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Literature Review

A literature review on the effectiveness of prophylactic foam dressings and pressure ulcer prevention in intensive nursing care

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Key Words: *prophylactic foam dressings; pressure ulcer prevention; intensive nursing care; evidence-based practice*

Abstract

Aim: This article reviews the literature on the strategies for mitigating pressure ulcers through the formulation and execution of minor modifications within hospital settings. **Methodology:** A search of the University's e-databases Cumulative Index, Nursing and Allied Health Ultimate, CINHAL Ultimate and Medline retrieved n=37 research studies and n=2 found to meet the inclusion and exclusion criteria. A hand search identified a further n=6 to total n=8 research studies. **Findings:** Each research study aimed to reduce the incidence of hospital acquired pressure ulcers in intensive care units, improve routine practice and compare the effectiveness of multi layered foam dressings for prevention. Three common themes were identified: first, evaluating the effectiveness of prophylactic sacral dressings. Second, educating nurses on improving clinical outcomes and third, the use of various interventions to prevent hospital acquired pressure ulcers in intensive care units. **Discussion:** Intensive care unit patients are at significant risk of developing pressure ulcers due to a variety of contributing factors such as vulnerability, lack of movement, a need to physically examine skin, medical device use, managing continence, poor nutrition, repositioning and applying prophylactic multi layered foam dressings. **Conclusion:** Properly addressing risk factors and harmonising preventive protocols is essential in minimising pressure ulcer development and improving overall patient care in an intensive care unit and other cases involving at risk patients.

Introduction

A pressure ulcer (PU), also commonly known as a pressure injury (NPIAP, 2019), bed sore or pressure sore, is damage to the skin and the deeper layer of tissue below, due to pressure applied to the skin over time, reducing blood flow (NICE, 2014). Worldwide, the incidence of hospital acquired pressure ulcers (HAPUs) is between 0-72% (EPUAP et al., 2019), with 700,000 patients developing PU's in the United Kingdom (UK), and 180,000 new cases diagnosed each year (Wood et al., 2019). The cost to the National Health Service (NHS) is reported to be £3.8 million per day, indicating a considerable problem for nursing care. Therefore, preventing HAPUs is not only cost effective but aims to reduce unnecessary harm, pain, disfigurement, infection, extended inpatient care and decreased quality of life (Wood et al., 2019).

International and national organisations (for example, EPUAP et al., 2019; NPIAP, 2019; 2025; NICE, 2014; 2024) were established to promote effective prevention and management of PU's through evidence-based guidelines. These guidelines promote the use of regular nursing assessment using the SSKIN bundle (skin, surface, keep moving, incontinence and nutrition) and recommend the use of repositioning, pressure relieving mattresses, managing incontinence, and providing good nutrition to reduce the intensity and duration of pressure on a patient's skin (NHSi, 2018).

Intensive Care Unit (ICU) patients are at heightened risk of developing PU's for several reasons such as prolonged immobility and the use of sedation which hinders their ability to relieve pressure on vulnerable areas (NWCSP, 2023). Additionally, being ventilated further increases susceptibility to PU's due to nutritional imbalances, hypoxia, and hypoperfusion (NWCSP, 2023). The rise of HAPU cases in an ICU can be attributed to a preventive protocol against ventilator-associated pneumonia. This protocol involves elevating the head of the bed to a 40-degree angle, except during personal care (Güner & Kutlutürkan, 2021). However, the NPIAP (2019; 2025) recommend not elevating the head of the

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bed more than 30-degree to prevent sacral PU's. This contradiction in protocols reduces the occurrence of ventilator-associated pneumonia in ICU patients. However, it makes patients more susceptible to PU's because the risk of slumped positioning increase shear over the sacrococcygeal area. Properly addressing these risk factors and harmonising preventive protocols is essential in minimising PU development and improving patient care in ICU's (NICE, 2014).

Prophylactic foam dressings

Current standards of care for PU prevention are clearly inconsistent and the use of prophylactic foam dressing as a preventative strategy for critically ill patients is recommended (Haesler et al., 2017; EPUAP et al., 2019). NICE (2014) do no mention the use of foam dressings on patients' bony prominences but NICE (2024) suggested the use of multi-layer heel dressings as a prophylactic measure to reduce shear and friction, however, comparisons between prophylactic multi-layered dressings for heels and standard care showed no significant difference in effectiveness (Greenwood et al, 2022). This may be due to heel PU's developing and healing differently compared to other body parts (Greenwood et al., 2022). In contrast, Lavallée et al. (2019) suggested the use of foam dressings constructed with multiple layers in other body parts reduces the occurrence of PU's (*see figure 1*) because they were designed to effectively distribute pressure over wider areas and protecting external shearing forces on the skin. However, the material's properties and individual-specific needs are also key factors (Mervis & Phillips, 2019).

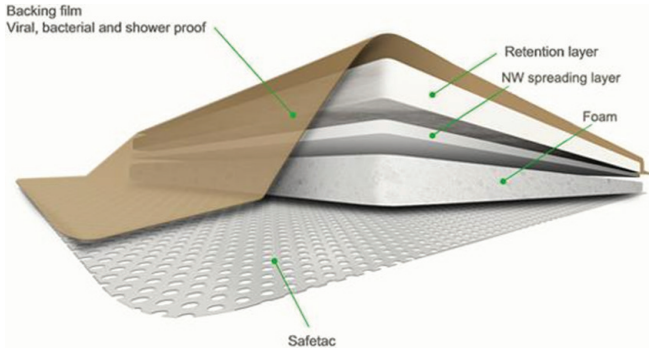

Figure 1: An example of a multi-layered foam dressing (courtesy of Molnlycke health care AB © foam silicone)

The effectiveness of multi-layered foam dressings has been confirmed in large-scale randomised controlled trials (RCT's), to demonstrate a 10% reduction in the incidence rate of PU's (Santamaria et al., 2013). Their effectiveness is because applying a dressing over the sacral area further reduces mechanical pressure on the skin and underlying tissues. Furthermore, these dressings play an additional role in maintaining the skin's microclimate level, creating a conducive environment for wound healing and reducing the risk of PU development (Gefen et al., 2019). Studies on bordered sacral foam suggest the foam component helps redistribute pressure to surrounding tissue from a high-risk area to surrounding tissue, and the outer surface help to reduce friction (Han & Ceilley, 2017). The layered structure of the dressing absorbs shear forces instead of the skin and the microclimate is managed by transferring and absorbing sweat by the middle layer of the foam dressing (Han & Ceilley, 2017). This can be seen in figures 2 and 3.

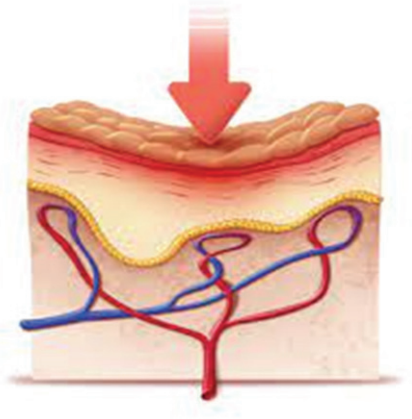

Figure 2: Pressure to a single area

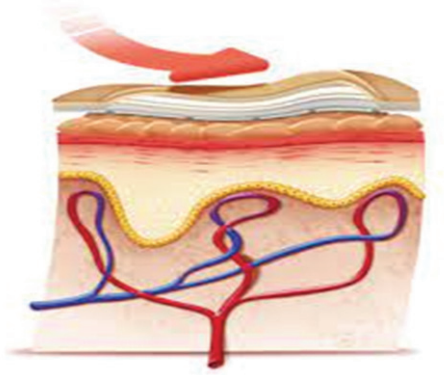

Figure 3: Redistributing pressure

Search strategies

A PICO (population, intervention, comparison, and outcome) table (*see table 1*) was used to ensure clarity and clinical relevance (Schardt et al., 2007), followed by a search of the literature from 2013 to 2024. The search terms were "ICU patients or intensive care unit patients" and "foam dressing or prophylactic dressing or silicone dressing" and "reduce pressure injury or decrease pressure sore or pressure ulcers…" Boolean operators were added and e-databases searched; Allied Health Ultimate (n=6), CINHAL Ultimate (n=27) and Medline (n=23) and Medline with full text (n=23). The retrieved studies totalled n=37 and after referring to the inclusion and exclusion criteria (*see table 2*), the location of PU's and many full text studies not being available (n=16), n=2 were left (Lee et al., 2019; Santamaria et al., 2013). Therefore, a hand search was performed and n=6 found to be relevant. The n=8 total of research studies used n=6 RCT's n=6 (Aloweni et al., 2017; Forni et al., 2022; Kalowes et

al., 2016; Oe et al., 2020; Santamaria et al., 2013; and Sillmon et al., 2021). Of the n=8, n=2 non were RCT studies chosen for their contribution to understanding the clinical context and to add to the dearth of studies found [Gefen et al., 2020; Sillmon et al., 2021] (*See figure 4: entitled PRISMA flow diagram and table 3 entitled; Table of findings*). The number of retrieved research studies was consistent with a Cochrane review updated in 2022 which found n=33 RCT's in their search (Langer et al., 2024).

Table 1: PICO

Population	Intervention	Comparison	Outcome
ICU Patients	Foam Dressing	Foam Dressing	Reduced PU's
		Silicon Dressing	Reduced HAPU/I's

Table 2: Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Published between 2013 and 2024	Qualitative research studies
RCT's	Pressure ulcers other than sacral area
Compared outcomes between the intervention group (protective dressing and standard care) and control group (only standard group)	Healing treatment on existing pressure ulcers
Full-text article available	Non-hospital
Ventilated	Non ventilated
In English	Incontinence
Focusing on reducing sacral pressure ulcers	Pilot and feasible studies

Critical appraisal

Critical appraisal of research studies is important to identify reliability and trustworthiness of the aims, methods, and findings significance to clinical practice. Many variables impact on the relevance of research studies, such as geography, socio-economic culture, product orientated research, transparency, bias, trustworthiness, replicability, and generalisability (Clougherty et al., 2021). Santamaria et al. (2013) conducted their research in Australia, while Lee et al. (2019) focused on Korea. Studies in other nations included Oe et al. (2020) in Japan, and Kalowes et al. (2016) in the United States (US). In contrast, the study by Sillmon et al. (2021) spanned multiple settings beyond just ICU's, involving medical wards in countries such as Australia, Korea, the United States, Italy, and Singapore, thus providing a broader, international perspective. Forni et al. (2022) conducted a comprehensive investigation spanning 12 hospitals in Italy, including ICU and medical wards. Additionally, Aloweni et al. (2017) focused on medical and surgical units in Singapore. Gefen's (2020) review article used theoretical models and simulations in a variety of geographical areas by applying the US Food and Drug Administration's (FDA) evidence-based guidelines.

All the n=6 studies used RCT's to produce trustworthy data to support clinical practice and policy choices (Clougherty et al., 2021). In the study by Lee et al. (2019), neither randomisation nor allocation concealment was reported, which compromised the internal validity and affected the confidence of the findings. Similarly, Santamaria et al. (2013) could not report the outcome measure due to a considerable proportion of the randomised sample being lost during the initial stage (reason unknown). Moreover, Gefen's (2020) work primarily used computational models and biomechanical indices which do not fully capture the variability and complexity found in real-world clinical settings. The smaller sample size in the study by Sillmon et al. (2021), limited the ability to draw robust conclusions from the study.

Additionally, every RCT study, except Lee et al. (2019), was identified as open label (non-masked or non-blinded in the publication or protocol). Open-label trials are susceptible to bias since participants and researchers were aware of the treatment assignment which might affect findings and introduce performance bias (Rosenberger & Lachin, 2016). Therefore, due to the risk of bias, caution should be used when interpreting research outcomes and applying them to clinical practice with overlapping issues, participant anomalies, foam dressing's specific properties and sample size (Clougherty et al., 2021).

Overlapping issues

The research methodology across various disciplines consistently employed RCT's as the preferred methodology for investigating the efficacy of interventions to reduce PU's. The use of foam dressings in conjunction with preventative care of HAPUs in ICU's, as previously mentioned, was recommended by international guidelines (EPUAP et al., 2019). However, inconsistencies in RCT's sample size, different methodologies used, generalisability of results, potential biases, and dropout rates, including the difficulty of blinding assessors due to the visibility of dressing marks, reduced confidence in the findings. All the n=6 RCT's typically evaluated two groups, allowing for comparative analysis and assessment of the intervention's impact. The intervention group received foam dressing in addition to standard care, whereas the control group received only standard care. All the studies consistently demonstrated positive results in reducing PU's by implementing the proposed interventions along with standard care in ICU's. In Lee et al.'s (2019) study, the intervention group had notably fewer participants (n=1, 2.9%) than the control group (n=9, 29%). Additionally, five participants out of the n=71 randomised participants were lost, and it was unclear which group they were from. Aloweni et al. (2017), had a 22% dropout rate in the intervention group and an 8% dropout in the control group with no reasons given. We will now discuss the three themes.

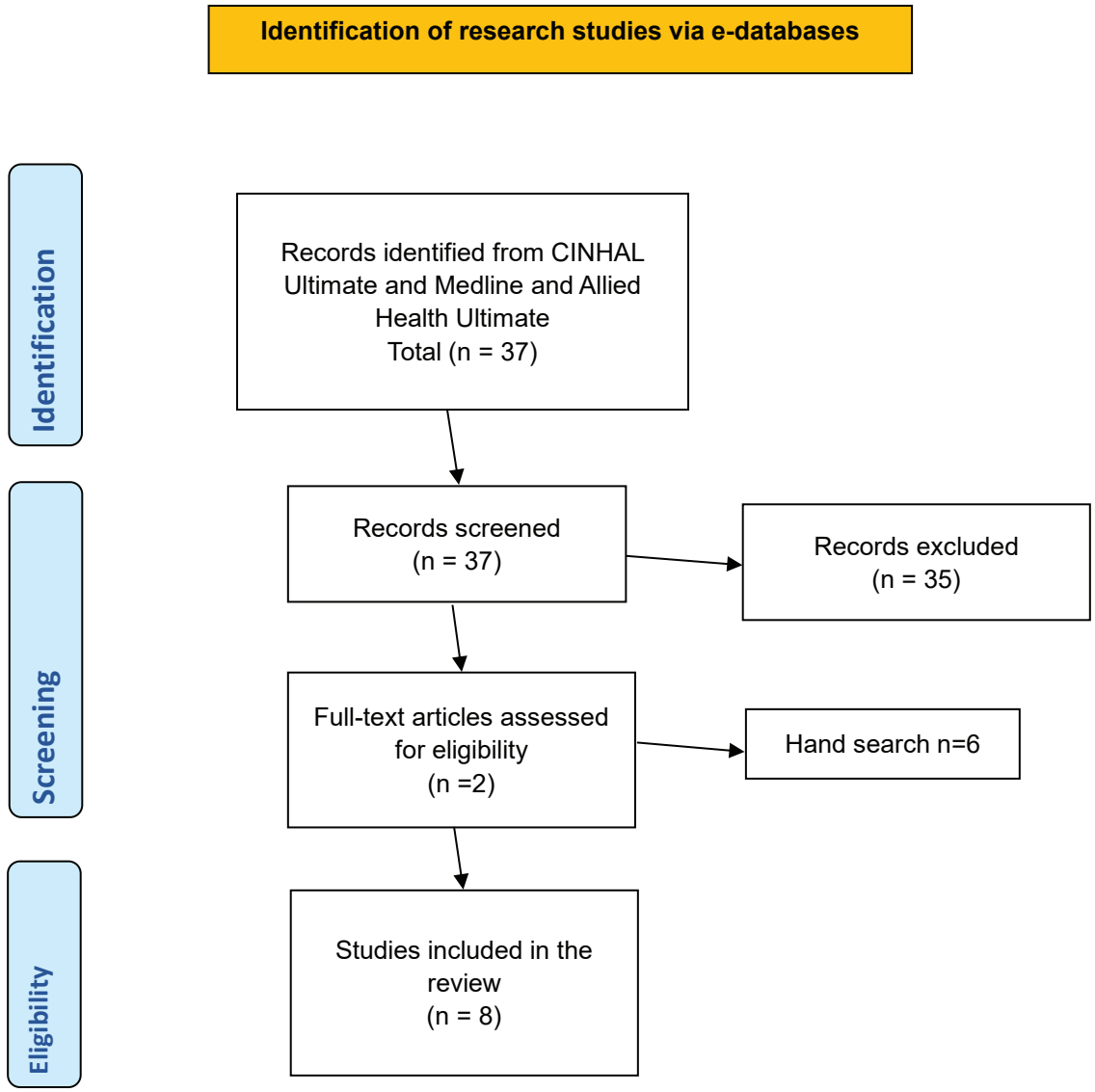

Figure 4: PRISMA flow diagram

Thematic analysis

Three common themes were identified: first, evaluating the effectiveness of prophylactic sacral dressings. Second, educating nurses on improving clinical outcomes and third, the use of various interventions to prevent HAPUs in ICU, which we discuss next.

Prophylactic sacral dressing

The primary focus of the literature was on utilising prophylactic sacral dressings as an intervention to minimise PU's. Several of the n=6 RCT studies evaluated the effectiveness of several types of dressings. Among these, two studies used ALLEVYN LIFE TM multi-layered hydro cellular foam dressing by Smith and Nephew© (Forni et al., 2022; Lee et al., 2019) whilst Lee et al. (2019) additionally added silicone gel adhesive. Silicone gel adhesive helps for high adhesion and painless removal, thus minimising the wound and surrounding skin's trauma (Lam, 2021). Two studies (Kalowes et al., 2016; Santamaria et al., 2013) evaluated the findings using Mepilex® Border Sacrum five-layered foam dressing (*see figure 1 Molnlycke* ©). Gefen (2020) compare the effectiveness of multiple silicone-foam dressing designs from various manufacturers to the RSB superabsorbent cellulose dressing. Gefen (2020) suggested that to guarantee continuous protection against tissue stress, an efficient preventive dressing must achieve high values in both the Protective Efficacy Index (PEI) and the Protective Endurance (PEN) Index. According to Schwartz and Gefen (2019), the PEN Index evaluated how well the dressing maintains its protective efficacy over time, especially when changing from a dry to a moist condition. Meanwhile, the PEI measures the dressing's capacity to reduce tissue stress in both dry (PEI) and moist (PEI) conditions. A dressing that achieved a PEN near 100% having similar PEI dry and PEI moist values could be called an ideal dressing (Schwartz & Gefen, 2020).

However, despite differences in dressings, these studies consistently demonstrated positive outcomes in using this intervention to minimise pressure ulcers. This method effectively redistributed pressure, protected the skin from friction, and maintained a balanced microclimate.

One major drawback identified in Lee et al.'s (2019) study was the need for more information regarding the number of dressings applied to patients in the intervention group. Fulbrook et al. (2019) clarified that it was one dressing per patient by correspondence with the author. All the studies administered dressings within 24 hours of admission to the ICU and were checked daily for routine skin assessment. n=5 RCT's mention changing the dressings every three days or when soiled, but Aloweni et al. (2017), changed dressings after seven days or when soiled. In Sillmon et al. (2021), the study was conducted across various settings and populations, with different dressing types and outcome measures, which complicated synthesising the results and drawing definitive conclusions. Nonetheless, the findings demonstrated positive outcomes and emphasised the significance of early dressing application and standard care assessment in preventing PU's (Bastian, 2017).

Table 3: Table of findings

Author/ year/ country	Aim of study	Methodology	Sampling strategy	Findings	Ethical issues
Aloweni et al. (2017)	To evaluate effectiveness of silicone foam dressing/ fatty acids oil spray and standard preventative care in preventing sacral PU among high-risk patients	RCT Patients allocated to 3 groups based of PU location	ICU n= 461 participants	The general difference was not significant statistically Significant reduction in PU in fatty acid group and dressing group compared to control group	Limited in statistical significance Lesser follow up period Lack of blinding Single centred study
Forni et al. (2022)	Evaluate multi-layer silicone-adhesive polyurethane sacral foam dressing prevents PUs development in addition to standard PU preventive care for	Multi centred RCT Open label	ICU, medical and surgical patients from 12 hospitals n= 709 participants	Fewer participants accrued HAPU in medical and surgical ward when foam dressing used as an intervention	Lack of assessment Lack of blinding Follow up duration was too short
Gefen (2020)	Evaluate PU-QOL scale for PU patients	Multi -level methodology including self-evaluation, semi structured interviews and psychometric tests for reliability and validity	Virtual patient	During the period of prolonged tissue loading in a supine position, the sacral area receives extra tissue protection when a prophylactic dressing that is sufficiently effective when applied	Dependence on specific conditions Studies on virtual work which is different from a real clinical scenario
Kalowes et al. (2016)	Evaluate difference in incidence rates of HAPUs in critically ill patients between those treated with usual preventive care and a 5-layered soft silicone foam dressing versus a control group receiving usual care.	Prospective RCT	ICU n= 366	Identified the risk factors in HAPUs cost savings and PU rates. Risk factors found were such as mechanical ventilation, sedation, vasopressor, no PU dressing used.	Single centred study Lack of blinding Short follow up period
Lee et al. (2019)		RCT Ratio approx. 1:1	ICU Patients aged >18. n= 71	Fewer PU patients in intervention group compared to control group	Lack of blinding Single centred study Small participant size
Oe et al. (2020)	Evaluate multilayer silicone foam dressings preventing sacral and coccyx PU's for patients with persistent severe diarrhoea and/ or fragile skin.	Prospective RCT All participants were enrolled from three Japanese institutions	Total of 600 hospitalised patients with persistent severe diarrhoea and/or fragile skin who were at high risk of	Significantly more participants in the control than the intervention group developed pressure ulcers	Short follow up period Blinding Single intervention type
Santamaria et al. (2013)	Investigate effectiveness of multi-layered soft silicone foam dressings in preventing intensive care unit (ICU) PUs when applied in the emergency department	RCT, prospective study Open label	ICU n= 440 participants	Intervention group had fewer PU occurrence and hazard ratio compared to the control group	Restriction in patient population Single centred study Lack of blinding
Sillmon et al. (2021)	To identify and evaluate use of prophylactic foam dressings for prevention of hospital-acquired pressure injuries (HAPI's).	Systematic Reviews and Meta-analysis Statement Multi-national	n= 910 patients Derived from multiple studies	All studies show a decrease in HAPI incidence with use of sacral foam dressings	Variability in Study Designs Lack of specific statistical details in some studies

Educating nurses on clinical outcomes

NICE (2024) guidelines suggest an essential component in preventing PU's is providing education to healthcare professionals to enhance competency levels. According to Lee et al. (2019), Oe et al. (2020) and Aloweni et al. (2017), educating staff on the aseptic non-touch technique (ANTT) dressing method and emphasising the importance of reducing PU's resulted in a notable decrease in PU's. These studies collaborated with wound care specialists and research team members to apply preventative dressings on the sacrum, coccyx, and buttocks. Moreover, Aloweni et al. (2017) noted that nursing staff in participating wards received annual training for PU skin assessment and were equipped to conduct Braden scale assessments. Oe et al. (2020) also found that nurses who participated in training programmes for identifying high-risk patients and correctly using prophylactic dressings were better equipped to make informed decision regarding patient care.

NICE (2024) guidelines also emphasised the significance of collaboration among various multidisciplinary team members to ensure the delivery of quality care for maintaining skin integrity in their guidelines for PU prevention and management. All the studies selected participants by RCT, and results indicated a decrease in PU's within the intervention group compared to the control group. To reinforce this point the following table 4 presents the clinical outcomes of the RCT studies. Aloweni et al. (2017), found that only the high-risk subgroup exhibited a noticeable decrease in PU's, suggesting the effectiveness of intervention might relate to individuals' risk profiles. In contrast, Forni et al. (2022) identified no significant reduction in PU's in ICU. The variation in results highlighted the potential influence of patient demographics, clinical settings, or other factors that could affect the outcomes. However, all the research studies consistently reported a positive decrease in PU's among the intervention group.

Table 4: Clinical outcomes of the conducted RCT studies

Name of the author(s)	PU occurred in the intervention group	PU occurred in control group
Aloweni et al. (2017)	n = 0/60, 0%	n = 4/83, 4.8%
Forni et al. (2022)	n =7/351, 4.8%	n = 46/358, 12.8%
Kalowes et al. (2016)	n = 1/184, 0.6%	n = 7/182, 3.8%
Lee et al. (2019)	n = 1/35, 2.9%	n = 9/31, 29.0%
Oe et al. (2020)	n = 5/300, 1.67%	n = 22/300, 7.33%
Santamaria et al. (2013)	n = 2/161, 1.2 %	n = 8/152, 5.3%

Variable methods of assessment and prevention of PU's

The identification and classification of PU's in ICU is conducted within 24 hours of admission following the EPUAP et al. (2019) and NICE (2014; 2024) guidelines. Risk assessment is crucial in healthcare settings (Bastian, 2017) and the importance of experienced clinical judgement can identify potential risk factors the assessment tools may not detect, with less experienced staff (Theeranut et al., 2020). Furthermore, the RCT studies employed the Braden scale to assess pressure ulcers, which is a tool designed to facilitate assessment when prescribed turning schedules were used with the use of pressure reducing support surfaces (Braden & Maklebust, 2005). However, each study used different threshold values in their evaluations to determine the incidence of PU's affecting incident report rates and evaluation of the efficacy of prevention interventions.

Air mattresses and slide sheets

The use of specialised mattresses and sliding sheets has shown promise in PU management. Although the findings did not explicitly address the impact of a specific mattress and sheet on PU reduction, the patient outcomes demonstrated the potential influence of this choice of equipment. Three studies used mattresses as an intervention in PU management; Santamaria et al. (2013) conducted their study on Hill-Rom Versa Care low air loss beds; Kalowes et al. (2016) used TotalCare SpO2RT 2 Therapy Bed and Aloweni et al. (2017) used alternating air mattresses to reduce interface pressure. Three studies also highlighted using sliding sheets to move patients to minimise shearing force (Forni et al., 2022; Lee et al., 2019; Oe et al., 2020). These studies provided evidence that using sliding sheets is effective in reducing shearing force when compared to moving patients without.

Evaluating skin assessment

Various methodologies were employed across different studies to ascertain the occurrence of HAPUs. Two studies (Kalowes et al., 2016; Santamaria et al., 2013) suggested the implementation of specialised nurses in ICU to regularly detect HAPUs, despite guidelines recommending the role of all nurses to conduct daily skin assessments (EPUAP et al., 2019). In terms of statistical analysis, four of the articles reviewed used Fisher's exact test, used to compare percentages of a clear-cut outcome according to different independent groups (Kim, 2017), to compare PU's in the intervention and control groups (Aloweni et al., 2017; Forni et al., 2022; Kalowes et al., 2016; Santamaria et al., 2013). Two studies did not specifically refer to any specific strategic tests (Gefen, 2020; Oe et al., 2020). Moreover, Sillmon et al. (2021) identified results from numerous studies using multiple statistic tests including Braden scale, Fisher's test, Norton scale and Waterlow score for prediction of PU risk to present their findings. Forni et al. (2022) used the Mann-Whitney U test to compare the time it took to develop PU's, which is a non-parametric test used for comparing continuous variables. Santamaria et al. (2013) used the Australian Wound Management Association's (AWMA) four staging systems to identify the PU's developed during their study accurately. In conclusion, inconsistencies in assessment

of PU classification may impact the reliability, comparability, and generalisability of the research findings.

Repositioning

The most traditional method for reducing HAPUs was repositioning which is recommended to improve comfort and relieve pressure for bedrest patients (Avsar et al., 2020). The eight papers reviewed unanimously advocated the use of repositioning as one of the most effective strategies in PU prevention. n=6 RCT studies discussed 2-3 hourly turning intervals (Aloweni et al., 2017; Kalowes et al., 2016; Lee et al., 2019; Oe et al., 2020; Santamaria et al., 2013; Sillmon et al., 2021). According to all studies, two hourly turns were considered a standard interval to prevent PU's. In contrast, Forni et al. (2022) routinely repositioned patients four hourly and included a visual checklist to serve as a reminder to reposition patients and promote mobility. Aloweni et al. (2017) and Forni et al. (2022) suggested increased frequency in repositioning did not minimise PU's but increased nursing workload and side effects, due to medical devices influencing PU outcomes. Overall, while repositioning remained crucial strategy in PU prevention, it is important to balance the evidence related to the frequency of repositioning and its effectiveness in reducing HAPUs.

Conclusion

Three common themes were identified by the review. The first major theme identified a need for effective prophylactic multi layered foam dressings to an ICU patient's sacrum and coccyx skin areas. Dressings with silicone gel adhesive helped maintain high adhesion and painless removal. Comparing the effectiveness of multiple silicone-foam dressing designs from various manufacturers was important in identifying the ideal dressing with a high protective efficacy in both dry and moist conditions over time to reduce tissue stress (Schwartz & Gefen, 2019; 2020).

The second theme identified the positive clinical outcomes of continuing development for nurses and the consistent use of aseptic non-touch technique (ANTT) method when applying a dressing significantly reduced the incidence of HAPUs (Aloweni et al., 2017; Lee et al., 2019; Oe et al., 2020). The effectiveness of clinical outcomes of HAPU training related to improved individual patient's risk profiles, improved nursing competencies in identifying high-risk patients, correctly using prophylactic dressings, and promoting informed decision making (Aloweni et al., 2017; Lee et al., 2019; Oe et al., 2020).

The third theme identified the different practises to assess HAPUs risk, such as SSKIN bundle assessment by specialised nurses, instead of all nurses (Kalowes et al., 2016; Santamaria et al., 2013), the use of air mattresses, slide sheets and finally schedules for the frequency of repositioning between 2-4 hours (Aloweni et al., 2017; Kalowes et al., 2016; Lee et al., 2019; Santamaria et al., 2013; Sillmon et al., 2021; Oe et al., 2020). These themes reinforced the importance of using standardised criteria to classify and stage PU's and follow international and national evidence-based guidelines to prevent HAPUs occuring in the first place (EPUAP et al., 2019; NICE, 2024).

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