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Effect of Simulation-Based Learning on Critical Care Nurses' Adherence to SKINCARE Bundle

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Abstract

Background: Pressure injuries remain a significant concern in critical care settings, contributing to patient morbidity, increased healthcare costs, and prolonged hospital stays. Adherence to evidence-based prevention strategies, such as the SKINCARE bundle, is essential to mitigate these adverse outcomes. Nevertheless, achieving consistent implementation among critical care nurses can be challenging. **Aim of the Study:** This study aimed to evaluate the effect of simulation-based learning on critical care nurses' adherence to SKINCARE bundle. **Design:** A quasi-experimental one-group (pre–post-test) design was employed. **Subjects:** 54 nurses working in the intensive care units of a Mansoura university hospital in Egypt. **Tool:** Data was collected by using one tool: the Simulation-based evaluation checklist for nurses' adherence to the SKINCARE bundle. **Results:** Post-intervention findings revealed a statistically significant improvement in nurses' adherence to the SKINCARE bundle compared to pre-intervention levels ($p < 0.001$). **Conclusion:** Simulation-based learning is an effective educational strategy for enhancing critical care nurses' adherence to the SKINCARE bundle. **Recommendation:** These findings highlight the importance of continuous and innovative educational approaches to ensure the consistent application of evidence-based practices, ultimately leading to improved patient outcomes and quality of care in critical care environments. The study reinforces the need for healthcare institutions to invest in and integrate simulation-based training into their ongoing professional development programs for nursing staff.

Keywords: Adherence, Critical Care Nurses, SKINCARE Bundle & Simulation-Based Learning

Introduction

The skin is the largest organ of the human body, functioning primarily as a protective barrier between the internal systems and the external environment. Covering an approximate surface area of two square meters and accounting for 12 to 15 percent of total body weight **(Lawton, 2020).** The skin plays a critical role in maintaining homeostasis. It safeguards the body from potentially harmful external agents while preserving internal structures and facilitating sensory perception (**De Szalay & Wertz, 2023).**

Skin injury refers to the progressive damage and deterioration of the skin's integrity, often resulting from prolonged pressure, friction, shear forces, or moisture exposure **(Fathy et al., 2022).** If not managed promptly, skin injury can advance to superficial abrasions, where the outermost layer of the skin is worn away due to mechanical trauma. Understanding the stages and characteristics of skin breakdown is essential for early identification and effective intervention to prevent further tissue damage and associated complications **(National Pressure Injury Advisory Panel [NPIAP], 2022; Thomas, 2020).**

The prevalence of skin injury in intensive care units (ICUs) varies significantly, ranging from 12% to 32.7%, and is reported to be the highest compared to other healthcare environments **(NPIAP, 2023; Jacq et al., 2021)**. As patients being cared for in ICUs are particularly at risk of medical device-related pressure injury (MDRPIs) due to their lack of ability to change position independently, they are connected to several medical devices **(Santy-Tomlinson & Limbert, 2020).** Moreover, sedation and anesthesia, diminished circulation, and malnutrition. These injuries in hospitalized patients are linked to longer hospital stays, increased healthcare expenses, and worse patient outcomes **(NPIAP, 2023; Jacq et al., 2021).**

Critically ill patients (CIPs) are the most vulnerable group to MDRPI. Implementing an evidence-based practice is an essential step supporting skin integrity for those patients **(Munoz et al., 2022).** The bundle uses best practices to minimize variations in nursing interventions, and documentation can be standardized with the use of a pressure injury prevention program, such as the SKINCARE bundle **(Kennedy, 2023).**

SKINCARE bundle is an evidence-based practice for the prevention of MDRPI. It consists of eight

domains: First, keep repositioning more than twice daily, then inspecting the skin under the device more than twice daily, and nutrition assessment. In addition to choosing appropriately sized and typed medical devices, avoiding placement of devices over previous or existing pressure injury sites, reporting MDRPI accurately and promptly, and finally educating staff about prevention strategies for device-related pressure injuries (**Tayyib et al., 2021; Kottner et al., 2019; Rabab, 2018; Sayed, Ali, & Diab, 2022).**

Critical care nurses (CCNs) have an essential role in maintaining the integrity of skin, assessing physiological status, and preventing the risk of developing skin injuries **(Nasr ELdin, et al., 2022).** Health care professionals, such as nurses, can learn by using simulation-based learning (SBL), which is acknowledged as a good teaching strategy worldwide. The goal of SBL is to improve the learning and development of knowledge and skills, while also supporting their long-term retention. Simulation-based learning can be utilized extensively in clinical practice and integrated into nursing programs to assist qualified nurses in enhancing their competence, knowledge, and abilities (**Miller, 2023).**

Critical care settings include advanced technologies and infrequent emergencies that nurses might not regularly experience during traditional clinical training **(Munshi, et al., 2015).** So, SBL can reduce the risks associated with real-world practice by enabling nurses to acquire practical experience and improve their skills in a critical setting (Sjöberg et al., 2025). A systematic review conducted by **Alharbi, et al., (2024)** reported SBL as a potentially valuable experiential teaching strategy in nursing education. A variety of activities can be used in SBL, including a realistic clinical scenario, lifelike virtual environments, and role-playing, not merely working with mannequins (**Kim, et al.,, 2016).**

Significance of the Study

Pressure injuries are a prevalent and serious complication among critically ill patients, often resulting in extended hospitalization, increased healthcare costs, and diminished patient quality of life **(Jacq et al., 2021).** Evidence indicates that approximately 20% of pressure injuries in CIPs develop within the first 48 hours postoperatively **(Molon & Estrella, 2021),** underscoring the critical importance of early and effective preventive measures. The SKINCARE bundle, an evidence-based set of interventions, has been shown to significantly reduce the incidence of pressure injuries when applied consistently **(Tayyib et al., 2021).** However, adherence to such protocols can be challenging in the demanding environment of critical care units, where time constraints, workload, and competing priorities may limit compliance.

Simulation-based learning offers an interactive and practical approach to bridge the gap between theoretical knowledge and clinical application. By recreating real-life scenarios, even though using low-fidelity simulation techniques, nurses can practice, refine, and internalize the steps of the SKINCARE bundle in a safe and controlled environment. Educating critical care nurses through this method not only enhances adherence to preventive measures but also fosters confidence, critical thinking, and proactive decision-making (**Miller, 2023).** Therefore, this study is significant as it evaluates the impact of simulation-based learning on improving nurses' adherence to the SKINCARE bundle, ultimately aiming to reduce the occurrence of pressure injuries, improve patient outcomes, and strengthen the overall quality of care in intensive care settings.

Aim of the Study

This study aimed to evaluate the effect of simulation-based learning on critical care nurses' adherence to SKINCARE bundle.

Research Hypothesis

The current study hypothesized the following:

H1: Critical care nurses who participate in low-fidelity clinical simulation on the SKINCARE bundle would demonstrate significantly higher adherence to these preventive measures compared to their adherence before the intervention.

Operational Definitions

Simulation-Based Learning (Low-Fidelity): A teaching method that uses simplified, realistic scenarios and basic tools, e.g., role-play, paper-based case scenarios, posters, and task trainers to improve nurses' hands-on skills related to skin care practices **(Kim, et al., 2016).**

MethodDesign

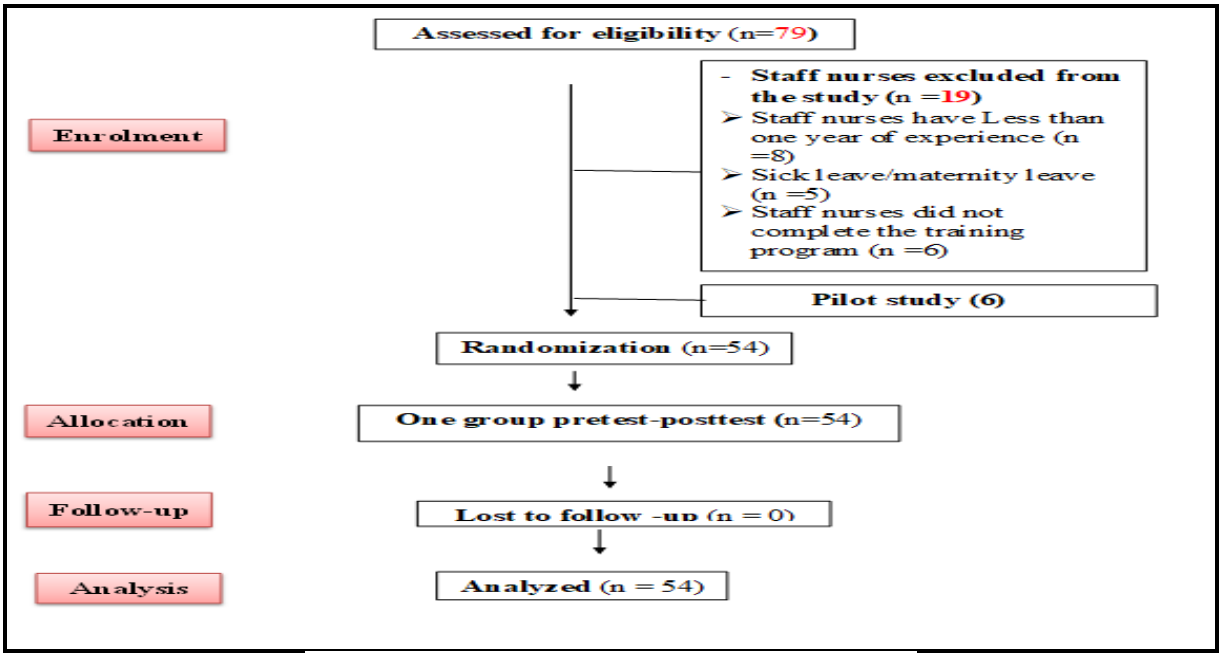
A quasi-experimental research design, specifically a one-group pretest-posttest approach, was employed to evaluate the changes in critical care nurses' adherence to the SKINCARE bundle following the implementation of a low-fidelity clinical simulation training intervention.

Setting

The study was conducted in three surgical ICUs at Mansoura Emergency Hospital. ICU 1 comprised two sections, each containing five beds. ICU 2 included ten beds, while ICU 3 consisted of twelve beds. These units provide care for patients with neurological and surgical conditions, as well as those suffering from multiple traumatic injuries. All ICUs are equipped with advanced medical technologies and adequately staffed to deliver high-quality care to CIPs. The nurse-to-patient ratio across these units was maintained at 1:2.

Subjects

A convenience sample of 54 nurses was recruited from the selected ICUs. Eligible nurses, including those who had a minimum of six months of clinical experience, were actively involved in direct patient care and provided informed consent to participate in the study.



Figure(1): Flow Chart of the Participants Nurses

Data Collection Tool

A single structured tool was utilized to collect data for this study:

Tool one: Simulation-Based Evaluation Checklist tool: This tool used to assess Nurses' Adherence to the SKINCARE Bundle, which was divided into two main parts:

This part gathered information related to the participating nurses' demographic and professional background, including age, gender, educational qualifications, years of work experience in the ICU, and prior participation in in-service training or educational programs about medical device-related pressure injuries.

Part (I): SKINCARE Bundle Observation Checklist

This part was adapted from **Tayyib et al. (2021),** with additional practices integrated following a comprehensive review of relevant literature (**Kottner et al., 2019; Rabab, 2018; Sayed, Ali, & Diab, 2022)**. It was designed to evaluate nurses' adherence to the SKINCARE bundle's evidence-based practices for the prevention of MDRPI. The bundle comprises eight core domains, each including a specific set of practices:

1. **S** – Secure the device and protect the skin with dressings at high-risk areas (e.g., nasal bridge): 6 items.
2. **K** – Keep repositioning more than twice daily (unless medically contraindicated); remove devices as soon as feasible: 5 items.
3. **I** – Inspect the skin under the device more than twice daily, especially in high-risk patients: 3 items.
4. **N** – Nutrition assessment, including nutritional deficits, weight loss, hydration status, and supplementation: 7 items.
5. **C** – Choose appropriately sized and typed medical devices to fit individual needs: 5 items.
6. **A** – Avoid placing devices over previous or existing pressure injury sites; assess pressure injury risk status: 6 items.
7. **R** – Report MDRPI accurately and promptly: 4 items.
8. **E** – Educate staff about prevention strategies for device-related pressure injuries: 15 items.

Scoring system: Each correctly performed intervention was scored one point, while incorrectly performed or omitted interventions received zero points. The maximum total score for participant nurses' adherence to SKINCARE bundle practices was 51. Based on the total score, adherence levels were categorized as follows: Satisfactory: ≥ 80% adherence and unsatisfactory: < 80% adherence **(Sayed et al., 2022).**

Validity of the Tool

The content validity of the tool was evaluated by a panel of seven experts four from faculty members specializing in critical care and emergency nursing and three faculty members from the Faculty of Medicine. The experts reviewed the tool for clarity, relevance, comprehensiveness, and appropriateness to the study objectives. The Content Validity Index (CVI) for the tool was calculated based on their ratings and was found to be 0.92, indicating excellent content validity.

Reliability of the Tool

Internal consistency reliability of the adapted SKINCARE bundle observation checklist tool was tested using e Cronbach's alpha and yielding a coefficient of 0.883, indicating high reliability.

Pilot Study

Before the implementation of the main study, a pilot study was conducted in March 2025 involving six nurses (representing 10% of the total sample) to evaluate the objectivity, feasibility, and clarity of the data collection tool. This preliminary phase ensured that the tool was practical and appropriately aligned with the study's objectives. The nurses who participated in the pilot study were excluded from the main study sample to prevent any potential bias. Based on the feedback and findings from the pilot, necessary modifications were made to refine the tool for optimal application.

Ethical Considerations

Ethical approval for conducting the study was obtained from the Research Ethics Committee at the Faculty of Nursing, Mansoura University (Approval No. P.0767). Additionally, official permissions were secured from the administrative authorities of the selected hospital. Informed consent was obtained from all participating nurses after they were thoroughly informed about the study's purpose, procedures, potential benefits, and associated risks. Participation was entirely voluntary, and confidentiality and anonymity were maintained throughout the research process.

Data Collection Process

Researcher collected data throughout the period from March to July 2025 in three phases: preparation, intervention, and evaluation.

Preparation Phase: The Researcher introduced herself to the participant nurses and conducted a 15-minute introductory session, providing an overview of the study's title, aim, and procedures.

Intervention Phase: The intervention phase was carried out to improve nurses' adherence to the SKINCARE bundle through structured simulation-based training. Initially, the PI collected demographic data from the participant nurses using part I of the tool. Following this, a baseline assessment of current nursing practices was conducted using a non-participant observational approach. The PI observed nurses' adherence to the SKINCARE bundle using part II of the tool to identify gaps in practice. Based on the assessment findings and a review of relevant literature, a structured simulation-based training program was developed to enhance nurses' adherence to the SKINCARE bundle. The training program was implemented over two months and was designed to incorporate low-fidelity clinical simulations using realistic ICU scenarios and basic tools such as role-play, posters, and task trainers. Each simulation scenario addressed key components of the SKINCARE bundle, including skin inspection, risk assessment, patient repositioning, device securing, moisture management, nutritional support, and documentation. Sessions were designed to promote skill acquisition, critical thinking, and adherence to clinical guidelines. Each nurse participated in one theoretical session followed by three practical simulation sessions. The theoretical session provided an overview of the SKINCARE bundle concept, its evidence-based components, the importance of preventing pressure injuries, and the role of nurses in early detection and intervention. It also included discussions on risk assessment tools and factors affecting skin integrity. The practical sessions focused on hands-on application of the SKINCARE bundle components through scenario-based learning. Nurses practiced performing systematic skin assessment, accurate risk scoring, safe patient repositioning techniques, securing medical devices to prevent skin damage, managing moisture, and providing appropriate nutritional support. The duration of each session ranged from 30 to 45 minutes. Participants were organized into small groups of 4 to 6 nurses based on their shift schedules to minimize disruption to clinical duties. Training sessions were conducted during both the morning shift (after routine patient care) and the afternoon shift. Throughout the training, the PI maintained open lines of communication to support engagement, clarify procedures, and enhance learning outcomes. Following the completion of the simulation training program, the PI conducted a post-intervention reassessment of the nurses' adherence to the SKINCARE bundle using the same observation tool.

Evaluation Phase: This phase assessed the effectiveness of the simulation-based training on nurses' adherence to the SKINCARE bundle. All participants were evaluated before and immediately after the intervention using the simulation-guided SKINCARE bundle observation checklist. A comparison of pre- and post-training scores was conducted to determine improvements in practice and the impact of the simulation training program.

Data Analysis: Data was analyzed using the Statistical Package for the Social Sciences (SPSS) software, version 20.0 (IBM Corp., Chicago, IL, USA). Categorical variables were presented as frequencies and percentages. Fisher's exact test was applied to examine associations between categorical variables. Pearson's correlation coefficient was used to assess relationships between continuous variables. A p-value of less than 0.05 was considered statistically significant (Field, 2024).

Results

Table (1): Nurses' Demographic Characteristic

Variables	Participant nurses (n=54)	
	n	%
Gender		
- Male	18	33.3
- Female	36	**66.7**
Age (years)		
- < 30	17	31.5
- 30-40	27	50.0
- > 40	10	18.5
Educational Level		
- Technical Institute of Nursing	25	46.3
- Bachelor of Nursing	24	44.4
- Postgraduate study	5	9.4
Years of work experience in the ICU		
- 1 – < 5	28	51.8
- 5 - 10 years	12	22.2
- >10 years	14	26.0
Attending previous in-service training courses or programs on the prevention of pressure injury		
- No	46	85.2
- Yes	8	14.8

ICU: Intensive Care Unit
Data are expressed as numbers (n) and percentages (%), SD Standard Deviation.

Table (2) : Percentage distribution of adherence to the SKINE CARE Bundle Domains Pre- and Post-Educational Sessions among studied group

SKIN CARE Bundle Domains	Participant Nurses (n=54)							
	Pre-sessions				Post-sessions			
	Non-Adherent		Adherent		Non-Adherent		Adherent	
	n	%	n	%	n	%	n	%
S- Secure the device and protect the skin with dressings in high-risk areas	17	31.5	37	68.5	8	14.8	46	85.2
Z test (P)	**3.020 (0.003)** **							
K- Keep repositioning more frequently than twice daily (if not medically contraindicated); remove the medical device as soon as medically feasible	42	77.8	12	22.2	6	11.1	48	88.9
Z test (P)	**6.013 (<0.001)** **							
I- Inspect the skin under the device more than twice daily; high-risk patients will require more frequent assessments	40	74.1	14	25.9	9	16.7	45	83.3
Z test (P)	**5.568(<0.001)** **							
N- Nutrition and hydration; nutrition deprivation and insufficient dietary intake are risk factors for MDRPI and impaired wound healing	38	70.4	16	29.6	11	20.4	43	79.6
Z test (P)	**5.196 (<0.001)** **							
C- Choose the correct size and type of medical device to fit the individual	20	37.0	34	63.0	7	13.0	47	87.0
Z test (P)	**3.606 (<0.001)** **							

SKIN CARE Bundle Domains	Participant Nurses (n=54)							
	Pre-sessions				Post-sessions			
	Non-Adherent		Adherent		Non-Adherent		Adherent	
	n	%	n	%	n	%	n	%
A- Avoid placing devices over sites of prior or existing pressure injury/assess the patient's risk status	11	20.4	43	79.6	4	7.4	50	92.6
Z test (P)	**2.646 (0.008)** **							
R- Report MDRPI correctly and immediately, monitor incidence and prevalence	18	33.3	36	66.7	8	14.8	46	85.2
Z test (P)	**3.162 (0.002)** **							
E- Educate staff on the correct use of devices and prevention of skin breakdown (younger and older patients are at high risk), never apply additional pressure when securing a device, and do not position the patient directly on a medical device unless it cannot be avoided	13	24.1	41	75.9	5	9.3	49	90.7
Z test (P)	**2.828 (0.005)** **							

MDRPI: Medical devices related to pressure injury
Data are expressed as numbers (n) and percentages (%) by Student's Z-test, significant if p-value ≤ 0.05

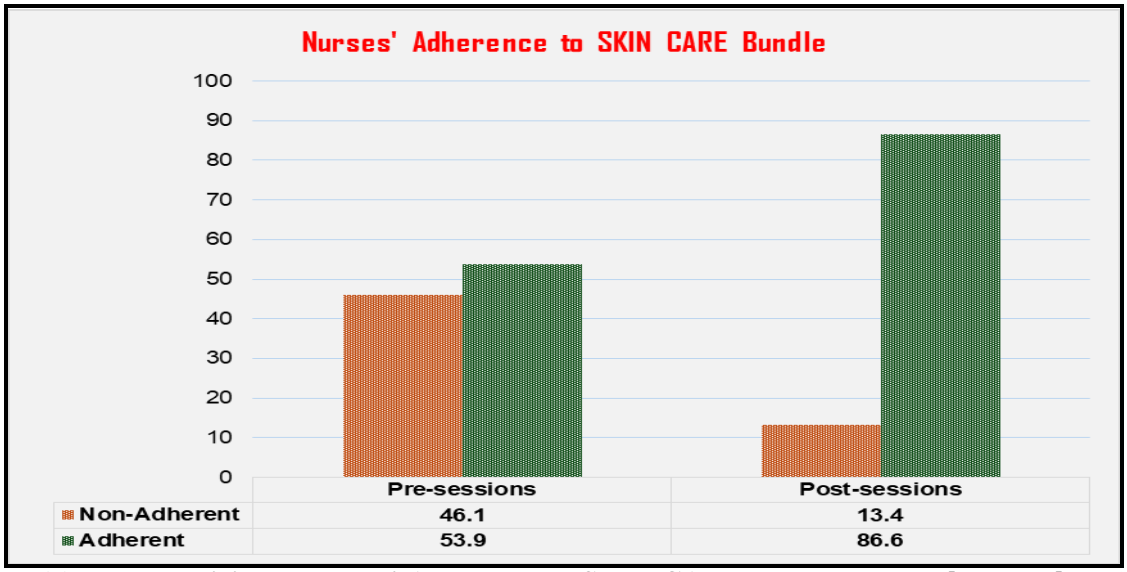


Figure (1): The Participant Nurses' Adherence to SKIN CARE Bundle Pre- and Post-Educational Session

Table (3): Association Between the Nurses' Adherence to the SKINCARE Bundle and Their Demographic Characteristics Pre- and Post-Educational Sessions

Variables	Nurses' Adherence (n=54)							
	Pre-sessions				Post-sessions			
	Non-Adherent		Adherent		Non-Adherent		Adherent	
	n	%	n	%	n	%	n	%
Gender								
- Male	9	36.0	9	31.0%	3	50.0	15	31.3
- Female	16	64.0	20	69.0%	3	50.0	33	68.8
X^2 (P value)	0.149 (0.700)				0.844 (0.358)			
Age (years)								
- < 30	8	32.0	9	31.0%	0	0.0	17	35.4
- 30-40	8	32.0	19	65.5%	0	0.0	27	56.3
- > 40	9	36.0	1	3.4%	6	100.0	4	8.3
X^2/ Mc (P value)	**10.703 (0.005)** **				29.700 (<0.001) **			

Variables	Nurses' Adherence (n=54)							
	Pre-sessions				Post-sessions			
	Non-Adherent		Adherent		Non-Adherent		Adherent	
	n	%	n	%	n	%	n	%
Educational Level								
- Technical Institute of Nursing	22	88.0	3	10.3%	0	0.0	17	35.4
- Bachelor of Nursing	3	12.0	21	72.4%	0	0.0	27	56.3
- Postgraduate study	0	0.0	5	17.2%	6	100.0	4	8.3
X^2/ Mc (P value)	**32.824 (<0.001)** **				7.830 (0.020) **			
Years of Work Experience in the ICU								
- < 5 years	5	20.0	23	79.3%	5	83.3	23	47.9
- 5 - 10 years	10	40.0	2	6.9%	0	0.0	12	25.0
- >10 years	10	40.0	4	13.8%	1	16.7	13	27.1
	19.286 (<0.001) **				3.013 (0.222)			
Attending Previous In-Service Training Courses or Programs on the Prevention of Pressure Injury								
- No	24	96.0	22	75.9%	6	100.0	40	83.3
- Yes	1	4.0	7	24.1%	0	0.0	8	16.7
X^2/ FE (P value)	**4.314 (0.038)** *				1.174 (0.279)			

ICU: Intensive Care Unit
Data are expressed as numbers (n) and percentages (%), (*) Statistically significant at p ≤0.05,
χ2 = chi-square, MC: Monte Carlo test,

Table (1): Presents the demographic characteristics of the studied nurses and shows that more than two-thirds of the participants (66.7%) were female, and 50% were between 30 and 40 years old. Additionally, 46.3% had graduated from the Technical Institute of Nursing. About half of the participants had between 1 and less than 5 years of ICU work experience. The results also indicated that the majority of nurses (85.2%) had not previously participated in in-service training sessions or programs on the prevention of pressure injuries.

Table (2): Compares the participant nurses' adherence to the SKINCARE bundle domains before and after the educational sessions. According to the current results, 85.2% of the studied nurses adhered to securing devices with dressings in high-risk areas after the teaching sessions. Before the training, fewer than 22.2% of the participating nurses adhered to repositioning medical devices more than twice daily. Following the training sessions, most of them (88.9%) adhered to this practice. In addition, there was a marked improvement in the nurses' ability to inspect the skin under the device more than twice daily and to assess the nutrition and hydration status of high-risk patients (pre-sessions: 25.9% & 29.6%, respectively; post-sessions: 83.3% & 79.6%, respectively). Regarding choosing the correct size and type of medical device to fit the individual, most of the studied nurses (87.0%) adhered to this practice after the teaching sessions. To avoid placing devices over sites of prior or existing pressure injuries, the vast majority of the nurses (92.6%) adhered to this guideline post-education. Moreover, there was improvement in the nurses' ability to correctly report medical device–related pressure injuries and to educate staff on the correct use of devices and prevention of skin breakdown after the educational sessions (85.2% & 90.7%, respectively).

Figure (1): Compares the participant nurses' level of adherence to the SKIN CARE bundle pre- and post-educational sessions. According to the current results, nurses' adherence to the SKINCARE bundle domains post-educational sessions was significantly increased compared to pre-educational sessions. Most of the studied nurses were more adherent after the teaching sessions than before (post-sessions: 86.6% & pre-sessions: 53.9%).

Table (3): Displays the association between the nurses' total practice scores of the oral care bundle pre- and post-educational sessions and their demographic characteristics. Pre-educational sessions, the results demonstrated that the practice scores of the participant nurses did not exhibit a statistically significant correlation with their demographic characteristics. In contrast, a statistically significant correlation was found between the practice scores of the participant nurses and their years of work experience in the ICU, as well as their educational level (p = 0.035 & 0.002, respectively).

Discussion

Pressure injuries remain a substantial healthcare challenge, affecting up to 12.8% of hospitalized patients **(Wassel, et al., & Larson, 2020).** The SKINCARE bundle provides a structured, evidence-based framework for prevention; however, its effectiveness is contingent on consistent implementation by bedside nurses **(Fathy Amr et al.,**

2022). The present study highlights the pivotal role of simulation-based training utilizing low-fidelity scenarios in enhancing nurses' adherence to this protocol. Such training offers a safe, controlled environment to reinforce best practices, bridge the theory–practice gap, and build confidence in executing preventive interventions.

The current study provided information on the demographic characteristics of the participating nurses. The finding of the present study that only fifteen percent of nurses had prior training in pressure injures prevention highlights a critical gap in nursing education, which could impact the quality of care provided **(Stevenson et al., 2018).** From the researchers' point of view, the lack of prior training in pressure injures prevention among a large proportion of nurses highlights the importance of regular and comprehensive training programs. Enhancing education and awareness among ICU nurses is essential for improving adherence to best practices in preventing MDRPI.

Johnson & Taylor (2018) investigated the impact of combining SKINCARE bundles with staff education programs. The intervention included workshops, real-time feedback, and competency assessments. MDAPI rates reduced significantly from 11.2% to 5.4%. The study attributed success to increased awareness and adherence to bundle protocols among healthcare workers.

The role of education and training in enhancing bundle implementation was evident in **Padula & Delarmente (2019)** study, which assessed the impact of adding educational sessions to SKINCARE bundles in a single-center ICU. The study reported a reduction in MDAPI rates from 18% to 7% post-intervention, with compliance exceeding 85%. These findings echo the current study's results, where educational interventions significantly improved nurses' adherence to the SKINCARE bundle. This highlights the necessity of structured educational programs to ensure sustainability and adherence to prevention protocols.

The findings from the studies reviewed indicate that the SKINCARE bundle is a highly effective tool for preventing MDAPIs in CIPs. However, the variation in results across different settings highlights the importance of consistent implementation and adherence to all components of the bundle. The results from the current study reinforce this evidence and emphasize the need for continued research and refinement of prevention protocols to optimize patient outcomes.

The current study's finding shows significant improvements in nurses' adherence to all SKINCARE bundle domains after educational interventions. The largest increases in adherence were seen in "Keep repositioning more frequently" and "Educate staff on correct device use". This is consistent with studies that have shown that education and training are effective in improving adherence to pressure injures prevention protocols (**Manley et al., 2020)**. In the researchers' opinion, the dramatic improvements in adherence to the SKINCARE bundle domains post-education confirm the effectiveness of educational interventions in changing nursing behaviours and improving care practices. This suggests that regular in-service training could have a significant impact on reducing pressure injuries in ICU settings.

A study conducted by **Smith et al. (2022)** explored the effectiveness of the SKINCARE bundle in reducing MDAPIs in an ICU setting. A total of 200 patients were included, with 100 patients receiving the SKINCARE bundle and 100 receiving routine care. The study found a significant reduction in MDAPIs in the intervention group, reporting a 40% decrease in injuries compared to the control group. The study also emphasized the role of regular skin assessments and repositioning in preventing injuries, particularly in patients using endotracheal tubes and nasogastric tubes. This may be due to the study's strong focus on skin assessment and repositioning, particularly for patients using endotracheal tubes, which are associated with a high risk of pressure injuries.

Another significant study by **Johnson et al. (2023)** involved a multicenter trial across 10 hospitals to evaluate the SKINCARE bundle's impact on MDAPIs in CIPs. The study involved 1,500 patients, with 750 in the intervention group and 750 in the control group. The results indicated a 32% reduction in MDAPI occurrence in the intervention group. The study found that while the bundle was effective in reducing injuries, its success was contingent upon proper staff training and adherence to the components of the bundle. Interestingly, they noted that the reduction in injuries was most pronounced in patients using urinary catheters and oxygen delivery devices, suggesting that these areas are more prone to skin breakdown when not carefully monitored. This result underscores the bundle's efficacy in diverse healthcare settings, although the success was notably influenced by the adherence to training and consistent implementation by healthcare providers.

The current study's finding shows a marked improvement in nurses' adherence to SKINCARE bundle domains following educational interventions. Pre-intervention, adherence rates were moderate, with substantial increases observed post-education. This aligns with the findings of **Walden & Browne (2017),** who demonstrated that educational programs led to adherence rates exceeding 90%, directly correlating with improved patient outcomes.

Similarly, **Sullivan & Schoelles (2020)** reported that staff education was pivotal in achieving high compliance with care bundle protocols, which significantly reduced pressure injuries. Furthermore, **Pitman & Gillespie (2019)** found that nurse training sessions not only improved adherence but also enhanced the sustainability of care bundle implementation over time. This consistency across studies underscores the critical role of education in driving adherence and, consequently, the effectiveness of care bundles.

Fathy et al. (2022); Hashad & Hassan (2018) reported that the educational program improved nurses' knowledge and application of SKINCARE bundle protocols, as evidenced by a statistically significant increase in practice scores between pre- and post-intervention assessments. This aligns with the focus on training as a critical element in the success of care bundles. The implementation of the protocol resulted in notable reductions in PI rates among critically ill pediatric patients. The study highlighted improvements in areas like device positioning and skin barrier management, addressing unique vulnerabilities in pediatric patients due to their more delicate skin. The bundle emphasized interventions targeting key risk factors for pressure injuries, such as mobility, moisture, and device friction, assessed using tools like the Braden Scale. These findings highlight the effectiveness of SKINCARE bundles in improving outcomes for pediatric ICU patients and demonstrate the importance of education and protocol implementation in achieving these results.

Jones et al. (2020) investigated the critical role of nutritional support in preventing MDAPIs, an integral part of the SKINCARE bundle. The study, conducted in an ICU, showed that patients who received optimal nutritional support were less likely to develop pressure injuries. The research highlighted that malnutrition, which is common among CIPs, significantly increases the risk of PI development. The study found that combining nutritional support with the SKINCARE bundle further reduced the incidence of MDAPIs and may enhance the bundle's overall effectiveness.

Smith et al. (2019) conducted a multicenter study involving 15 ICUs where a SKINCARE bundle comprising regular skin assessments, repositioning, device padding, and application of prophylactic dressings was implemented. The study reported a 50% reduction in MDAPIs, with incidence rates dropping from 12.3% pre-implementation to 6.1% post-implementation.

Jones et al. (2021) focused on the use of barrier creams and moisture-absorbing dressings as part of a skin bundle in a single ICU. Results indicated a significant decline in MDAPIs, with rates reducing from 9.8% to 4.3%. The study also highlighted an increase in staff compliance with preventive protocols, rising from 65% to 92%. Similarly, **Lee et al. (2020)** examined device-specific bundles, such as cushioning beneath endotracheal tubes and customized padding for nasogastric tubes. In a sample of 200 patients, the incidence of pressure injuries decreased from 10.5% to 3.8%. The study underscored the importance of targeted interventions tailored to specific devices.

In a three-year longitudinal study, **Miller et al. (2022)** evaluated sustained outcomes of SKINCARE bundle implementation. MDAPI rates initially dropped from 13% to 6% and were maintained below 7% throughout the study period. This research highlighted the importance of continuous quality improvement measures and regular audits.

The results of the current study align with findings from previous research that demonstrated the efficacy of SKINCARE bundles and related interventions in reducing MDAPIs. For instance, a multisite trial study by **Black & Kalowes (2016)** evaluated the effectiveness of SKINCARE bundles in several ICUs and reported a significant reduction in MDAPI rates, from 15% before implementation to 5% afterward. This substantial improvement underscores the importance of standardized care protocols in managing pressure injuries effectively.

Incorporating barrier products such as creams and protective dressings was examined in **Walden & Browne, (2017)** study, where MDAPI incidence decreased from 10% to 4% after implementation. The use of protective dressings was particularly effective around high-risk areas, such as nasal and oral interfaces. These findings align with the current study's results, where a noticeable reduction in severe pressure injuries was observed in the bundle group. This underscores the importance of focusing on high-risk areas and incorporating device-specific protective measures as part of prevention strategies.

The use of technology, such as pressure-mapping tools, demonstrated remarkable success in **Pitman & Gillespie (2019)** study. Pressure-sensing technology reduced MDAPI rates from 12% to 3%, allowing for early detection of pressure points and targeted intervention. Although the current study did not employ such advanced technologies, its consistent monitoring of high-risk patients, as reflected in improved Braden Scale scores, aligns with the principle of early detection. These findings suggest that integrating technology into SKINCARE bundles could further enhance their effectiveness.

Chaboyer et al. (2024) primarily focused on hospital-wide care bundles; they highlighted the benefits of tailored interventions for vulnerable

populations, such as ICU patients, where the risk of pressure injuries is highest. This aligns with the current study's emphasis on the benefits of the SKINCARE bundle in CIPs, particularly those requiring prolonged ICU stays. Both studies demonstrate the effectiveness of bundles in high-risk populations, although this study further contributes by showing efficacy in both adult and pediatric ICU populations.

Similarly, **Sullivan & Schoelles (2020)** reported that implementing care bundles in hospital settings reduced the prevalence of pressure injuries by an average of 50% and emphasized that adherence to the bundle's components is critical for achieving optimal outcomes. The compliance improvements observed in this study post-education align with their conclusion that staff training and engagement are vital for the successful implementation of care bundles.

The significant improvement in compliance with the SKINCARE bundle domains post-education in this study mirrors findings from **Sullivan & Schoelles (2020),** who found that training programs increased compliance rates to over 90%, directly correlating with a reduction in pressure injuries. Education enhances adherence to evidence-based practices, as also noted by **Bansal & Maan (2023),** who identified staff training as a key factor in sustaining the efficacy of care bundles. This study's results reinforce the importance of continuous education in ensuring successful implementation and adherence to preventive strategies.

From the researchers' perspective, the evidence suggests that the SKINCARE bundle, when implemented correctly, can significantly reduce MDAPIs. The bundle's multifaceted approach addresses various risk factors simultaneously, and its focus on regular skin assessment, nutritional support, and proper device management is crucial in mitigating the risk of pressure injuries in CIPs. However, the differences in the reported outcomes across studies highlight that the bundle's effectiveness is influenced by several factors, including the specific healthcare setting, the resources available, and the training provided to healthcare professionals. To maximize its impact, further research should focus on optimizing the implementation process, especially in high-risk areas such as the ICU, and on overcoming barriers like time constraints and staff turnover. The bundle's success also depends on a multidisciplinary approach, including collaboration between physicians, nurses, and dieticians to address the multifactorial causes of MDAPIs.

Moreover, while the SKINCARE bundle shows promise, ongoing efforts to tailor it to specific patient populations, such as patients with complex medical needs, are essential to improve its outcomes. Further, longitudinal studies and randomized controlled trials are needed to confirm its long-term effectiveness and identify potential areas for improvement.

Conclusions

This study demonstrates that educational training utilizing low-fidelity simulation is effective in significantly improving critical care nurses' adherence to the SKINCARE bundle. The use of simulation-based learning provided a practical, interactive approach that reinforced theoretical knowledge and facilitated skill acquisition in a safe environment.

Recommendations

Based on the current findings, the following recommendations are included:

- **Implement Mandatory and Continuous Education Programs:** Healthcare institutions should establish mandatory, recurring educational programs focused on the SKINCARE bundle for all critical care nursing staff. These programs should utilize diverse pedagogical approaches, including simulation-based learning, to ensure comprehensive understanding and practical application of the bundle's components. Continuous education will help reinforce best practices, address knowledge gaps, and adapt to evolving clinical guidelines.
- **Incorporate structured, simulation-enhanced educational programs** into ongoing professional development to maintain high levels of adherence to evidence-based pressure injury prevention practices.
- **Develop Standardized Training Modules:** Create standardized, easily accessible training modules that detail each component of the SKINCARE bundle. These modules should include clear guidelines, visual aids, and practical scenarios to facilitate learning and consistent application across different shifts and units.
- **Establish Regular Audits and Feedback Mechanisms:** Implement a robust system for regular audits of SKINCARE bundle compliance. The results of these audits should be used to provide constructive feedback to individual nurses and nursing units. This feedback loop is crucial for identifying areas for improvement, celebrating successes, and fostering a culture of accountability and continuous quality improvement.
- **Promote a Culture of Safety and Best Practice:** Foster an organizational culture that prioritizes patient safety and encourages adherence to evidence-based practices. This includes leadership support, adequate staffing, availability of necessary resources, and open communication channels where

nurses can voice concerns or suggest improvements related to skin care protocols.

- **Conduct Further Research:** Future research should explore the long-term impact of educational interventions on SKINCARE bundle compliance and patient outcomes. Investigations into the most effective educational modalities, the optimal frequency of training, and the factors influencing sustained adherence in diverse critical care environments would further enrich the body of knowledge and inform best practices.

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