

Effect of Pressure Ulcer Care Bundle on Nurses' Performance at the Intensive Care Unit

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Abstract

Background: Pressure ulcer care bundle is an evidence-based intervention to assist nursing staff in implementing pressure ulcer prevention, it is considered as an essential component to combat the incidence of Pressure ulcers. This study aimed to evaluate the effect of pressure ulcer care bundle on nurses' knowledge and practice at the intensive care unit.

Materials and Methods: A convenience sample of 60 nurses working in intensive care units was included in the study. **Setting:** This study was conducted at medical and surgical intensive care units affiliated to Ain Shams University Hospitals. Two tools were used: 1) Self-administered questionnaire (nurse's demographic characteristics and nurse's level of knowledge about pressure ulcer), 2) Observational checklist about pressure ulcer care bundle.

Results: the mean age of the nurses was 32.9± 4.71 years. More than half of the nurses had a nursing institute educational level. There were highly statistically significant differences between the nurses as regards knowledge and practice scores pre-post bundle implementation.

Conclusion: there was a highly statistically significant improvement regarding nurses' knowledge and practice from pre to post-implementation of the bundle, and there were highly statistically significant correlations between scores of nurses' knowledge and scores of nurses' practice post bundle implementation. This study recommended that future research needs to be conducted to compare the retention of nurses' performance over time based on differences in the used methods of evaluation.

Keywords: Pressure ulcer care bundle, knowledge, practice.

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I. Introduction

Pressure ulcer (PU) is major health problem causing severe consequences for patients, for health professionals, as well for health care institutions because of the high costs of its management. (López-Franco, Anguita, Comino-Sanz, & Pancorbo, 2020). Intensive care units are reported to have the highest pressure ulcer prevalence rates among hospital settings since critically ill patients are expected to have much morbidity that increases the risk of pressure ulcer development. As ulcers are considered to be preventable problems, nurses who're in direct contact with these patients have a main role in preventing them from developing (Habiballah, 2018).

In the intensive care unit, patients have many issues that increase the risk of developing pressure ulcers. Generally, the patient has respiratory equipment, multiple intravenous catheters, urinary catheters, compression equipment, and the infusion of vasoactive agents for hypotension that may lead to the inability to turn patients and increase the risk of pressure ulcer development. Management and prevention of pressure ulcers, as an important quality of care indicator for all health care organizations, require a multidisciplinary team having a holistic care approach (Mallah, Nassar & Kurdahi, 2015). Nurses in this team have vital roles in the protection of skin integrity and the prevention of complications. Evidence-based nursing interventions applied in the initial period have great significance in the prevention of pressure ulcers (Köse et al., 2016).

Management of pressure ulcer highlighting that prevention is better than cure. Thus, the pressure ulcer care bundle is reflected as an important component of pressure ulcer prevention that depends upon adequate knowledge and practice as well as effective identification and prediction of the patient's risk factors (Roberts et al., 2016). So nurses play a critical role in the prevention of pressure ulcers, as she is the one who early detects the signs of pressure ulcers during patients' stay in hospitals. The methods of pressure ulcer prevention need skilled nursing assessment of the integumentary system and knowledge of risk factors, in addition to a continuing evaluation plan to detect the incidence and efficacy of nursing care (Mohamed & Weheida, 2015).

Pressure ulcer care bundle is an evidence-based intervention to support nurses in applying pressure ulcer preventions (Hashad, & Hassan, 2018). The evidence-based care bundle contains five basic elements:

risk assessment, skin assessment, support surfaces, nutrition, and repositioning. Each of these elements is important in clinical practice. For the active implementation of the care bundle, the nurses should have proper education and training to implement the care bundle in intensive care units. For the success of the care bundle, compliance with all the elements of the care bundle must be firmly detected (Zuo & Meng, 2015).

Significance of the study :

Pressure ulcers have been described as one of the most costly and physically debilitating complications in the 21st century. Pressure ulcers are the third most expensive disorder after cancer and cardiovascular diseases (Qaseem et al. 2015). Pressure ulcer remains one of the major health problems around the world. For every 1,000,000 patients who developed pressure ulcers, 65,000 die from complications which presents a major health challenge worldwide (Bereded, Salih & Abebe, 2018). Pressure ulcer was a significant financial burden to any health care system and had adverse effects on achieving goals of care. Pressure ulcers come at a high cost to everyone. They result in pain, suffering, diminished quality of life, and even death for some residents. For nursing, they represent extra staff hours, and medical supplies spent caring for a preventable condition, as well as more residents, are hospitalized (Hefnawy & Abd El-Monem, 2017).

Aim of the Study:

The study aimed to:

Evaluate the effect of pressure ulcer care bundle on nurses' performance at the intensive care unit through:

- 1-Assessing nurses' knowledge and practice regarding pressure ulcer care bundle to determine their needs.
- 2- Planning and implementing a pressure ulcer care bundle.
- 3- Evaluating the effect of pressure ulcer care bundle on nurses' knowledge and practice at intensive care units.

Research Hypothesis:

The mean scores of nurses' knowledge and practice will be increased after the implementation of a pressure ulcer care bundle than before as measured by the tool (I, II).

Operational Definition:

Performance: Nurses' knowledge and practice regarding pressure ulcer care bundle as measured by nurses' level of knowledge and Observational checklist.

II. Material And Methods:

1- Technical Design: The technical design includes research design, setting, subject, and tools for data collection.

Research design:

A quasi-experimental design was utilized to achieve the aim of this study.

Quasi-experiment design is effective because it uses "pre-post testing" and it has independent variables. Quasi-experimental research is a prospective or retrospective study in which patients self-select or are selected into one of some different treatment groups to compare the real effectiveness and safety of non-randomized treatments (Maciejewski, 2020).

Setting: The study was conducted at medical and surgical intensive care units affiliated to Ain shams University Hospitals. The medical intensive care unit had two rooms, one room had 16 beds and the second had 14 beds, while, the surgical intensive care unit had 30 beds.

Subjects: A convenience sample of 60 nurses working at the mentioned intensive care units was included in the study.

The sample size was determined according to the statistical calculation which guided by the power of the test = 80%

Confidence Level =95%.

The accepted level of error =5%.

Study tools:

Tool I: Self-administered questionnaire:- This tool included 2 parts:

Part I: Nurse's demographic characteristics

This tool was developed by the researchers based on an extensive literature review (Said, 2016); (Habiballah, 2018); (Köse et al., 2016). It contained items regarding nurse's data such as (age, gender, marital status, years of experience, knowledge source about pressure ulcers).

Part II: Nurse's level of knowledge regarding pressure ulcer care bundle

This tool was adapted from the knowledge assessment instrument (Simonetti, et al, 2015) to assess nurses' knowledge about pressure ulcers and pressure ulcer care bundle.

It consists of 26 multiple choice questions and three alternative responses reflecting 8 parts: (1) Definition and grades of pressure ulcers; (2) Causes of pressure ulcers; (3) Definition of pressure ulcer care bundle. (4) risk assessment; (5) skin assessment; and (6) Pressure-relieving devices; (7) repositioning; and (8) nutrition.

Part II scoring system of Nurse's level of knowledge regarding pressure ulcer care bundle:

One mark for each correct answer and zero for the wrong answer. The total knowledge score was (26) marks.

The satisfactory level if score $\geq 70\%$ of the maximum score.

The unsatisfactory level if score $< 70\%$ of the maximum score.

Tool II: Observational checklist regarding pressure ulcer care bundle.

This tool was developed by the researcher based on an extensive literature review (Zuo & Meng, 2015); (Hashad, & Hassan, 2018), to assess nurses' practice during caring for pressure ulcer patients and includes 19 items reflecting 5 parts: Risk assessment (4 items), Skin assessment (5 items), Surface support (3 items), Repositioning patient (3 items), and Nutrition (4 items).

Tool II scoring system of Observational checklist regarding pressure ulcer care bundle:

It was scored as follows: done (2 marks), not done (1) with a maximum score (38), and a minimum of (0) and it was competent if score $\geq 75\%$ of the maximum score and incompetent if score $< 75\%$ of the maximum score.

Pressure ulcer care bundle:

The evidence-based care bundle contains five basic elements: risk assessment, skin assessment, support surfaces, nutrition, and repositioning.

Implementation of the bundle includes two parts (theoretical and practical part)

1) First: theoretical part (6 sessions)

It included revising nurses' basic knowledge about the anatomy of the skin, defining pressure ulcers, its incidence, causes, and risk factors, defining the care bundle and explaining components of pressure ulcer care bundle.

2) Second: practical part (session for each nurse)

It included demonstration and redemonstration with each nurse on components of the pressure ulcer care bundle:

- **Risk assessment includes** assessing risk factors as immobility, age, nutritional status, disease severity, and assessing tissue perfusion related variables (edema, diabetes, circulation, and BP).
- **Skin assessment includes** performing a complete skin assessment once during each shift and Recording any changes in skin condition.
- **Surface support includes** using pillows for the support of bony prominences off bed surfaces and constant low-pressure surfaces, such as foams, air, and water mattresses.
- **Repositioning includes** turning patients at least once every 2 h and once every 4 h on pressure redistribution mattress and elevating the head of bed no higher than 30 degrees.
- **Nutrition includes** identifying the nutrition status of patients upon admission, assessing albumin and pre albumin levels, assessing the continence status frequently.

2- Operational Design:

The operational design includes the preparatory phase, [tools validity and reliability, pilot study, and fieldwork.

A) The preparatory phase:

- The first step of this phase was concerned with a review of the related literature to the topic of the study, using books, articles, periodicals, magazines, and internet research.
- Select and modify the proper tools for data collection.
- Test tools validity and reliability.

Content validity

Content validity was conducted to test the tool for appropriateness, relevance, correction, comprehension, and clearance through a jury of seven experts, from the medical-surgical nursing staff. Juries were from different academic categories (professors and assistant professors). Their opinions were elicited regarding the tool format layout, consistency, and scoring system.

Testing reliability:

Testing reliability was measured by Cronbach's alpha test to measure the internal consistency of the tools used in the study as follows; Nurse's level of knowledge about pressure ulcers = 0.749, Observational checklist about pressure ulcer care bundle. = 0.883. The values of Cronbach's alpha of the study tools are considered acceptable.

B) Pilot study:

- A pilot study was carried out on 10% of the nurses to test feasibility and applicability of the tools; as well as to estimate the time needed for each tool to be filled in. Nurses who participated in the pilot study were included in the main study sample because there were no modifications in the tools.

C) Fieldwork:

Assessment phase:

During this phase nurses' assessment was done pre-implementation of the Pressure ulcer care bundle through an interview with the nurses to assess their demographic data, knowledge level about pressure ulcers and pressure ulcer care bundle using a self-administered questionnaire (Tool I) before teaching sessions (pretest), it takes 20 minutes to fill the questionnaire, and assess nurses' practice during caring of pressure ulcers patients using observational checklist pre bundle implementation (Tool II).

Planning phase:

This phase concerned with planning the contents of the Pressure ulcer care bundle based on the related literature review as well as estimate the time needed to apply the sessions.

Implementation phase:

- Data collection was started and completed within 6 months in the period from the beginning of August 2018 until the end of January 2019.
- In this phase, the Pressure ulcer care bundle was implemented by the researchers for the study sample. This bundle contained two parts:

A-Theoretical part:

1. The theoretical part was given through 6 sessions, each session included 10 nurses and each session lasted about 45 minutes with total time four and a half hours. These teaching sessions were done in groups (10 nurses/ session).
2. Teaching sessions included the following contents: pressure ulcers causes and its risk factors, the definition of pressure ulcer care bundle, components of pressure ulcer care bundle (assessment of risk factors of pressure ulcers, assessment of patient's skin and stages of pressure ulcers, pressure-relieving devices, repositioning patients and patient nutrition).
3. The researchers used the following teaching aids: printed material (booklet), PowerPoint presentation, Video film, and graphic pictures.
4. Evaluation of nurses' level of knowledge after teaching sessions using the nurse's level of knowledge about pressure ulcer (posttest).

B-Practical part:

1. The study sample was divided into 2 groups, group for each researcher.
2. Each researcher demonstrated 30 nurses and demonstrated each nurse for 20 minutes and the total time for each researcher was 10 hours.
3. Demonstration sessions include:
 - How to assess risk factors for developing pressure ulcers (patient's age, obesity, nutritional status, immobility, disease severity, and excessive moisture,).
 - How to assess patient's skin (assessment of sites and stages of pressure ulcers, monitoring patients with Stage I pressure ulcers very closely, assessing the incontinent patient for fecal skin contamination).
 - How to use pressure-relieving devices (using pillows for the support of bony prominences off bed surfaces, using constant low-pressure surfaces, such as air mattresses, keeping beds padding to a minimum so that pressure-relieving surfaces are effective).
 - How to reposition the patient in bed (turning patient at least once every 2 h and once every 4 h on pressure redistribution mattress, elevating the head of bed no higher than 30_ to prevent pressure on the coccyx).
 - How to assess the nutritional status of patients (assessing albumin and prealbumin levels, assessing the continence status and monitoring patients receiving an enteral nutritional formula)
4. Evaluation of nurses' practice during caring for pressure ulcer patients using observation checklist (tool II).

Evaluation phase:

This phase included the evaluation of the effect of pressure ulcer care bundle on nurses' knowledge and practice during the care of pressure ulcer patients at the intensive care unit.

3- Administrative Design:

To carry out the study, the necessary approvals were obtained from the hospital director and nursing director of Ain Shams University Hospitals. Official letters were issued to them explaining the aim of the study to obtain permission for data.

Ethical considerations:

The researcher explained the aim of the study to nurses who agreed to participate in the study. Written consent was obtained from nurses who agreed to participate in the study. The researcher assured maintaining anonymity and confidentiality of the subjects' data. Nurses were informed that they have the right to withdraw from the

study at any time.

4-Statistical analysis:

The data obtained were synthesized, analyzed, and presented in numbers; percentage in the form of tables, figures, and diagrams as required, and suitable statistical tests were used to test the significance of results obtained using SPSS.

III. Results

Table no 1: illustrate that the mean age of the nurses was 32.9± 4.71 years. The majorities of nurses were female and were married (80.0 % &76.7 %) respectively. more than half of nurses (55%) had a nursing institute educational level. While half of the nurses (50%) were working in ICU for 6-10 years and one-third of nurses (33.3%) knew about pressure ulcers from their colleagues.

Table no 1: Demographic Characteristics of the nurses (N=60).

Items		N	%
Age	20-29	18	30.0 %
	30-40	42	70.0 %
(Mean ± SD)		32.9± 4.71	
Gender	Male	12	20.0 %
	Female	48	80.0 %
Marital status	Single	14	23.3 %
	Married	46	76.7 %
Educational level	Diplome	24	40 %
	Nursing institute	33	55 %
	Baccalaureate	3	5 %
Years of experience in ICU	1-5 years	26	43.3 %
	6-10 years	30	50 %
	11-15 years	4	6.7 %
(Mean ± SD)		6.38 ± 2.86	
knowledge source about pressure ulcer	Colleagues	20	33.3 %
	Books	12	20.0 %
	Internet	10	16.7 %
	Others	18	30.0 %

Table no 2: illustrates that the highest mean score of nurses' knowledge pre- bundle implementation was for pressure-relieving devices. While the highest mean score of nurses' knowledge post bundle implementation was for risk assessment. There were highly statistically significant differences between the nurses as regards to total knowledge mean scores pre- post-care bundle implementation

Table no 2: Comparison of nurses' knowledge regarding pressure ulcer care bundle pre& post bundle implementation (N=60).

Items	Pre	Post	T-test	P-value
	Mean ±SD	Mean ± SD		
Definition and grades of pressure ulcers.	2.18 ± 0.54	2.93 ± 0.32	-13.035	<0.001**
Causes of pressure ulcers.	1.83 ± 0.94	2.50 ± 0.92	-10.230	<0.001**
Definition of Pressure ulcer care bundle.	1.08 ± 0.74	2.78 ± 0.12	-14.634	<0.001**
Risk assessment.	2.93 ± 0.61	4.90 ± 0.82	-11.241	<0.001**
Skin assessment.	3.20 ± 0.92	4.55 ± 0.54	-14.221	<0.001**
Pressure-relieving devices.	3.61 ± 0.71	4.68 ± 0.32	-12.371	<0.001**
Repositioning patient.	3.06 ± 0.53	3.85 ± 0.72	-17.035	<0.001**
Nutrition	1.31 ± 0.61	2.26 ± 0.12	-12.281	<0.001**
Total	4.90 ± 2.14	23.26 ± 2.16	-31.47	<0.001**

**Highly Significant (HS) p ≤ 0.001

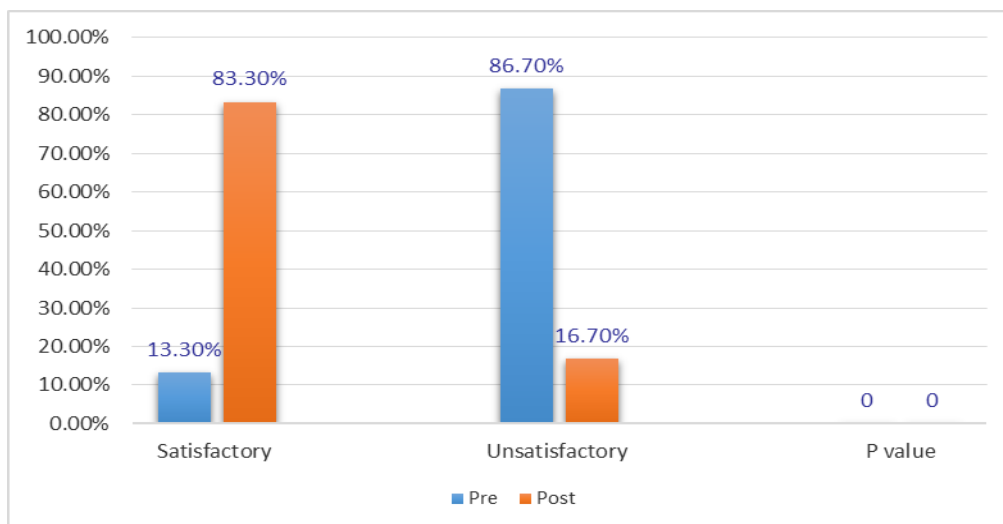


Figure no 1: Comparison of total satisfactory & unsatisfactory level of nurses' knowledge about pressure ulcer care bundle pre and post bundle implementation (N=60).

Figure no 1: reveals that the total satisfactory level of knowledge pre bundle implementation was (13.3%).while the total satisfactory level of knowledge post bundle implementation was (83.3%). there were highly statistically significant differences between the nurses regarding the total satisfactory scores of knowledge ($p \leq 0.001^{**}$).

Table no 3: illustrates that, regarding risk assessment, one-third of the study sample (33.3%) pre bundle implementation and majority of the study sample (90%) post bundle implementation assessed moisture-related variables.

Regarding skin assessment, half of the study sample (50%) ensured that the patient was not sliding in bed pre bundle implementation. While the majority of the study sample (93.3%) recorded skin changes post bundle implementation.

Concerning the Surface support, more than half of the study sample (58.3%) pre bundle implementation and the majority of the study sample (91.6 %) post bundle implementation used constant low-pressure surfaces.

As regard Patient repositioning, more than half of study sample (58.3%) elevated the head of bed no higher than 30 pre bundle implementation while the majority of the study sample (95 %) turned patient at least once every 2 h and every 4 h on pressure redistribution mattress post bundle implementation.

Regarding nutrition less than half of the study sample (40%) pre bundle implementation and the majority of the study sample (93.3 %) post bundle implementation assessed the continence status frequently.

Table no 3: Comparison of nurses' practice regarding pressure ulcer care bundle pre& post bundle implementation (N=60).

Items	Pre		Post		Chi-square	P-value
	Competent		Competent			
	N	%	N	%		
Risk Assessment						
Assessment of risk factors	5	8.3	39	65	88.80	0.000
Assessment of tissue perfusion	6	10	52	86.6	97.48	0.000
Assessment of moisture related variables	20	33.3	54	90	79.01	0.000
Monitoring of hematological measures	9	15	43	71.6	98.04	0.000
Skin Assessment						
Performing complete skin assessment each shift	20	33.3	54	90	78.18	0.000
Ensuring that patient is not sliding in bed.	30	50	51	85	97.48	0.000
Recording of skin changes	22	36.6	56	93.3	66.53	0.000
Monitoring patients with Stage I PUs closely.	27	45	52	86.6	87.48	0.000
Assessing incontinent patient for fecal skin contamination, skin maceration	19	31.6	48	80	93.18	0.000
Surface support						
Using pillows for support of bony prominences	20	33.3	50	83.3	30.85	0.000
Using constant low-pressure surfaces	35	58.3	57	95	47.28	0.001
keeping bed padding to a minimum	32	53.3	54	90	31.03	0.001

Patient Repositioning						
Turning the patient at least once every 2 h and every 4 h on pressure redistribution mattress.	34	56.7	57	95	24.05	0.001
When repositioning, turn the patient's body laterally 30.	17	28.3	46	76.6	57.32	0.000
Elevating head of bed no higher than 30	35	58.3	56	93.3	30.19	0.001
Nutrition						
Identifying the patient's nutrition status on admission.	8	13.3	38	63.3	36.93	0.000
Assessing albumin and prealbumin levels.	12	20	47	78.3	44.39	0.000
Assessing the continence status frequently.	24	40	56	93.3	24.05	0.000
Monitoring patients receiving enteral nutritional formula.	11	18.3	46	76.6	47.86	0.000

**Highly Significant (HS) $p \leq 0.001$

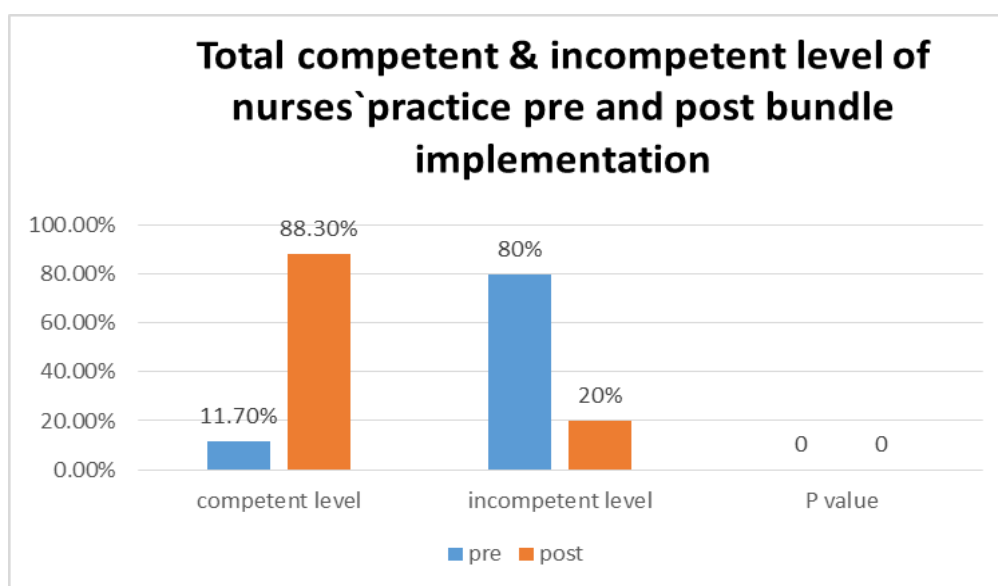


Figure (2): Comparison of total competent & incompetent level of nurses' practice regarding pressure ulcer care bundle pre and post bundle implementation. (N=60)

Figure (2): reveals that the total competent level of practice pre bundle implementation was (11.7%), while the total competent level of practice post bundle implementation was (88.3%). There were highly statistically significant differences among study groups regarding the total competent scores of practice ($p \leq 0.000^{***}$).

Table no 4: shows that there were statistically significant relations between age, marital status, and satisfactory level of nurses' knowledge about pressure ulcers post-care bundle implementation with p (0.016, & 0.043) respectively. While there were no statistically significant relations between other demographic characteristics (gender, educational level, working years in ICU, and knowledge source about pressure ulcer) and level of nurses' knowledge about pressure ulcers

Table no 4: Relation between demographic characteristics and satisfactory level of nurses' knowledge about pressure ulcers post-care bundle implementation.

Items		Knowledge about pressure ulcers				Chi-square	P-value
		Satisfactory		Unsatisfactory			
		N	%	N	%		
Age	20-29	18	30	0	0	5.773	0.016*
	30-40	31	51.7	11	18.3		
Gender	Male	12	20	0	0	3.367	0.067
	Female	38	63.3	10	16.7		
Marital status	Single	14	23.3	0	0	4.099	0.043*
	Married	35	58.3	11	18.4		
Educational level	Diplome	18	30	6	10	1.767	0.622
	Nursing institute	27	45	5	8.3		
	Baccalaureate	4	6.6	0	0		
Years of experience in ICU	1-5 years	20	33.3	2	3.3	1.421	0.491
	6-10 years	27	45	5	8.3		
	11-15 years	6	10	0	0		
knowledge source about pressure ulcer	Colleagues	15	25	5	8.3	5.269	0.153
	Books	8	13.3	4	6.6		
	Internet	10	16.7	0	0		
	Others	15	25	2	3.3		

* Significant (S) $p \leq 0.05$

Table no 5: The table shows that there were highly statistically significant correlations between scores of nurses' knowledge and scores of nurses' practice post-program implementation.

Table no 5: Correlations between nurses' knowledge and practice regarding pressure ulcer care bundle (n=60)

		Knowledge pre	Knowledge post
Practice pre	Correlation coefficient	-0.157	0.268
	Sig. (2-tailed)	0.232	0.038*
Practice post	Correlation coefficient	-0.231	0.760
	Sig. (2-tailed)	0.076	0.000**

**Highly Significant (HS) $p \leq 0.001$

IV. Discussion

Concerning the age of the studied nurses, the results of the present study revealed that the mean age of the nurses was 32.9 ± 4.71 years. This result is inconsistent with **Köse et al., (2016)**, who studied knowledge of nurses working in intensive care units concerning preventing pressure ulcers and denoted that the average age of the participants was 27.63 ± 5.88 years.

Regarding the gender of nurses, this study results showed that the majority of nurses were female. This may be due to the direction of female Egyptian toward the nursing profession. This result is in accordance with **Said, (2016)**, who explored the nurses' level of knowledge about the prevention and management of pressure ulcers in Oman and reported that the majority of the study sample was female.

As regard to marital status, the majority of the study sample were married. This may be due to the majority of the nurses were female, and most of the Egyptian female youth get married in the twenties of their age. This result is congruent with **Uba, et al., (2015)**, who assessed nurses' knowledge, attitude, and practices of pressure ulcer prevention in the university of Maiduguri teaching hospital and found that the majority of the study sample were married.

Concerning nurses' level of education, the present study showed that more than half of the study sample had nursing institute certificates as their highest qualification. This result is in disagreement with **Habiballah, (2018)**, who assessed nurses' attitudes towards pressure ulcer prevention and denoted that the majority of the study sample had a bachelor's degree.

As regard to years of experience in ICU, this study results revealed that half of the nurses were working in ICU for 6-10 years. This result is inconsistent with **Florin et al., (2016)**, who compared attitudes towards pressure ulcer prevention between registered nurses, assistant nurses, and student nurses, and revealed that less than a quarter of nurses had working experience in ICU of 5-10 years.

Considering nurses' level of knowledge about pressure ulcers, the present study illustrated that there were highly statistically significant differences between the nurses as regards to total knowledge mean scores

pre- post-care bundle implementation. This finding is consistent with **Cano, et al, (2015)**, who aimed to improve outcomes by implementing a pressure ulcer prevention program and found a significant increase in average post-test knowledge results after bundle implementation among the nurses.

Concerning mean scores of nurses' knowledge about pressure ulcers, the present study results showed that the highest mean score of nurses' knowledge pre- bundle implementation was for Pressure-relieving devices. This reflects that nurses had knowledge about **Pressure-relieving devices**, but didn't perform these measures to prevent pressure ulcers effectively. This result is in agreement with **Mohamed, & Weheida, (2015)**, who studied the effects of implementing an educational program about pressure ulcer control on nurses' knowledge and safety of immobilized patients and denoted that nurses' knowledge about management of pressure ulcer had the highest level preprogram implementation.

As well, the present study results showed that the highest mean score of nurses' knowledge post-bundle implementation was for risk assessment. This proves the effectiveness of the pressure ulcer care bundle on improving nurses' knowledge about the pressure ulcer care bundle and its component. This result is incongruent with **Mohamed, & Weheida, (2015)**, who revealed that nurses' knowledge about management of pressure ulcer had the highest level post-program implementation.

Concerning nurses' level of practice about pressure ulcers, the present study illustrated that there were highly statistically significant differences among the study group regarding the total competent scores of practice. This finding is consistent with **Shadbad et al., (2018)**, who assessed nurses' knowledge and practice in the prevention of pressure ulcers among patients undergoing cardiac surgery following an educational program and found a statistically significant difference between the pre-posttest practice scores.

As regards to the highest competent level of nurses' practice, the study results showed that nurses' practice regarding using constant low-pressure surfaces had the highest competent level pre- bundle implementation. This may be due to the most available measure for nurses to prevent pressure ulcers is to provide pressure support devices. This result disagreed with **Sachdeva, Koul, & Batra, (2018)**, who assessed the effectiveness of care bundle for hospital-acquired pressure ulcers in ICU and declared that the highest level of nurses' practice in the pre-intervention phase was involving the attendants' inpatient care.

On the other hand, the present study results revealed that nurses' practice regarding using constant low-pressure surfaces and turning patients at least once every 2 h and every 4 h on pressure redistribution mattress had the highest competent level post- bundle implementation. This may be due to the effect of pressure ulcer care bundle on enhancing nurses' performance during repositioning patients. This result agreed with **Sachdeva, Koul, & Batra, (2018)**, who denoted that nurses' practice during using air mattress had the highest level in the post-intervention phase.

Considering the relation between demographic characteristics and satisfactory level of nurses' knowledge, this study results showed that there were statistically significant relations between age, marital status, and satisfactory level of nurses' knowledge about pressure ulcers post-bundle implementation. This finding is consistent with **Hashad, & Hassan, (2018)**, who evaluated the effect of implementing a designed SKIN care bundle protocol on modifying nurses' practices toward pediatric intensive care unit patients and declared a significant positive relation between nurse's age and their total knowledge about pressure ulcers and SKIN care bundle post-program implementation

Concerning correlations between nurses' knowledge and practice regarding pressure ulcer care bundle, the study results showed that there were highly statistically significant correlations between scores of nurses' knowledge and scores of nurses' practice post bundle implementation. This finding is in agreement with **Mohamed, & Weheida, (2015)**, who found statistically significant correlations between the level of knowledge and practice for the study group post-implementation of the program.

V. Conclusion

There were highly statistically significant differences between the nurses as regards knowledge and practice total scores pre-post bundle implementation. There were statistically significant relations between age, marital status, and satisfactory level of nurses' knowledge about pressure ulcers post- bundle implementation. Also, there were highly statistically significant correlations between scores of nurses' knowledge and scores of nurses' practice post bundle implementation.

The results of this study supported the hypothesis of the study that, pressure ulcer care bundle improved the level of nurses' knowledge and practice about pressure ulcer at the intensive care unit

VI. Recommendations:

- This study results should be repeated with a larger probability sample size in a different geographic location to confirm the findings.
- Additional research using different assessments of knowledge to assess nurses' knowledge about pressure ulcers.

- Future research needs to be conducted to compare the retention of nurses' performance over time based on differences in the used methods of evaluation.

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