation of a protocol with a set of recommendations for the prevention of pressure injuries influenced the practice of the PICU nurses, with better performance of preventive actions.

Other factors influencing nurses' performance scores in the present study included the female gender and the days infants are on mechanical ventilation. Both factors were having negative influence on nurses' performance scores. The gender effect could be explained by that male nurses are newcomers in the nursing profession in Egypt, and thus tend to do their best to prove themselves. Moreover, they are mostly bachelor degree nurses. As regards the effect of the duration the infant stays on mechanical ventilation, it could be due to lowered nurses' enthusiasm as the infant's condition deteriorates.

Concerning the effect of the educational intervention on the risk and incidence of pressure injuries among infants, the present study results indicate a relatively low incidence. The rate is less than a half of the rate reported in a literature review, where the incidence was as high as 26% in PICUs [28]. Moreover, the incidence rate in the present study (12.0%) is very close to the rate reported in a study in Chile, which decreased to 14.0% after implementing a risk management program for prevention of pressure ulcers [29]. A similar success in reducing the incidence of pressure ulcers was reported in a study in the United States [27].

The incidence of pressure injuries among the infants in the present study was influenced by nurse's age as well as the risk scores. Thus, the older the nurse, the higher is the risk of injury in the infant under her/his care. This could be explained by the tendency to more loose and less enthusiastic performance among older nurses. In agreement with this, in a study in Australia, found that the younger age nurses were having significantly better performance compared with their older colleagues [30].

The risk scores among the infants in the present study at different assessment points in time seem to have opposing influences on the risk of development of a pressure injury. Thus, a higher admission risk score is associated with a lower probability of occurrence of a pressure injury. On the contrary, a higher risk score on the third day increases the risk by almost 20%. This could be explained by that the healthcare team, including the nurse, may provide more close attention to an infant at higher risk of injury in the admission assessment. On the other hand, a higher risk on the third day is indicative of deterioration, and is a true predictor of the occurrence of pressure ulcer. In line with this, a study in



the United Kingdom revealed that the admission assessment was not often a good predictor of patient outcomes such as pressure ulcers, but rather the subsequent assessments following it [31].

## Conclusion and Recommendations

The current study results concluded that nurses who received the educational guidelines had a significant improvement in their total knowledge and practice scores than before, with low risk score of pressure injury among infants. Nurses in PICUs can gain evidence-based knowledge and skills related to pressure injury prevention through simple educational guidelines associated with practical training. Therefore, the developed intervention should be implemented in settings providing critical care to infants and children. The impact of such guidelines on the incidence of pressure injury needs further research using a randomized clinical trial design for more robust evidence.

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