

Original Article

Intensive Care Nurses' Knowledge, Practice and Attitudes Related to Pressure Ulcer Prevention: A Single Tertiary Center in Greece Case

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Abstract

Pressure ulcers are a major problem in patient care and are associated with the patient's quality of life, pain, depression, loss of function, lack of independence, increased incidence of infection and sepsis, as well as additional surgeries and extended hospital stays.

Purpose: The present study aims to investigate the knowledge of nurses in intensive care units (ICUs) for the prevention and treatment of pressure ulcers.

Method: This is a descriptive cross sectional study that used the Sparta Tool PU 2014 scale in nurses working in the ICUs in a tertiary cardiosurgical hospital in Athens, Greece. The study period was from November 2019 to May 2020. In total 107 nurses participated the study (90.68% of the ICU nurses). Kolmogorov-Smirnov test, t-test, analysis of dispersion (one way ANOVA), Kruskal-Wallis test were used. The statistical analysis was performed at a statistical significance level of $p < 0.05$ with the use of statistical package IBM SPSS v. 23.0.

Results: The mean age of the sample was 39.04 ± 5.6 years with a mean length of working experience 14.45 ± 6.02 years. According to their statements regarding daily practice it is estimated that a mean of 8.69% of ICU patients, which they treated during the week prior to the study, developed pressure ulcers, independently of their severity. All the nurses follow a basic training programme regarding pressure ulcer prevention and treatment when they are still trainees, and 91.6% of them report using pads and other materials to treat or pressure ulcers as part of their daily

practice. Noticeably, nearly 1/3 of them reported that they had no additional training in the care of pressure ulcers and the participants' basic knowledge regarding causes of pressure ulcers was self-assessed as moderate. Participants showed moderate knowledge regarding assessment of risk for the development of pressure ulcer but higher knowledge regarding preventive measures. Even though, participants' knowledge about prevention were less in comparison to their knowledge regarding treatment ($p = 0.001$). The length of working experience was not associated with higher knowledge score in contrast with postgraduate studies that were positively associated ($p = 0.020$).

Conclusions: Nurses' knowledge regarding prevention and treatment of pressure ulcers was moderate. Data analysis revealed a number of opportunities for practice improvements and a clear need for continuous education.

Keywords: pressure ulcers, skin ulcers, nurses, knowledge, attitude, practice

Introduction

Pressure ulcers are localized injuries to the skin and/or underlying tissues usually over a bony prominence, as a result of pressure, or pressure in combination with shear and/or friction (NPUAP, EPUAP & PPIA, 2014). Pressure ulcers impact patients not only physically by increasing pain and infection risk but they are interrelated with negative impact on the quality of life of patients and their families and they increase costs for both patients, hospitals and the health system (Beeckman et al., 2010). Patients in intensive care units (ICUs) often develop pressure ulcers as a result of the limited mobility due to the severity of their clinical status along with the widespread use of medical devices for diagnosis and treatment (Clay et al., 2017). The patients in ICUs have a higher risk of developing medical device related pressure injuries (MDRPI) due to pressure ulcers occurrence rate stands as a core quality of care indicator and nurses play a primary role to their prevention. Moreover, the great number of the current available pressure ulcer prevention quality indicators (in a recent mapping were identified 146 quality indicators), with the vast majority of them used in hospital setting, demonstrate the importance of measuring pressure ulcer prevention quality (Kottner et al. 2018). Nurses' knowledge and positive attitude towards early enactment of pressure ulcers' prevention measures, are essential factors for the effective prevention and management of pressure ulcers (Florin et al., 2016; Simonetti et al., 2015). However, studies have shown that nurses do not fully comply with guidelines for the prevention of pressure ulcers and along with their limited knowledge regarding prevention are major factors leading to this outcome (Khojastehfar, Ghezeljeh & Haghani, 2020; Qaddumi & Khawaldeh, 2014). In

addition, a number of studies suggested that even though nurses' knowledge and attitudes regarding prevention of pressure ulcers were poor, the management of pressure ulcers was relatively acceptable (Simonetti et al., 2015; Lotfi et al., 2019). A number of recent articles supports the evidence that ICU nurses' limited knowledge regarding pressure ulcers prevention is related to increased risk for pressure ulcer in their patients (Gu & Li, 2020; Zhang et al., 2021). Nurses' knowledge of pressure ulcers is essential for the assessment, risk management, implementation of preventive measures and treatment of pressure ulcers (Coyer et al., 2019). However, studies on the knowledge and attitudes of nurses in ICUs about pressure ulcers in patients, their prevention and management are relatively limited. The aim of this study was to investigate the knowledge and attitudes of ICU nurses for the prevention and management of pressure ulcers in a tertiary cardiology center in Athens.

Methods

Sample: This is a descriptive cross sectional study in a convenience sample of nurses, working in Onassis Cardiac Surgery Center, a tertiary hospital in Athens, carried out from November 2019 to May 2020. The data collection was performed with the formation of an anonymous questionnaire that was distributed to nurses working in the three ICUs (Cardiac ICU, Pediatric ICU and Cardiac ICU) in the specific hospital, in different time periods. In total 107 participants from the 121 nurses (88.43%) working as nurses at the study period signed informed consent and participated the study. The study was performed after approval was granted from the Scientific and Ethics' Committee of the hospital (PEP: 582). The data collection form was distributed by the primary researcher.

Tools: The Sparta Tool PU2014 scale was used (with the subscales: knowledge, practices, and attitudes). The PU2014 scale was developed and published in Greek language and validated in a sample of Greek nurses. We used the scale in our study with the permission by its creator (Vasilopoulos, 2015). The Sparta Tool PU2014 scale evaluates the knowledge, practices and attitudes of nurses for the prevention and treatment of pressure ulcers. The Sparta tool PU2014 consists of 55 questions divided into 3 sections (knowledge 31, practice 11, attitudes 13). The knowledge subscale contains the dimensions: prevention (15 items), treatment (8 items) and staging (9 items). The assessment of knowledge was performed through the calculation of the score of PU2014 knowledge. According to the creator of the questionnaire, the maximum score of PU2014 knowledge is 31 and the minimum is 0. The questions are closed and some are open. The questionnaire consists of two sections: the first is about demographics and the second is knowledge about pressure ulcers.

Data collection: Participants were asked to sign informed consent in order to get enrolled in the study after adequate information regarding the scope of the study, the methods and data protection was provided. The information was provided by the primary researcher and the participants were informed that they were free to withdraw at any stage of the study. All the measures to preserve the anonymity of the participants were engaged and the access to the personal data was limited to the members of the research team. The participants were asked to complete the questionnaire and the primary researcher was available to answer any of their queries. There was set no time limit for the completion of the questionnaire.

Statistical analysis: The statistical analysis was performed at a $p < 0.05$ level of statistical significance and the analysis was performed with the statistical package IBM SPSS v. 23.0. Continuous variables are presented with reference to their frequency, mean value and standard deviation (SD), median, value range and intra-quadratic range (IQR). For the categorical variables the calculation of frequency and percentage was applied. The quantitative variables of the study were tested for normality with the help of the Kolmogorov-Smirnov test. Appropriate parametric and non-parametric methods were used for

inductive statistical analysis and related hypothesis control depending on whether the variables followed the normal distribution or not. Indicatively, the t-test for independent samples and the analysis of variance parametrically with one way analysis of variance (ANOVA) and non-parametric with the Kruskal-Wallis criterion for independent samples are mentioned.

The answers in PU2014 scale were coded as dichotomous (False = 0, True = 1). Answers "I do not know the answer" and not completing the answer, were coded as wrong. Accordingly, the participants' answers to the questions for the calculation of the PU2014 attitude and the scientifically correct attitudes were coded with 1 Strongly Disagree, 2 Disagree, 3 Neither Agree-Disagree, 4 Agree, 5 Strongly Agree. In contrast, questions that expected scientifically incorrect attitudes or were negatively coded were inversely coded: 1 Strongly Disagree, 2 Disagree, 3 Neither Agree-Disagree, 4 Agree, 5 Strongly Agree (Källman & Suserud, 2009). Respectively, the answers that participated in the PU2014 practice were coded as Never = 1, Rare = 2, Occasional = 3, Usually = 4, Always = 5 and vice versa the negative ones.

Questionnaire reliability test: Cronbach's a coefficient for Sparta PU2014 and its subscales is presented in Table 1.

Results

The study enrolled 107 nurses (19.6%, N = 21) men, 86 (80.4%) women out of 118 nurses (participation rate 90.68%) working in ICU. The mean age of the sample was 39.04 ± 5.6 years with an average length of experience 14.45 ± 6.02 years and the average time after graduation was 16.7 ± 5.58 years. Their demographic data are presented in Table 2. The participants were asked to report the average percentage of patients with pressure ulcers during the previous week prior to the completion of the questionnaire, independently of the stage of the pressure ulcer. The average reported rate was 8.69%, with 73.9% of the participants stating that the ratio usually was lower than that and only 14 nurses (13.1%) reported a proportion of patients with a pressure ulcer greater than or equal to 20% during a specific time period. The vast majority N = 98 (91.6%) reported that they are familiar with the use of patches or other materials related to the treatment of pressure ulcers and even with products

and methods prior to the development of a pressure ulcer. The nurses were asked to self-evaluate the level of their knowledge regarding the care of pressure ulcers. Less than one in three (30.8%, N = 33) stated sufficient knowledge and even more 9.3% (N = 10) characterized their knowledge as confined. Almost 1/3 of the participants stated that they had limited education (N = 32, 29.9%) regarding pressure ulcer prevention and management, 46.6% (N = 50) state that they had been trained adequately but there has been more than 4 years since their last training and only 7.5% (N = 8) reported training within 0-12 months prior to the completion of the questionnaire. The answers were similar regarding the reading of a scientific article or the recent guidelines regarding ulcers prevention and management (NPUAP, EPUAP & PPPIA, 2014).

Descriptive data: The basic knowledge of the participants regarding the pathophysiology of pressure ulcers development was assessed as moderate. For example, even though the 96.3% of the participants knew the causes of pressure ulcers, 85% of the participants did not know that ulcers always start from the skin and extend deeper, and 53.3% did not know that first stage pressure ulcers could heal conservatively in first degree. Moreover, more than one in three nurses did not know that pressure ulcers are considered wounds potentially colonized with pathogenic microorganisms. The participants' answers are presented in detail in Table 3. The answers to the questions about the nurses' knowledge on the prevention of pressure ulcers differed significantly. Regarding the risk assessment their knowledge was moderate while on the contrary they were higher regarding the enactment of preventive measures. The main deficiencies of nurses' knowledge are presented in Table 3. Participants were asked to choose from a list of potential risk factors associated with pressure ulcer development which of them were risk factors or aggravating factors. Moisture, immobility, analgesia, obesity and poor nutrition were correctly identified by the majority of participants as aggravating factors causing pressure ulcers. On the contrary, cardiovascular diseases and the presence of an ostomy (colostomy) were less noted (42.1% and 19.6%, respectively).

The nurses answered that it is beneficial to use "donuts" type devices for the prevention of pressure ulcers (67.3%), a high-tech alternating air pressure

mattress (96.3%), a special protective zinc-based skin cream on healthy skin (59.8%), moisturizers on healthy skin (85%), gloves inflated with water under the heels (45.8%), transparent or hydrocolloid pads to prevent abrasion (50.5%) and others. In Table 4 there are presented the participants answers regarding the interventions they implement in daily practice in order to manage pressure ulcers. The attitudes of the participants regarding the prevention and care of pressure ulcers are reflected in their responses according to which:

- 82.3% of the nurses strongly or totally agree that patients are at potential risk of developing pressure ulcers,
- 72.9% that most pressure ulcers can be avoided,
- 57.9% that it is preferable for some pressure ulcers to remain "open in the air",
- 25.2% that are sufficient to guide their colleagues regarding proper pressure ulcers care,
- 84.1% that continuous nursing assessment will give them an accurate calculation of the risk of developing pressure ulcers,
- 13% that are less interested in pressure ulcers prevention than in other caregivers and
- 90.7% that pressure ulcers should be assessed systematically in all hospitalized patients.

Inductive analysis: Table 5 shows the scores of Scale PU2014 and subscales. According to the regularity check for the scores of Sparta Tool PU2014 and its subscales the p values are less than 0.05 and therefore the normal distribution is not followed.

In terms of knowledge, it was investigated whether the participants' knowledge of prevention was at the same level as the knowledge of dealing with pressure ulcers. It was found that the knowledge regarding prevention (average percentage of correct answers 46.04%) lagged behind the knowledge for the treatment of pressure ulcers (average percentage of correct answers 65.07%) $p = 0.001$ ($t = 36.456$, $df = 106$, 95% CI 0.43–0.48).

Also, the gender of the participants did not show a statistically significant difference in the individual scores of knowledge, attitudes and practices.

Accordingly, the use of materials and care products for pressure ulcers was not statistically significantly associated with a higher level of knowledge or differentiation in attitudes and practices. Also, the percentage of patients who experienced pressure ulcers last week was not statistically significantly correlated with any of the individual PU2014 scores.

The effect of recent training, postgraduate training, previous service and knowledge of the recent NPUAP, EPUAP & PPIA guidelines on the score of the PU2014 subscales of the participants was investigated. Postgraduate education was associated with a higher knowledge score on the overall PU2014 knowledge scale ($p = 0.020$, $t = 2.359$, 95% CI 0.268–3.097). Postgraduate education at any level ($p = 0.001$, $t = 3.487$, 95% CI 0.442–1.606), as well as postgraduate specialization in clinical subject ($p = 0.004$, $t = 2.939$, 95% CI 0.298–1.532) were associated with higher rating in the sub-scale PU2014 staging. Postgraduate education was not statistically significantly correlated with the score of the subscales PU2014 practices ($p = 0.363$) and PU2014 attitudes ($p = 0.071$). Nurses who had

completed a cycle of specialty training or clinical specialization were found to differ from the rest in terms of PU2014 attitudes score ($p = 0.036$, $t = -2.129$, 95% CI -11.043–10.391). Regarding the knowledge, the previous service was not found to have a statistically significant effect on their knowledge, attitudes or practices according to the overall score on the individual scales. Recent training in the treatment of pressure ulcers (over a period of < 12 months or even < 2-3 years) was not found to show a statistically significant difference in the level of knowledge in relation to the nurses who reported training for a longer period or unspecified training, regarding the care of pressure ulcers. An interesting finding was that the mean score in PU2014 knowledge & PU2014 prevention was higher in participants who stated limited or insufficient knowledge (Mean 17.06 & 7.23, respectively) than in participants who stated sufficient knowledge (Mean 15.00 & 6.03, respectively) which was also statistically significant ($p = 0.005$, $t = 2.879$, 95% CI 0.640–3.485 for PU2014 knowledge, and $p = 0.002$, $t = 1.204$, 95% CI 0.450–1.958 for PU2014 prevention).

Table 1. Reliability test of Sparta Tool PU2014

Scale/subscales	Items (N)	Cronbach's a
Sparta PU2014 knowledge	31	0.641
PU2014 prevention	15	0.682
PU2014 treatment	8	0.682
PU2014 staging basics	9	0.655
Sparta PU2014 practices	11	0.711
Sparta PU2014 attitudes	13	0.674
Sparta PU2014 Total	55	0.731

Two-tailed significance levels $p < 0.01$ were considered statistically significant for each test to ensure an overall significance level $p < 0.05$.

Table 2. Demographic data

	N	%
Gender		
Male	21	19.6%
Female	86	80.4%
Basic degree		
University	105	98.1%
Did not answer	2	1.9%
Postgraduate studies		
MSc	48	44.9%
PhD	3	2.8%
Postgraduate studies in Clinical Nursing	37	34.9%
Postgraduate studies in another field	13	12.1%
Previous service (years)		
0-10	24	22.6
11-20	66	62.3
> 20	18	15.1
Clinical specialty	7	6.5%

Table 3. Main deficiencies of nurses' knowledge for pressure ulcers

Deficiencies of nurses' knowledge	Answered incorrectly	
	N	%
For the prevention of pressure ulcers		
Massage over the bony protrusions helps prevent pressure ulcers	80	74.8
Pressure ulcers risk assessments accurately (100%) predict the patient at risk of developing pressure ulcer	75	70.1
The Norton scale is used to assess the risk of developing venous ulcers	96	89.7
The Jackson-Cubin Pressure Ulcer Risk Assessment Scale is recommended for use in ICUs	44	41.1
Common foam heel protectors relieve pressure on the heels	94	87.9
For the staging of pressure ulcers		
The erythema that does not whiten under pressure is a stage I pressure ulcer	27	25.2
Recognition of stage IV pressure ulcer	71	66.4
Recognition of stage II pressure ulcer	24	22.4
Description of stage IV pressure ulcer	20	18.6

For the treatment of pressure ulcers

The liquid method of treating ulcers is considered essential for the treatment of pressure ulcers	69	64.5
Routine care of evidence-free pressure ulcers should include the use of topical antiseptics	67	62.6
Patients with stage I-II pressure ulcers should be placed on a plain foam mattress	46	43.0
In pressure ulcers with moderate to high exudate production what kind of patch do you use	87	81.3

Table 4. Nursing interventions for the treatment of pressure ulcers

	Never		Rarely		Occasionally		Usually		Always		Did not answer	
	N	%	N	%	N	%	N	%	N	%	N	%
Documentation	2	1.9	4	3.7	18	16.8	38	35.5	42	39.3	3	2.8
Sterilized gloves	13	12.1	13	12.1	16	15.0	26	24.3	37	34.6	2	1.9
Patient cleanliness care	0	0	0	0	0	0	15	14.0	89	83.2	3	2.8
Systematic change of position	0	0	6	5.6	18	16.8	53	49.5	28	26.2	2	1.9
Daily skin assessment	0	0	1	0.9	4	3.7	22	20.6	77	72.0	3	2.8
Maintaining a nutritional balance	0	0	1	0.9	6	5.6	37	34.6	59	55.1	4	3.7
Use of risk assessment scales	13	12.1	10	9.3	18	16.8	29	27.1	34	31.8	3	2.8
Use of specialized mattresses	0	0	2	1.9	19	17.8	43	40.2	4	37.4	3	2.8
Use of povidone iodide	39	36.4	26	24.3	18	16.8	13	12.1	4	3.7	7	6.5
Care from medical representatives	48	44.9	15	14.0	18	16.8	13	12.1	7	6.5	6	5.6
Implementation of a policy of documenting & monitoring of pressure ulcers	0	0	2	1.9	9	8.4	8	7.5	83	77.6	5	4.7

Table 5. Score of PU2014 and subscales

Sparta Tool PU2014 score	N	Mean ± SD	Median (IQR)
PU2014 knowledge	107	16.5 ± 3.743	17 (4-25)
PU2014 prevention	107	6.91 ± 1.960	7 (2-12)

PU2014 treatment	107	5.21 ± 1.647	5 (0-8)
PU2014 staging	107	5.35 ± 1.608	6 (0-8)
PU2014 practices	105	45.04 ± 5.739	46 (30-54)
PU2014 attitudes	104	46.57 ± 3.491	47 (30-53)

Discussion

The basic knowledge of the participants regarding the onset of pressure ulcers was moderate. Typically 85% of nurses did not know that pressure ulcers always start from the skin and extend deeper, 96.3% did not know the causes of pressure ulcers, and 53.3% did not know that first degree pressure ulcers can be healed with conservative treatment. While more than one in three did not know that pressure ulcers are considered wounds potentially colonized with pathogenic microorganisms. These findings are in line with previous studies that concluded that the nurses' knowledge regarding pressure ulcer prevention, less that ulcer pressure management, are insufficient or moderate in the majority of cases (Khojastehfar, Ghezeljeh & Haghani, 2020; Charalambous et al., 2019). In the study of Vasilopoulos 79% of the participants did not know that pressure ulcers always start from the skin and extend in depth, while almost everyone knew that pressure ulcers are caused by the application of external pressure, shear force, friction or a combination of the above (Vasilopoulos, 2015). In the same study, 45% knew that pressure ulcers when treated with a conservative method are primarily cured, and 53% of them that all pressure ulcers are considered wounds colonized by pathogenic microorganisms. The study of Vangelatou et al. showed that the participating nurses had at least sufficient knowledge to prevent pressure ulcers (> 70%), while their knowledge regarding infections as well as the microbial load of pressure ulcers was low (49.6%) but quite higher in relevance to the devices used to prevent pressure ulcers (69.6%) (Vangelatou et al., 2017).

A careful review of the literature will easily lead a reader to the conclusion that the majority of previous studies concluded that there is a lack of knowledge and attitudes towards prevention and management of pressure ulcers (Aydin et al., 2019; Miller et al., 2017; Tirgari, Mirshekari, & Forouzi,

2018; Iranmanesh, Rafiei & Ameri, 2011). These findings are in contrast with the great recognition of pressure ulcer prevention in order to provide high quality care. Nowadays, hospital-acquired pressure ulcer surveillance and prevention is recognized as a cost saving strategy for hospitals and is implemented by nurse executives as a strategy to support quality outcomes (Spetz et al., 2013).

Strand & Lindgren in their study asked respondents to list their perceived opportunities as well as possible barriers for carrying out pressure ulcer prevention. Pressure relief (97.3%) and nutritional support (36.1%) were the most frequently reported preventive measures. The most common stated barriers were lack of time (57.8%) and severely ill patients (28.9%). Adequate knowledge (38%) and access to pressure relieving equipment (35.5%) were the most commonly named factors for facilitating prevention. However, more than two in three nurses stated that there were no implementation of routine practices for risk assessment (Strand & Lindgren, 2010). Aydogan & Caliskan in their study stated that regarding the challenges to preventing pressure ulcers, 334 nurses (85.6%) mentioned a shortage of nurses, 322 (82.6%) mentioned a lack of pressure-redistribution materials and equipment, and 310 (79.5%) mentioned a lack of assistive personnel. The most commonly cited barriers to pressure ulcers prevention were insufficient staff levels (85.6%) and pressure redistribution materials and equipment (82.6%) (Aydogan & Caliskan, 2019).

The answers to the questions about the nurses' knowledge on the prevention of pressure ulcers were quite different, influenced by the educational level and working experience. Zhang et al. argued that the low score of knowledge on preventing medical devices is related to occurrence of pressure ulcer (Zhang et al., 2021). Hu, Sae-Sia, & Kitrungrrote found that there was a significant and positive relationship between pressure ulcers

prevention practice and knowledge (Hu, Sae-Sia, & Kitrungrrote, 2021). While Tirgari, Mirshekari, & Forouzi claimed that there is a wide dispersion of the score of the subscales of nurses' knowledge on the prevention of pressure ulcers. More specifically scores varied widely; "nutrition" showed the highest mean score, but "etiology and development" and "classification and observation" showed the lowest mean scores (Tirgari, Mirshekari, & Forouzi, 2018). Aydogan & Caliskan found that the average pressure ulcers prevention knowledge score was moderate (Aydogan & Caliskan, 2019).

Regarding the risk assessment, the nurses' knowledge about pressure ulcers was moderate while on the contrary it was higher regarding the taking of preventive measures. In their study Miller et al. found that nurses scored higher on the staging system-related items as compared to the prevention-related items (81% vs 70%) (Miller et al., 2017). Nurses achieved higher staging subscale scores if they were younger, had less experience, and if they worked in the medical ICU. Similarly, other researchers claimed that there was a significant relationship between the knowledge and level of hospital of the nurses in ICU. Knowledge about the MDRPI prevention in subjects with tertiary hospital was significantly higher (Zhang et al., 2021). Also, Khojastehfar, Ghezeljeh, & Haghani argued that knowledge about the pressure ulcer prevention in subjects with training history was significantly higher (Khojastehfar, Ghezeljeh & Haghani, 2020).

Pressure ulcer prevention was performed for 44.1 – 58.7% of patients at risk for developing a pressure ulcer (Braden score < 17). Planned repositioning was performed least often. Patients at risk for developing pressure ulcers (Braden score < 17) had higher odds of having skin assessment documented, receiving pressure-reducing mattresses and planned repositioning. Patients with higher age were more likely to have risk and skin assessment documented (Sving et al., 2014).

The study of Vangelatou et al. showed that the knowledge level of the nurses regarding the prevention of pressure ulcers was very good (90.4%) as well as the use of the appropriate support surfaces (86.1%), while the percentage of nurses who had knowledge about the appropriate position

of patients for the prevention of pressure ulcers was only 42.6% (Vangelatou et al., 2017).

Moisture, immobility, analgesia, obesity and poor nutrition were correctly identified by the majority of participants as aggravating factors causing pressure ulcers. On the contrary, cardiovascular diseases and the presence of an ostomy (colostomy) were recognized in smaller percentages (42.1% and 19.6%, respectively). Similarly, Vasilopoulos claimed that the cardiovascular diseases (45%) and presence of an ostomy (18%) identified by the participants as aggravating factors causing pressure ulcers (Vasilopoulos, 2015). Tayyib, Coyer & Lewis found that several barriers influenced the ability of nurses to implement pressure ulcers prevention strategies including time demands, limitation of nurses' knowledge, and current documentation format. Statistically significant facilitating factors that increased respondents' ability to undertake pressure ulcers prevention were ease of obtaining pressure-reduction surfaces, collaboration with interdisciplinary teams, and availability of appropriate skin care products. Thematic analysis of open-ended questions highlighted workload as a barrier that impedes the implementation of care specific to pressure ulcers prevention (Tayyib, Coyer & Lewis, 2016).

Postgraduate education was associated with a higher score of knowledge in the overall PU2014 knowledge scale while postgraduate education at any level as well as postgraduate specialization in clinical subject was associated with a higher score in the PU2014 subscale staging. Postgraduate education was not statistically significantly correlated with the score of the subscales PU2014 practices and PU2014 attitudes. Aydin & Karadag reported significant correlations between the percentage of correct answers and the level of nursing education, previous experience with pressure ulcers management, and participation in in-service training programs (Aydin & Karadag, 2010). In addition, Zhang et al. in their study concluded that there was a significant relationship between knowledge and highest educational attainment of nurses and technical title of nurses. Knowledge about the pressure ulcers' prevention in subjects with bachelor degree was obviously higher, and advanced nurse practitioners were more knowledgeable than senior nurses (Zhang et al., 2021).

Aydin et al. supported that pressure injury knowledge and practices were positively associated with nurses having a bachelor's and/or postgraduate degree, nurses caring for a higher number of patients with pressure injuries per week, nurses practicing in ICUs and wound care clinics, nurses with specific education in pressure injury, and those indicating adequate skills and knowledge in pressure injury (Aydin et al., 2019). Similarly, in another study was noted that participants reported a moderate to high ability to rise above barriers in pressure ulcers prevention, a positive attitude towards pressure ulcers prevention, and considered this a priority in their care of patients. High patient acuity emerged as a barrier to implementing timely pressure ulcers prevention strategies. In the knowledge test participants with postgraduate qualifications answered more statements correctly (Coyer et al., 2019). It seems that clinical training affects nurses' knowledge regarding pressure ulcers' prevention and management. Strand & Lindgren found that there were significant differences in this section between nursing staff who had education in critical or anaesthesia care and those who did not (Strand & Lindgren, 2010).

The attitudes of the participants regarding the prevention and care of pressure ulcers are reflected in their responses according to which 82.3% of the nurses strongly or totally agree that patients are at potential risk of developing pressure ulcers, 72.9% that most pressure ulcers can be avoided, 57.9% that it is preferable for some pressure ulcers to remain "open in the air", 25.2% that are sufficient to guide their colleagues regarding proper pressure ulcers care, 84.1% that continuous nursing assessment will give them an accurate calculation of the risk of developing pressure ulcers, 13% that are less interested in pressure ulcers prevention than in other caregivers and 90.7% that pressure ulcers should be assessed systematically in all hospitalized patients. In previous studies was reported that 76.9% and 72.1% of the nurses, respectively, believe that all patients are at potential risk of developing pressure ulcers and that most pressure ulcers can be avoided (76% and 94.2%) (Moore & Price, 2004; Källman & Suserud, 2009).

Our findings did not reveal any correlation between knowledge or attitude score in relevance to working experience, working hours or type of ICU. This may be explained by the fact that all nurses in our study

have the same shift distribution, similar workload, the same patient/nurse ratio in all ICUs, similar working conditions and small differences in their payment. On contrary, in a previous study there was identified a statistically significant relationship between nurses' attitude and working hours with nurses working more hours per week scoring higher attitude score towards prevention of pressure ulcer. Moreover, there was noticed an almost stable increase in attitude score in correlation to an increase of working hours per week (Khojastehfarb, Ghezaljeha & Haghani, 2020). Aydin et al. modeled the predictive power of unit/patient characteristics, nurse workload, and nurse expertise in relation to hospital-acquired pressure ulcer preventive clinical processes of care. They concluded that unit/patient characteristics were potential predictors for the development of a pressure ulcer in a hospitalized patient. Nurses' workload, expertise, and processes of care in relation to risk assessment and preventive or treatment interventions, are significant predictors that can be addressed to reduce pressure ulcer incidence. They also commented that different strategies should be implemented in units where experienced full-time nurses are not available (Aydin et al., 2015). Tayyib, Coyer & Lewis argued about context-specific factors that influence the adoption and implementation prevention interventions by ICU nurses despite their positive attitude toward their implementation. For example the availability of pressure-relieving support surfaces and appropriate skin care products are essential in order to implement prevention measures. Moreover, the level of collaboration with the other members of the interdisciplinary healthcare team may affect the final outcome. Whereas, limited prevention knowledge regarding prevention and management of pressure ulcers along with nurses' workflow in relevance to workload, time demands and documentation stand as barriers to effective pressure ulcers' prevention (Tayyib, Coyer & Lewis, 2016).

Charalambous et al. supported that positive prevention attitudes are correlated with better knowledge regarding pressure ulcers prevention and management (Charalambous et al., 2019). Our findings are in line with these results indicating that continuous education and update of knowledge regarding pressure ulcers prevention via systematic training could be the key to enhance prevention

attitudes and clinical efficiency through skills development.

The result suggests that nurses had relatively inadequate knowledge levels and positive attitudes, attitudes and knowledges correlated statistically significantly and positively. It is proposed that through the development of educational programs and the frequent measurement of the two parameters further improvement can be achieved (Charalambous et al., 2019). Systematic assessment of the effectiveness of the prevention measures that are implemented by ICU nurses will not only guide evidence based practice but at the same time affects nurses' confidence in the effectiveness of prevention. Therefore, nurse clinical educators should invest more on the improvement of nursing knowledge and attitudes based on the latest scientific evidence for pressure injury prevention (Tirgari, Mirshekari, & Forouzi, 2018).

In parallel, Zhang et al. found that there was a statistically significant difference between the level of care and the prevention attitudes of nurses. For example, the attitudes of nurses working in tertiary care were significantly higher than that of nurses in secondary care. Moreover, there was a significant difference in attitudes between nurses employed in a general hospital and those in private hospitals. Noticeably, there was an obvious difference regarding the attitudes among nurses based to their hierarchy. For example, head nurses' attitudes were significantly more positive in comparison to senior nurses. Interestingly, participants with supervisor nurses showed significantly more positive attitudes in relevance to pressure ulcer prevention than nurses and senior nurses (Zhang et al., 2021). The use of valid tools for assessing the risk of developing pressure ulcers and systematic repositioning are also highly recommended in intensive care daily practice (Pancorbo-Hidalgo et al., 2007; Sving et al., 2014). Differences in knowledge affect attitudes and daily practice, as a result in clinical level we see that different strategies regarding prevention and management of pressure ulcers are implemented (Hollisaz, Khedmat & Yari, 2004; Thomas et al., 2005; Sving et al., 2014).

Nurses who had completed a cycle of specialty training or clinical specialization were found to differentiate from the rest in terms of PU2014 attitudes score. Regarding the knowledge, their

previous clinical expertise was not correlated to a statistically significant effect on their knowledge, attitudes or practices according to the overall score on the individual scales. Zhang et al. stated that there was an obvious and positive relationship between knowledge and attitudes. By increasing the knowledge score, attitudes scores were also increased. At the same time, knowledge and practice also had an obvious and positive relationship, which reported that increased knowledge score would increase practice score. The variables of level of hospital, scores of attitudes, and scores of practice were associated with ICU nurses' knowledge in their study (Zhang et al., 2021). In addition, Khojastehfarb, Ghezeljeha & Haghani found in their study that there was a significant and positive correlation between knowledge and attitudes. By increasing the knowledge score, attitudes scores were also increased. The coefficient of determination was 0.13, meaning that these two variables had 13% in common variance (Khojastehfarb, Ghezeljeha & Haghani, 2020). A training program in nurses with limited or no training in pressure ulcer prevention or/and management seem to lead to greater impact in comparison to nurses with prior training or education (Iovu et al. 2017).

A recent study concluded that there was a significant relationship between gender and knowledge as well as attitude towards pressure ulcers prevention. Women seem to have better knowledge and more positive attitude towards prevention in comparison to men. Also, there was a noticeable difference in attitudes between nurses employed in the general ICU and those in other sectors, in such a way that nurses working in the general ICU had higher attitude scores (Khojastehfar, Ghezeljeh & Haghani, 2020). This is not in line with our findings that gender did not differentiate the level of knowledge, practice or attitude towards pressure ulcer prevention. However, in our study the use of prevention measures was associated with better knowledge. Aydogan & Caliskan found that nurses' attitudes toward pressure ulcers prevention were affected by their self-sufficiency in pressure ulcers risk assessment, willingness to learn more about preventing pressure ulcers, gender, and knowledge (Aydogan & Caliskan, 2019).

Conclusions: In conclusion, based on the study findings the levels of knowledge, attitude, and practice of ICU nurses on preventing pressure ulcers were acceptable. Additionally, the findings suggest that nurses with post graduate education pose a more positive attitude regarding prevention and better level of knowledge regarding pressure ulcer prevention, early assessment and management. Moreover, the nurses in our study reported poor self-assessment regarding knowledge and low confidence in their individual competence regarding pressure ulcers' prevention. Interestingly, it seems that they are more familiar with the treatment of pressure ulcers and less in preventing them. A comprehensive educational approach with continuous ongoing training along with systematic updating of the most-recent evidence could be beneficial for raising the level of knowledge, attitude, and practice of ICU nurses and at the same time for improving the quality of care for critically ill patients.

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