

REVIEW

# Effects and Interventions of Pressure Injury Prevention Bundles of Care in Critically Ill Patients: A Systematic Review



Wenny Trisnaningtyas<sup>1</sup>, Retnaningsih Retnaningsih<sup>2</sup>, Nana Rochana<sup>3</sup>

<sup>1</sup>Master Program in Nursing, Department of Nursing, Faculty of Medicine, Universitas Diponegoro, Semarang, Indonesia

<sup>2</sup>Departement of Neurology, Dr. Kariadi General Hospital, Semarang, Indonesia

<sup>3</sup>Departement of Nursing, Faculty of Medicine, Universitas Diponegoro, Semarang, Indonesia

## Article Info

Article History:  
Received: 6 March 2020  
Revised: 19 May 2021  
Accepted: 6 July 2021  
Online: 27 August 2021

Keywords:  
Bundle of care; critically ill patient;  
multi-interventions; pressure  
injury

Corresponding Author:  
Wenny Trisnaningtyas  
Student of Master Program in  
Nursing, Department of Nursing,  
Faculty of Medicine, Universitas  
Diponegoro, Indonesia  
Email:  
wennytrisnaningtyas@gmail.com

## Abstract

**Background:** Many studies on pressure injury prevention bundles have been conducted outside the Intensive Care Unit (ICU). The bundles, which include multi interventions, have proven effective in reducing pressure ulcer incidents compared to a single intervention. However, the existing review studies on pressure injury prevention in ICUs still only investigate a single intervention rather than multi interventions. Only few reviews, to our knowledge, involves prevention bundle strategies in the ICU.

**Purpose:** This study aims to review the effects of the pressure injury prevention bundles of care on the incidents of pressure injury in critically ill patients and the intervention measures of the care bundles.

**Methods:** This review searched published articles from several databases, namely EBSCO, ScienceDirect, PubMed, ProQuest, Google Scholar, and Scopus from 2009 up to 2020. PRISMA flowchart was used to select relevant articles using several inclusion and exclusion criteria, resulting in 17 articles from 50 eligible full-text articles for assessment. The included studies were assessed for their quality using Joanna Briggs Institute (JBI) critical appraisal tools. The synthesis was then conducted narratively.

**Results:** As many as 17 studies, which mostly had good quality yet evidence level of II, were included in the analysis. The findings showed that the pressure injury prevention bundles of care decreased pressure injury incidents as many as 4.3%-36.2% in developed countries and 4.16%-25.72% in developing countries. Moreover, the bundles of care which significantly reduced the incidents of pressure injury consisted of 7 intervention measures, which were pressure injury risk assessment using Cubbin Jackson scale, skin assessment and care, repositioning, nutrition, education, support surface, and medical device care.

**Conclusion:** The review concluded that the pressure injury prevention bundles of care in critically ill patients significantly reduced the incidents of pressure injury. The study recommends more studies with stronger evidence levels to carry out and utilize 7 intervention measures as a preventive standard of care in critically ill patients.

**How to cite:** Trisnaningtyas, W., Retnaningsih, R., & Rochana, N. (2021). Effects and interventions of pressure injury prevention bundles of care in critically ill patients: A systematic review. *Nurse Media Journal of Nursing*, 11(2), 154-176. <https://doi.org/10.14710/nmjn.v11i2.28881>

## 1. Introduction

Pressure injuries still become a health problem related to patient safety in various parts of the world, regardless of the current progress in the quality of health care. The incidence of pressure injuries in the hospital is one of the unexpected events during hospitalization in the context of patient safety (Slawomirski et al., 2020). The incidence of pressure injuries in the Intensive Care Unit (ICU) in some countries is reported to be around 8.1%-63% (Clough et al., 2016; Dale et al., 2018). At the same time, the incidence of pressure injuries in some developing countries is about 4.16%-39.3% (Akhkand et al., 2020; Anderson et al., 2015; Girard et al., 2014; Lupe et al., 2015; Mallah et al., 2015;

Manzano et al., 2014; Ozyurek & Yavuz, 2015; Rogenski et al., 2015; Siracusa & Schrier, 2011; Tayyib & Coyer, 2016; Uzun et al., 2015). A pressure injury can occur in various anatomic locations due to intense or prolonged pressure or injury with a combination of shear and friction (Edsberg et al., 2016). The situation may worsen in the ICU resulting in some negative impacts.

Research shows that pressure injuries have adverse effects on patients, including physical, social, psychosocial, and financial aspects that will interfere with the quality of life (Brooke et al., 2019; Liu et al., 2019). Pain, sleep disturbances, and malaise are symptoms in physical aspects (McGinnis et al., 2014; Rutherford et al., 2018), while stress, depression, and social isolation are symptoms in psychosocial and social aspects (Artico et al., 2018; Repić & Ivanović, 2014), that patients with a pressure injury often complain. In terms of financial aspect, Demarré et al. (2015) reported that there was an increase in costs on the national budget for the treatment of pressure injury in some developed countries around 121.44 million - 2.59 billion euros annually, while estimated costs for each individual range from 15-69.472 euros. These adverse effects would have been more dangerous for critically ill patients.

Critically ill patients have the risk factors for developing pressure injury. These factors include immobilization, ventilators, sedation, unstable hemodynamics, poor perfusion, cardiac medication administration, vasopressors, and vasodilators (Alderden et al., 2017; Vollman, 2013). Pressure ulcers may be caused by the inadequate blood supply and resulting reperfusion injury when blood re-enters tissue. A simple example of a mild pressure sore may occur in healthy individuals, while immobilization in the same position for extended periods of time, the dull ache experienced is indicative of impeded blood flow to affected areas. Within 2 hours, this shortage of blood supply, called ischemia, may lead to tissue damage and cell death (Bhattacharya & Mishra, 2015). Pressure injuries have a detrimental effect on patients; however, they have the potential to be prevented (Padula et al., 2015).

Current international guidelines suggest the use of multiple interventions in the prevention of pressure injuries in critically ill patients (Haesler et al., 2017). Unfortunately, a single intervention is still used even though there is already published evidence of multi-interventions related to the effective prevention to reduce the incidence of pressure injuries (Donovan et al., 2016). Multi interventions have been proven effective in reducing pressure injury incidents compared to a standard or single intervention (Amr et al., 2017; Citra et al., 2010; Mallah et al., 2015; Riemenschneider, 2018; Saragih, 2018; Setyawati et al., 2015; Tam et al., 2019; Wayunah, 2018). However, these studies were conducted outside the ICU.

Many studies reported the use of a single intervention to prevent pressure injuries for critically ill patients (Behrendt et al., 2014; Cox & Rasmussen, 2014; Gill, 2015; J. Y. Kim & Lee, 2018; Krupp & Monfre, 2015; Langer & Fink, 2014; Manzano et al., 2014; Saghaleini et al., 2018; Wood et al., 2019), although there are now recent studies using multi-interventions in the ICU (Amr et al., 2017; Anderson et al., 2015; Richardson et al., 2017; Tayyib et al., 2015). As a result, many review studies had been done on a single intervention (Brooke et al., 2019; Gillespie et al., 2012; Lewis et al., 2016; Shi et al., 2018) to prevent pressure injuries in the ICU rather than multi-faceted interventions. Only a few review studies, to our knowledge, involves prevention bundle strategies in the ICU (Al-Dorzi, 2019; Emma & Rita, 2018; Lin et al., 2020; Zuo & Meng, 2015). However, three studies are literature reviews (Al-Dorzi, 2019; Emma & Rita, 2018; Zuo & Meng, 2015), and one study only focuses on the quality improvement program of pressure injuries and its strategies (Lin et al., 2020; Novelia et al., 2017). Therefore, a more comprehensive review on the prevention measures and specific reduction effects on the pressure injury incidents is required. This review aims to describe the effects of the prevention bundles of care on the incidence of pressure injuries. This review also analyzes multiple interventions used in the pressure injury prevention bundles of care in critically ill patients.

## **2. Methods**

### **2.1 Research design**

This study was a systematic review using the Preferred Reporting Items for Systematic Review and Meta-analyses (PRISMA) (Page et al., 2021) and employed PICO (population, intervention, comparison, and outcome) approach to search the literature.

## *2.2 Search methods*

This review conducted a comprehensive search of literature through several databases such as EBSCO, ScienceDirect, PubMed, ProQuest, Google Scholar, and Scopus from 2009 to 2020 using several pre-determined keywords in English and in the Indonesian language. “Adult”, “intensive care”, and “critical care” were used as keywords for the population. “Prevention”, “pressure ulcers/injury/sores”, “skin injuries”, “intervention bundle”, “bundle of care”, and “multi/multiple interventions” were used as keywords for the intervention and comparison. “Reduction” and “incident” were also used as keywords for the outcome. Boolean phrases were used during the searching process using the combination of keywords. Relevant articles from the reference lists of the included literature were also retrieved in order to get more thorough searching results. This searching process was done by one author (WT).

## *2.3 Inclusion and exclusion criteria*

The articles obtained from the searching process were then screened for their eligibility using some inclusion and exclusion criteria. The inclusion criteria were randomized controlled trial and experimental research studies, conducted in the critical care unit, examining pressure injury incidents and interventions, involving adult participants of 18-69 years old, participants without underlying diseases and pressure injuries before ICU’s commencements, treated in the critical units more than 24 hours, and utilizing more than one intervention of pressure injury preventions. The review excluded papers that were written in non-English and non-Indonesian languages and of their results which were difficult to be separated from other populations or interventions.

## *2.4 Screening of articles*

The Mendeley citation manager was used to pool and screen the search results. Two authors (WT and NR) independently screened the articles according to titles and abstracts, and also languages after duplicate removal. Full-text articles were then screened for their eligibility based on the inclusion and exclusion criteria. Any discrepancies were discussed between the two authors and consulted to the third author (RR).

## *2.5 Data extraction*

Quality assessment from the included studies and extraction of the data were separately done by two authors (WT, NR). Some disagreements were discussed between the two authors and resolved by the third author (RR). Furthermore, data extraction was done using predetermined extraction table consisting of author/year, city/country, aim, design, sample and setting, intervention measures, main result, and outcomes (Table 1) (see Appendix 1).

## *2.6 Quality appraisal*

The quality of studies was critically assessed using the Joanna Briggs Institute (2017) (JBI) critical appraisal tools and their level of evidence (Table 2). Checklists for quasi-experimental and randomized controlled trials were used to appraise the included studies (Munn et al., 2014). There were 9 questions of the quasi-experimental checklist and 13 questions of randomized controlled trials checklist with 4 options for the answer: yes, no, unclear, and not applicable. The answer of yes scored 1, while the answer of no, unclear, and not applicable scored 0. The studies were classified as good if the total score was >80%, fair if the total score was 50-80%, and poor if the total score was <50% (Reilly et al., 2016). Five level classical pyramids of evidence was also used to classify the included studies’ level of evidence. Level I and II included randomized controlled trials and cohort studies, respectively, while case-control studies were classified as level III (Greenhalgh et al., 2011; Higgins et al., 2021). There were no level IV and V studies.

## *2.7 Data analysis*

Heterogeneity in the methods and statistical values of the outcomes caused this review could not perform a meta-analysis of the pressure injury incidents. Therefore, a narrative synthesis was conducted. The studies’ characteristics, the incidents of pressure injury, and the intervention

measures of pressure injury's prevention bundle were separately summarized to enhance understanding and thorough analysis of the outcomes. The steps of narrative analysis were carried out according to nine syntheses without meta-analysis (SWiM) reporting items of systematic reviews (Campbell et al., 2020).

**Table 2.** Level of evidence and critical appraisal

No	Author, years	Level Evidence	Critical Appraisal
1	Chaboyer et al., (2016)	I	Good
2	Tayyib et al., (2015)	I	Fair
3	Anderson et al., (2015)	III	Fair
4	Amr et al., (2017)	III	Poor
5	Avşar & Karadağ, (2018)	III	Good
6	Mallah et al., (2015)	II	Good
7	Swafford et al., (2016)	II	Good
8	Rogenski et al., (2015)	II	Good
9	Uzun et al., (2015)	II	Good
10	Gage, (2015)	II	Fair
11	Vasconcelos & Caliri, (2017)	II	Poor
12	Coyer et al., (2017)	II	Fair
13	Siracusa & Schrier, (2011)	III	Fair
14	He et al., (2016)	II	Good
15	Lupe et al., (2015)	II	Poor
16	Loudet et al., (2017)	III	Fair
17	Lewis et al., (2015)	II	Fair

\*Notes. Critical appraisal Score: Good (>80% quality score), moderate (50%-80% quality score), and poor (<50%) (Alshahrani et al., 2021), \*I: Systematic review or meta-analysis, prospective cohort, II: RCT, cohort studies, III: Case control, IV: Case series, V: Expert opinion, report or clinical example (Greenhalgh et al., 2011)

### 3. Results

#### 3.1 Characteristic of the included studies

A PRISMA flowchart was used to select the included studies (Figure 1). In this review, 17 papers were included, consisting of quasi-experimental (n=14), RCT (n=2) and cohort (n=1) studies. Of this number, 9 studies were in developing countries (Anderson et al., 2015; Chaboyer et al., 2016; Coyer et al., 2016; Loudet et al., 2017; Lupe et al., 2015; Rogenski et al., 2015; Siracusa & Schrier, 2011; Swafford et al., 2016; Vasconcelos & Caliri, 2017), while 7 studies were carried out in developed countries (Amr et al., 2017; Avşar & Karadağ, 2018; He et al., 2016; Lewis et al., 2015; Mallah et al., 2015; Tayyib et al., 2015; Uzun et al., 2015). These studies were conducted in Australia, Saudi Arabia, Turkey, Lebanon, United States, Egypt, Brazil, United Kingdom, China, and Argentina; and included a total of 7,439 patients. Based on the review, the bundles of pressure injury were performed in various types of ICU such as medical, surgical, trauma, neurology, cardiovascular, and oncology. Twelve studies used a large sample of tertiary referral hospitals, 3 studies used small samples in an ICU, and 2 studies did not include sample sizes. The details for each study are presented in Table 1.

The results of the initial search identified 302,569 titles from online databases; their duplicates were removed. As many as 301,733 titles were excluded after a further screening on the titles and abstracts, and language, leaving 836 full-text. The results of the critical appraisal showed that most of the articles have good quality but with level II evidence. Only 2 articles show a high-quality and high level of evidence (Figure 1).

#### 3.2 Primary outcome measurement: Incidence of pressure injury

The outcome of all these studies was the incidence of pressure injuries. In this review, 14 of 17 studies reported a decreased incidence of pressure injuries (Amr et al., 2017; Anderson et al., 2015; Avşar & Karadağ, 2018; Chaboyer et al., 2016; Coyer et al., 2017; He et al., 2016; Loudet et al., 2017; Lupe et al., 2015; Mallah et al., 2015; Rogenski et al., 2015; Siracusa & Schrier, 2011; Swafford et al., 2016; Tayyib et al., 2015; Uzun et al., 2015). This review showed that the incidence of pressure injuries in patients after the implementation of pressure injury prevention bundle of care in ICU ranged from 4.3% to 36.2% in developed countries and from 4.16% to 25.72% in developing countries (Table 3).

The review also shows that pressure injuries often appear in sacral, ear, trochanter, heel, occiput tuberosity, and sacrum areas.

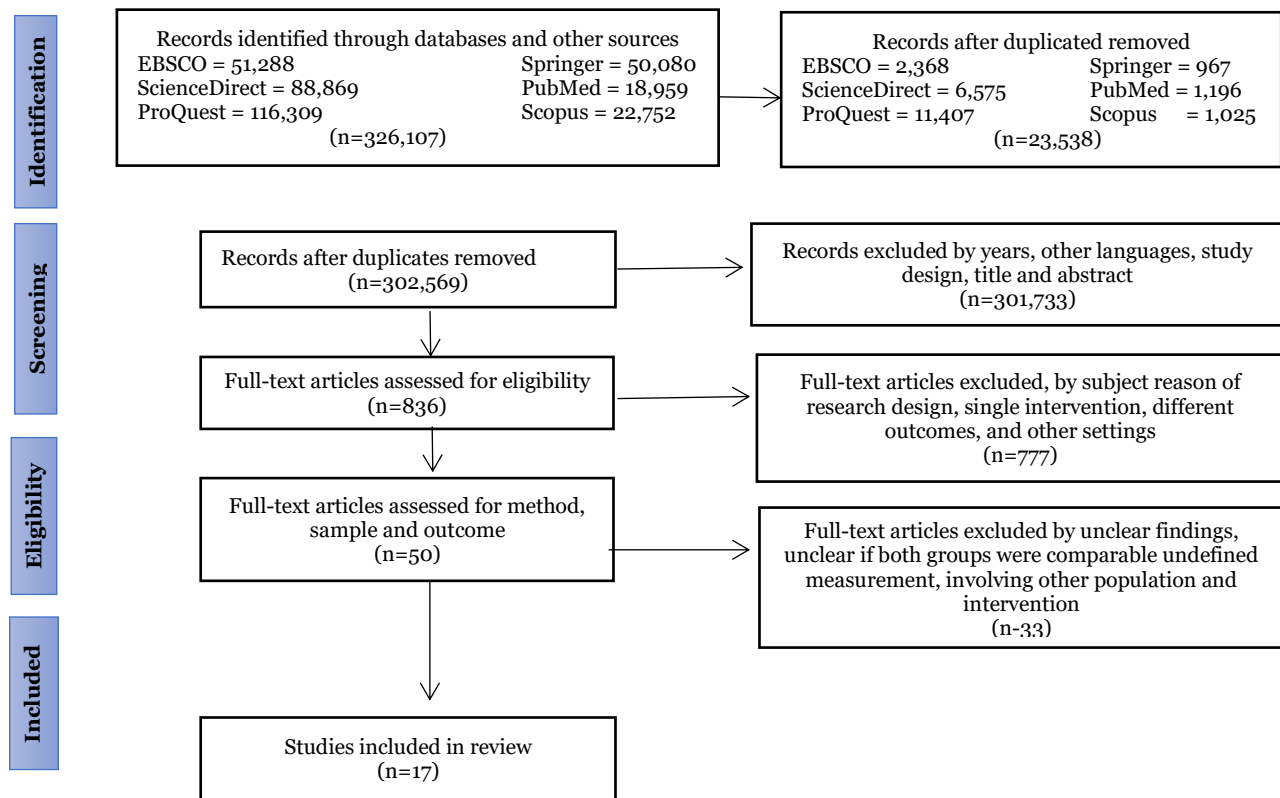


Figure 1. PRISMA Flowchart

The incidence of pressure injuries in patients after the implementation of pressure injury prevention bundle of care is presented in Table 3.

Table 3. Alterations of the incident of pressure injury in ICU

No.	Author, years	City/ Country	Incident		Δ incident
Developed country*					
1	Chaboyer et al., (2016)	Australia	12%	7.7%,	-4.3%
2	Anderson et al., (2015)	Minnesota, USA	15.5%.	2.1%	- 13.4%
3	Avşar & Karadağ, (2018)	Ankara, Turkey	54.5%	18.3%	- 36.2%
4	Swafford et al., (2016)	USA	10%	3%	- 7%
5	Coyer et al., (2017)	Australian	32%	15%	-17%
6	Siracusa & Schrier, (2011)	Pennsylvania, USA	10.9%	0.9%	-10%
7	He et al., (2016)	Hangzhou, China	62.5%	31.4%	-31.1%
8	Lupe et al., (2015)	Miami	11.7%	2.8%	-8.9%
9	Uzun et al., (2015)	Turkey	37%	17%	-20%
Developing country*					
1	Tayyib et al., (2015)	Saudi Arabia	32.86%.	7.14%	- 25.72%
2	Amr et al., (2017)	Saudi Arabia	4.6%	0.3%	- 4.4%
3	Mallah et al., (2015)	Lebanon	6.63 %	2.47%.	- 4.16%
4	Rogenski et al., (2015)	San Paulo, Brazil	41.02%	23.1%.	-17.92%
5	Loudet et al., (2017)	Buenos Aires, Argentina	11.7% 75%	2.8% 54%	-8.9% -21%

Notes: \*Classification of developed and developing country was based on The World Bank (2021)

### *3.3 Secondary outcomes: Pressure injury prevention strategies*

The interventions used to prevent pressure injuries were analyzed and reported by the type of intervention. This review found that multi-interventions (bundles) that significantly reduced the incidence of pressure injury consist of seven (7) interventions: risk assessment, skin care, reposition, nutrition, support surface, education, and medical device maintenance. It is shown that multi interventions with significant effects on reducing the incidence of pressure injury were risk assessment, skincare, support surface, and repositioning (Table 1).

#### *3.3.1 Pressure injury risk assessment (1st strategy)*

Several risk instruments were used in the studies to identify participants who were prone to stress injuries. The study showed that the incidence of pressure injury patients admitted to the ICU were assessed by Waterlow, Cubbin Jackson, Braden. The Braden scale was the most frequently used pressure injury risk assessment instrument in this study (Amr et al., 2017; He et al., 2016; Loudet et al., 2017; Lupe et al., 2015; Mallah et al., 2015; Rogenski et al., 2015; Siracusa & Schrier, 2011; Swafford et al., 2016; Tayyib et al., 2015; Uzun et al., 2015; Vasconcelos & Caliri, 2017). However, Cubbin Jackson scale had more comprehensive risk assessment aspects for critically ill patients.

#### *3.3.2 Skin care (2nd strategy)*

Maintaining the integrity of the skin is an important factor in reducing the occurrence of pressure injuries. There were 12 studies (Coyer et al., 2017; Gage, 2015; He et al., 2016; Karadag & Özdemir, 2008; Lewis et al., 2015; Loudet et al., 2017; Lupe et al., 2015; Rogenski et al., 2015; Siracusa & Schrier, 2011; Swafford et al., 2016; Uzun et al., 2015; Vasconcelos & Caliri, 2017) in Table 1 which showed that skin-based creams silicone application, using antiseptic soaps with 2% of hydrogen peroxide and prepacked pH balanced washcloth once per day, and giving basic skin moisturizer (petroleum jelly, VCO, sorbolence) every bath could reduce the incidence of pressure injuries in the patients admitted to critical units.

#### *3.3.3 Reposition (3rd strategy)*

Repositioning is an intervention to reduce the duration of pressure on tubal areas that are prone to pressure injuries, such as areas of bony prominence, in addition to providing a sense of security and maintaining the patient's functional ability. Studies related to reposition are presented in Table 1. As many as 15 studies (Amr et al., 2017; Avşar & Karadağ, 2018; Chaboyer et al., 2016; Coyer et al., 2017; He et al., 2016; Lewis et al., 2015; Lupe et al., 2015; Mallah et al., 2015; Manzano et al., 2014; Siracusa & Schrier, 2011; Swafford et al., 2016; Tayyib et al., 2015; Uzun et al., 2015; Vasconcelos & Caliri, 2017) reported the benefits of patients' repositioning. The repositioning used a three- or two- or six-hour play schedule using a "play clock." The legs of the bed were elevated by 20 degrees if clinically permitted. The patient's heel was elevated and supported. Also, draw sheets were used to transfer and lift patients (Gillespie et al., 2012; Zhang, 2021; Zuo & Meng, 2015). Behrendt et al. (2014) reported that a bedside pressure mapping system was able to support clinical staff to optimize repositioning and duration of repositioning, allowing interventions to reduce initial pressures. When two methods were compared for patient repositioning, a clockwise rotation system was effective in reducing the incidence of pressure injury compared to standard pillow care (Whitty et al., 2017).

#### *3.3.4 Nutritional intervention (4th strategy)*

Nutrition plays an important role in the prevention and treatment of pressure injuries (He et al., 2016). Macro and micronutrients were needed by each organ system in a certain amount to promote the growth, development, maintenance, and repair of body tissues. Nutrition-related studies were presented in Table 1. Four studies (Amr et al., 2017; Chaboyer et al., 2016; Gage, 2015; Mallah et al., 2015; Siracusa & Schrier, 2011) related to nutrition for the prevention of pressure injuries. In addition, albumin levels as an indicator of malnutrition should be assessed routinely (weekly or biweekly) to determine trends in nutritional therapy adequacy. A recent study reported by Amr et al.,

(2017) pointed out that enteral nutritional formula fortified with fish oil containing polyunsaturated fatty acids, significantly reduced the incidence of stress injuries in critical units.

### *3.3.5 Support surface (5th strategy)*

The support surface is the surface on which a patient is placed to manage pressure, shear, and microclimate loads. This surface includes mattresses, trolleys, operating table mattresses, integrated bed systems, and pillow chairs. The support surface is designed to reduce interface pressure ulcers by increasing the surface area of the body or alternating the area of the body in contact with the support surface. Table 1 shows the results of the support surface of 10 studies (Anderson et al., 2015; Gage, 2015; He et al., 2016; Loudet et al., 2017; Lupe et al., 2015; Mallah et al., 2015; Ozyurek & Yavuz, 2015; Tayyib et al., 2015; Uzun et al., 2015). These studies only evaluated mattresses; no studies related to pillow performance were found. Ozyurek & Yavuz (2015) assessed the effect of two types of viscoelastic mattresses (viscoelastic foam 1 consisting of two layers and viscoelastic foam 2 consisting of three layers) in patient admitted to critical units. They found no statistically significant difference between patients using plain foam and patients using viscoelastic foam to decrease the incidence of pressure injury grade  $\geq$  II when compared with the overlay of APAM (*alternating pressure air mattress*) in patients admitted to critical units.

### *3.3.6 Educational (6th strategy)*

This review showed that staff education was an important component of pressure injury prevention. The educational programs should include a variety of factors that reflect the multifactorial nature of pressure injury. There were 6 studies (Chaboyer et al., 2016; Gage, 2015; Lupe et al., 2015; Swafford et al., 2016; Tayyib et al., 2015; Vasconcelos & Caliri, 2017) in Table 1 which showed the results of education and education of health workers. The education with a focus on preventive care can be effective in reducing the incidence of pressure injury in critical care settings.

### *3.3.7 Medical device maintenance (7th strategy)*

Treatment using medical devices is proven to reduce pressure injuries by using several dressings on the skin area where the medical device is attached. Based on Table 1, there were two studies (Tayyib et al., 2015; Zakaria et al., 2018) reporting that dressing on medical devices was effective in preventing pressure injuries. There was one type of dressing that showed a statistically significant reduction in the incidence of pressure injuries, such as polyurethane film dressings rather than hydrocolloid dressings (Boyko et al., 2018). Lewis et al. (2015) and Tayyib et al. (2021) found that coated thin hydrocolloid and silicone single-layer dressings were effective in reducing pressure injuries on the medical device fixated areas (non-invasive ventilator, endotracheal tubes/ tracheal tubes, nasogastric tubes, urinary catheter, non-rebreathing/oxygenation mask) in critically ill patients when previously applied within 24 hours of admission to the critical care room.

## **4 Discussion**

This review aimed to identify the impact of the pressure injury prevention bundles of care on the pressure injury incidents in critically ill patients and to identify the intervention measures of the care bundles. The result of this review showed that the bundles of care reduced the incidents of pressure injury in critically ill patients both in developed and developing countries although the reduction was higher in the former countries. Furthermore, risk assessment, skin care, reposition, nutrition, support surface, education, and medical device maintenance were identified as effective strategies for preventing pressure injuries in critically ill patients.

### *4.1 The incidence of pressure injury*

The use of multiple interventions reduces the incidence of pressure injury in critically ill patients by 4.3% to 36.2% in 9 developed countries, and 4.16%-25.72% in 5 developing countries (The World Bank, 2021). The success of the bundles in reducing the incidence of pressure injury is affected by nurses and is dependent on standard operating procedures, nurses' knowledge, compliance with nursing actions supported with clear documentation, and complete data interpretation (Lavallée et

al., 2017; Zuo & Meng, 2015). This review cannot perform meta-analysis due to a heterogeneity of the included studies, and lacking of RCTs. The decrease in the incidence of pressure injury in developed countries is higher due to nurse compliance, the number and ratio of nurses caring for the number of patients (1:1.96 or 1: 3.24) (Zhang, 2021). Low nurse workload (Lee et al., 2019), support from ICU nursing organizational institution (hospital management conducts continuous audits regarding the performance of nurses) (Amaravadi et al., 2000; Driscoll et al., 2018), The success of pressure injury prevention bundles was influenced by education and training of nurses in prevention bundles, nurse awareness related to pressure injury prevention (Rivera et al., 2020), collaboration with unit-based wound care expertise, audit feedback to doctors, and consistency of nurses identifying pressure ulcer events (Floyd et al., 2021; Krupp & Monfre, 2015). Moreover, The bundle approach is more effective than a single method in the Chinese ICU (Zhang, 2021).

#### *4. 2 Pressure injury intervention strategies*

This review describes pressure injury prevention bundle that could reduce the pressure injury incident consisting of 7 intervention components, namely pressure injury risk assessment (1), skin care (2), repositioning (3), nutrition (4), education (6), support surface (5) and medical device maintenance (7).

##### *4.2.1 Scale of pressure injury (1st strategy)*

The developed scales for ICU patients are 7, such as Braden, Norton, PURAS, Waterlow, Cubbin Jackson, EVARUCI, and Suriadi Sanda. A meta-analysis by Chen et al. (2016) showed that the Braden scale had a moderate prediction value (AUC of 0.7686, moderate sensitivity (0.80) and low specificity (0.42)) to predict pressure injury risks. While meta-analysis Wei et al. (2020) stated the opposite; to predict pressure injury risk in ICU patients, the Braden scale had AUC of 0.7812, sensitivity of 0.89, and specificity of 0.28. Deng et al. (2017) stated that the Braden scale was more suitable to assess pressure injury in general ward because it evaluated skin damages in seven domains: sensory perception, moistness, activity, mobility, nutrient, and friction, and shear (Gomes et al., 2011; Lewicki et al., 2000).

Components of the Braden scale were absolutely less proper to be applied to ICU patients, the risk factors of pressure injury incident were generally caused by age, some comorbidities, unstable hemodynamic status, sedation, peripheral perfusion change, hypotension, vasoactive and vasopressor medication, frequent incontinence and edema which needed sustainable assessment due to rapidly changing condition of critically ill patients (Hyun et al., 2013; Kim et al., 2013; Manzano et al., 2014; Seongsook et al., 2004). Some studies (Cooper, 2013; Seongsook et al., 2004; Manzano et al., 2014; Shi et al., 2018) stated that the Cubbin & Jackson scale had better validity compared to the Braden scale because the domains in the Cubbin & Jackson scale was specifically used to assess pressure injury in ICU patients. Cubbin and Jackson (1991), Jackson (1999), and Shi et al. (2018) reported that the Cubbin & Jackson scale had a value of sensitivity by 89 % and 61% lower than Braden scale for its specificity. Cubbin & Jackson scale reflected the complex condition of critically ill patients such as patients with comorbidities, unstable hemodynamic status, ventilated, vasoactive medication who needed sustainable assessment due to rapidly changing condition of critically ill patients.

The Suriadi & Sanda scale had three domains, namely interface pressure, temperature, and cigarette smoking history, which effectively detected pressure injury in ICU patients. However, the weakness of this scale was that it was conducted only in one city in a country despite the sensitivity value of 81%, and specificity of 83% (Suriadi et al., 2007). EVARUCI scale had five domains containing consciousness, hemodynamic status, respiratory status, mobility and others (Souza et al., 2018). This scale was effective to screen pressure injuries in ICU patients due to its relatively high predictive value; the ROC value was around 0.938, which was a very good value. However, it had a limitation for its small number of samples. The writers compared scales in this review and concluded that the use of pressure injury risk scale in ICU was better than using prediction capacity. The reduction of pressure injury incidents was pertained to risk factor identification and the use of care intervention to prevent pressure injuries. Therefore, scale identification with a good predictive



capacity would contribute to improving accuracy in care decisions which could provide support in critical care.

#### *4.2.2 Skin care (2nd strategy)*

The skin care component of the prevention bundle in this review was taken from some studies. Skin care in the prevention of pressure injury able to reduce the incidence of pressure injury included risk assessments using physical assessments which were done comprehensively from the patient's skin and documented within 24 hours after entering ICUs, and evaluated every shift; bathing the patient using antiseptic soap with 2% of hydrogen peroxide / prepackaged washcloths (pH balanced once per day; giving basic skin moisturizer (petroleum jelly, VCO, sorbolence) every bath (Zuo & Meng, 2015). Foam dressing had the ability to move water vapor out of the dressing to minimize the accumulation of heat and excess moisture so it could prevent skin maceration in patients with lateral positions. Multilayer materials in foam dressing, i.e., silicon foam composite, could minimize friction when the dressing touches skin surface and protect skin from mechanical wound (Huang et al., 2015). Ohura et al., (2005) stated that foam could be compressed, but it was easily damaged; it also effectively reduced pressure and friction. Film dressing, based on the review, effectively reduced pressure injury because it was semi-occlusive with multilevel permeability, but it could not be used in patients with high fever and excessive sweat (Sood et al., 2014; Weller et al., 2020). Tayyib et al. (2015) stated that most frequent pressure injuries were located on the sacrum area, tailbone, and heel, so the high-risk of friction was likely to occur. It became a challenge for nurses to protect those areas because dressings were easily saturated, or even dirty. However, some studies had limitations related to this topic. Studies by Avsar and Karadag (2018), Tayyib et al. (2015); and Zakaria et al. (2018) were conducted in a relatively short period, while a study by Loudet et al. (2017) in this review did not document their risk assessment.

#### *4.2.3 Reposition (3<sup>rd</sup> strategy)*

Repositioning was to move a person to a different position to distribute pressure from a certain body parts. Amr et al. (2017) suggested the time distributed for one position was not more than 2 hours. However, the repositioning frequency had to consider the general medical condition, skin condition, and comfort. Repositioning could be a hard duty, so it had to be performed by trained personnel by practicing correct techniques to prevent further pressure injury. A study by Tayyib et al. (2015) in medical ICU found that employment of mobility team consisting of pressure injury prevention nurses, skin care mobility assistants, and patient mobility assistants was pertained to significantly reduce pressure injury in ICUs (6.1% vs. 9.2%,  $p=0.04$ ). Chaboyer et al. (2018) and Wayunah (2018) found that repositioning in critical care patients (by an hourly-repositioning) only occurred around 50% from time to time. Lateral position often became a choice when intervention and care were frequently performed in ICU, which might contribute to pressure injury incidents in that area. The problem was in the practice of lifting the patient's head until 45° to prevent pneumonia, considering that the position of mechanically ventilated patients received bigger pressure in the sacrum and heel (Gillespie et al., 2012; Lewis et al., 2015). Patients in this position tended to slide down the bed and increased the risk of skin exposure with friction and shear (Lewis et al., 2015). Even though there was no definite evidence of repositioning frequency and determination in critically ill patients, it was clearly shown that regular re-repositioning was important prevention. A study by Al-Dorzi (2019) showed a-2 hour-repositioning reduced pressure injury about  $1.35\pm 0.520$  compared to control group ( $1.73\pm 0.790$ ,  $p=0.000$ ).

#### *4.2.4 Nutritional intervention (4<sup>th</sup> strategy)*

Nutrition components in this review were found only in two studies (Gage, 2015; Siracusa & Schrier, 2011) which included nutrition in pressure injury prevention bundles. These studies reported that nutrition intervention significantly reduced pressure injury ( $p=0.05$ ). This was correlated to patients with malnutrition status that increased pressure injury risks. Generally, nutrition support had to target prevention or nutrition deficit correction. Based on the circumstantial evidence, guidelines recommended the supply of 30 to 35 kcal/kg weight per day for malnutrition patients or

in malnutrition risk on pressure injuries (Al-Dorzi, 2019; EPUAP et al., 2019). Recommended protein and meta-analysis from eight studies (6,062 patients) which compared mixed nutritional supplement to hospital standard diet did not find an obvious effect from supplemented nutrition in pressure injury development (risk ratio 0.86; confidence interval 95%, 0.73-1.00;  $p=0.05$ ) (Al-Dorzi, 2019).

#### *4.2.5 Support surface (5<sup>th</sup> strategy)*

Support surface component was based on 10 studies reviewed about pressure injury prevention bundles (Anderson et al., 2015; Gage, 2015; He et al., 2016; Loudet et al., 2017; Lupe et al., 2015; Mallah et al., 2015; Ozyurek & Yavuz, 2015; Tayyib et al., 2015; Uzun et al., 2015). Ozyurek and Yavuz (2015) conducted a study by comparing the efficacy of two viscoelastic beds; one was with two layers, while the other was with three layers. The result showed that there was a significant difference in pressure injury prevention ( $p=0.44$ ). This was in line with a study by de Camargo et al. (2018) which found that pressure injury incidence with support surface was about 32.2% compared to the group with no support surface 80.6% ( $p\leq 0.001$ ); viscoelastic could redistribute pressure and affect micro climate that could reduce skin moisture to prevent pressure injuries. Studies showed that the use of pressure air mattress and pillow to position patients successfully reduced pressure injuries, statistically significant about 4.1-17% (Lupe et al., 2015; Uzun et al., 2015). In a study by Tayyib et al., (2015), the use of support surfaces to manage the weight and pressure of patients along with a-two hour-repositioning reduced the pressure injury incidence for 39%. Also, Anderson et al. (2015) and Tayyib et al. (2015) reported that the use of two air mattresses reduced pressure injury incidence by 2.1%-7.14%. The use of support surface aimed to reduce the duration of pressure between the patient body and support surfaces in pressure injury prevention (McInnes et al., 2015).

#### *4.2.6 Education (6<sup>th</sup> strategy)*

There were not many studies about pressure injury prevention bundles that discussed education component, but the study by Anderson et al. (2015), Tayyib et al. (2015), and Uzun et al. (2015) showed that an education of element bundles to the ICU nurses was an important action that can reduce pressure injury by 2.1% to 39.3%. Giving education was considered important to improve staff awareness in pressure injury prevention. Staff education and training also contribute to the successful result in care improvement and patient outcomes. Education pertained to effective bundles improves care quality because it combines some core interventions to “care package”, like VAP bundle approach to reduce pneumonia pertained to ventilator usage and respiratory tract infections in critically ill patients (Anderson et al., 2015; Tweed & Tweed, 2008).

#### *4.2.7 Medical device (7<sup>th</sup> strategy)*

The incidence of pressure injury due to the use of medical equipment was estimated at about 10-12% (Brooke et al., 2019). According to Padula et al. (2015) the incidence of pressure injury related to the use of medical equipment was about 30-70% and mostly it was caused by external factors. Medical equipment which were usually used in critically ill patients, such as intravenous catheters, splints, niv mask, servical collar, nasogastric tube, and endotracheal tube. A recent study by Hanonu and Karadag, (2016) showed that the incidence of pressure injury related to the use of breathing assist devices was the highest percentage (about 30-70%) started about 3.3 days after administration and 20% of nurses were unaware of the fact that medical devices could also lead to ulcer formation. While a study in the Netherlands Ham et al. (2017) showed that support surface intervention, reposition every 2-4 hours, and nutrition factors gave contribution to the incidence of pressure injury related to immobilized patients, and also the use of manual tightening rope in immobilized patient contributed 20.1% of pressure injury incident. A study by Zakaria et al. (2018) showed that manipulating the position of breathing assist tube will reduce pressure injury from 77.8% to 13.1%.

Tayyib et al. (2021) describe the maintenance of medical equipment in the prevention of pressure injury. The procedures begin with securing medical equipment, protecting the skin with silicon hydrocolloids in areas at high risk of pressure ulcers, and avoiding to directly install medical devices with the patient's skin unless the patient's condition is not possible. Next, checking the skin under the medical device more than 2 times a day, monitoring nutrient intake, and choosing the right

size and type of medical device to suit the patient's condition were conducted. Last, monitoring the incidence and prevalence of pressure ulcers related to the installation of medical devices is carried out in a regular basis (Mehta et al., 2019; Tayyib et al., 2021). Risk identification instrument of pressure injury (Gómez et al., 2017; Jackson, 1999; Lyder et al., 1999; Suriadi et al., 2007) used by most hospitals today was not sufficient to identify the risks of pressure injury related to the attached medical device. There were lots of medical devices which could initiate pressure injuries, and those instruments alone were ineffective to examine and identify pressure injuries in mucus membrane. According to this finding, we need future studies to develop appropriate instruments that can be used specifically to examine and identify patients with a high risk of developing pressure injuries related to medical devices.

## **5 Implication and limitation**

This review may implicate the critical health care providers especially critical nurses and the ICUs for providing comprehensive overview through a thorough and systematic study to prevent pressure injuries in the critically ill patients. Intervention measures, such as risk assessment, skin care, reposition, nutrition, support surface, education, and medical device maintenance could be applied as a bundle of care for the better patient nursing care, compared to the single intervention.

The strength of this review is the importance of raising the topic of the pressure injury prevention bundle guided by the librarian's comprehensive search strategy and the systematic review of this review represents a novelty in synthesizing related literature containing multi-component prevention of pressure injury and incidents of pressure injury in critically ill patients. With these facts, the bundles, by such findings in this review, might be implemented as a multi-intervention alternative to prevent pressure injury in critical care units. This review might be chosen as a reference of Indonesian nursing as a guideline in daily practice.

One considerable limitation from this review was unable to perform a meta-analysis as the included studies varied in the methods and statistical values of the outcomes. From 13 studies, there were only 2 studies which used true high quality RCT method, while other studies used low quality method. In addition, there were so many components of the bundle for pressure ulcer prevention, and each hospital implemented this bundle in various techniques that differ from one hospital to the others. Thus, clinical staffs who were involved in this bundle should have more attention to detail when implementing this bundle to patients with complex medical situations and diseases. There was no single component of this bundle that was proven to be the most effective to prevent the incidence of pressure injuries. The bundle prevention of pressure injury in this review could not show meta-analysis purpose. Besides, this review did not evaluate the working quality of medical and nursing staff while implementing this bundle, but only showed that this bundle prove to be more effective in lowering the incidence of pressure injury in critically ill patients.

## **6 Conclusion**

Pressure injury prevention bundles can reduce the incidence of pressure by 4.3% to 36.2% in developed countries and 4.16% to 25.72% in developing countries. The intervention strategies in the prevention bundles included the risk assessment of pressure injury using the Cubbin Jackson scale, skincare, repositioning, nutrition, education, support surfaces, and medical device care. This bundle was a multi-intervention method of prevention, which consists of 7 components, and still need supervision from higher-rank of nurses in critical care units in order to early detect the incidence of pressure injuries. Although the prevention bundle can reduce the incidence of pressure injuries, this review found that scientific evidence of its effect is still lacking. Only 2 studies used high quality RCT. Therefore, it is recommended to conduct randomized clinical trials for next studies to investigate the effect of prevention bundles to reduce the incidence of pressure injury.

## **Acknowledgment**

The authors would like to express their gratitude to the Department of Nursing, Faculty of Medicine, Universitas Diponegoro for the support to this research.

### Author contribution

WT: data searching, articles' selection, data extraction, quality appraisal, data analysis, manuscript writing; RR: study design, quality appraisal, data analysis; NR: study design, articles' selection, data extraction, quality appraisal, data analysis, manuscript writing

### Conflict of interest

The authors declare that there are no conflicts of interest.

### References

- Akhkand, S. S., Seidi, J., Ebadi, A., & Gheshlagh, R. G. (2020). Prevalence of pressure ulcer in Iran's intensive care units: A systematic review and meta-analysis. *Nursing Practice Today*, 7(1), 12–20.
- Al-Dorzi, H. (2019). Prevention of pressure injury in the intensive care unit. *Saudi Critical Care Journal*, 3(1), 24. <https://doi.org/10.4103/2543-1854.259474>
- Alderden, J., Rondinelli, J., Pepper, G., Cummins, M., & Whitney, J. (2017). Risk factor for pressure injuries among critical-care patients: A systematic review. *International Journal of Nursing Studies*, Jun(71), 97–114. <https://doi.org/10.1016/j.ijnurstu.2017.03.012>.
- Amaravadi, R. K., Dimick, J. B., Pronovost, P. J., & Lipsett, P. A. (2000). ICU nurse-to-patient ratio is associated with complications and resource use after esophagectomy. *Intensive Care Medicine*, 26(12), 1857–1862. <https://doi.org/10.1007/s001340000720>
- Amr, A. A., Yousef, A., Amirah, M., & Alkurdi, M. (2017). A pre-post study evaluating the effectiveness of a new initiative, the “PRESSURE Bundle,” Compared with standard care in reducing the incidence and prevalence of sacral pressure ulcers in critically ill patients in an intensive care unit in Riyadh, Saudi. *Saudi Critical Care Journal*, 1(3), 75. [https://doi.org/10.4103/sccj.sccj\\_29\\_17](https://doi.org/10.4103/sccj.sccj_29_17)
- Anderson, M., Guthrie, P. F., Kraft, W., Reicks, P., Skay, C., & Beal, A. L. (2015). Universal pressure ulcer prevention bundle with WOC nurse support. *Journal of Wound, Ostomy and Continence Nursing*, 42(3), 217–225. <https://doi.org/10.1097/WON.000000000000109>
- Artico, M., D'Angelo, D., Piredda, M., Petitti, T., Lamarca, L., De Marinis, M. G., Dante, A., Lusignani, M., & Matarese, M. (2018). Pressure injury progression and factors associated with different endpoints in a home palliative care setting: A retrospective chart review study. *Journal of Pain and Symptom Management*, 56(1), 23–32. <https://doi.org/10.1016/j.jpainsymman.2018.03.011>
- Avşar, P., & Karadağ, A. (2018). Efficacy and cost-effectiveness analysis of evidence-based nursing interventions to maintain tissue integrity to prevent pressure ulcers and incontinence-associated dermatitis. *Worldviews on Evidence-Based Nursing*, 15(1), 54–61. <https://doi.org/10.1111/wvn.12264>
- Behrendt, R., Ghaznavi, A. M., Mahan, M., Craft, S., & Siddiqui, A. (2014). Continuous bedside pressure mapping and rates of hospital-associated pressure ulcers in a medical intensive care unit. *American Journal Critical Care*, 23(2), 127–133. <https://doi.org/10.4037/ajcc2014192>
- Bhattacharya, S., & Mishra, R. K. (2015). Pressure ulcers: Current understanding and newer modalities of treatment. *Indian Journal Plastic Surgery*, 48(1), 4–16. <https://doi.org/10.4103/0970-0358.155260>.
- Boyko, T. V., Longaker, M. T., & Yang, G. P. (2018). Review of the current management of pressure ulcers. *Advances in Wound Care*, 7(2), 57–67. <https://doi.org/10.1089/wound.2016.0697>
- Brooke, J., Jackson, D., Sarki, A. M., & Betteridge, R. (2019). Medical device-related pressure ulcers: A systematic review and meta-analysis. *International Journal of Nursing Studies*, 92, 109–120. <https://doi.org/10.1016/j.ijnurstu.2019.02.006>
- Campbell, M., McKenzie, J. E., Sowden, A., Katikireddi, S. V., Brennan, S. E., Ellis, S., Hartmann-Boyce, J., Ryan, R., Shepperd, S., Thomas, J., Welch, V., & Thomson, H. (2020). Synthesis without meta-analysis (SWiM) in systematic reviews: Reporting guideline. *British Medical Journal*, 368, 1–6. <https://doi.org/10.1136/bmj.l6890>

- Chaboyer, W., Bucknall, T., Webster, J., McInnes, E., Gillespie, B. M., Banks, M., Whitty, J. A., Thalib, L., Roberts, S., Tallott, M., Cullum, N., & Wallis, M. (2016). The effect of a patient centred care bundle intervention on pressure ulcer incidence (INTACT): A cluster randomised trial. *International Journal of Nursing Studies*, 64(Dec), 63–71. <https://doi.org/10.1016/j.ijnurstu.2016.09.015>
- Chaboyer, W. P., Thalib, L., Harbeck, E. L., Coyer, F. M., Blot, S., Bull, C. F., Nogueira, P. C., & Lin, F. F. (2018). Incidence and prevalence of pressure injuries in adult intensive care patients: A Systematic review and Meta-analysis. *Critical Care Medicine*, 46(11), e1074–e1081. <https://doi.org/10.1097/CCM.0000000000003366>
- Chen, H., Shen, W.-Q., & Liu, P. (2016). Meta-analysis to evaluate the predictive validity of the braden scale for pressure ulcer risk assessment in long-term care. *Ostomy Wound Manage*, 62(9), 20–28.
- Citra, B. D., Sitompul, H. C., & Restuastuti, T. (2010). Effectiveness of 2-hour repositioning against the prevention of pressure ulcer in post-stroke old patients in the neurology ward of Arifin Achmad Pekanbaru Hospital. *Journal of Medical Science*, 4(2), 133–140. <https://doi.org/10.26891/JIK.v4i2.2010.133-140>
- Clough, Y., Krishna, V. V., Corre, M. D., Darras, K., Denmead, L. H., Meijide, A., Moser, S., Musshoff, O., Steinebach, S., Veldkamp, E., Allen, K., Barnes, A. D., Breidenbach, N., Brose, U., Buchori, D., Daniel, R., Finkeldey, R., Harahap, I., Hertel, D., ... & Scheu, S. (2016). Land-use choices follow profitability at the expense of ecological functions in Indonesian smallholder landscapes. *Nature Communications*, 7, 13137. <https://doi.org/10.1038/ncomms13137>
- Cooper, K. L. (2013). Evidence-based prevention of pressure ulcers. *Critical Care Nurse*, 33(6), 57–67. <https://doi.org/http://dx.doi.org/10.4037/ccn2013985>
- Cox, J., & Rasmussen, L. (2014). Enteral nutrition in the prevention and treatment of pressure ulcers in adult critical care patients. *Critical Care Nurse*, 34(6), 15–27. <https://doi.org/10.4037/ccn2014950>
- Coyer, F., Gardner, A., & Doubrovsky, A. (2017). An interventional skin care protocol (InSPiRE) to reduce incontinence-associated dermatitis in critically ill patients in the intensive care unit: A before and after study. *Intensive and Critical Care Nursing*, 40, 1–10. <https://doi.org/10.1016/j.iccn.2016.12.001>
- Coyer, F., Miles, S., Gosley, S., Fulbrook, P., Sketcher-Baker, K., Cook, J. L., & Whitmore, J. (2016). Pressure injury prevalence in intensive care versus non-intensive care patients: A state-wide comparison. *Australian Critical Care*, 30(5), 244–250. <https://doi.org/10.1016/j.aucc.2016.12.003>
- Cubbin, B., & Jackson, C. (1991). Trial of a pressure area risk calculator for intensive therapy patients. *Intensive Care Nursing*, 7(1), 40–44. [https://doi.org/10.1016/0266-612X\(91\)90032-M](https://doi.org/10.1016/0266-612X(91)90032-M)
- Dale, C. M., Smith, O., Burry, L., & Rose, L. (2018). Prevalence and predictors of difficulty accessing the mouths of intubated critically ill adults to deliver oral care: An observational study. *International Journal of Nursing Studies*, 80, 36–40. <https://doi.org/10.1016/j.ijnurstu.2017.12.009>
- de Camargo, W. H. B., Pereira, R. de C., Tanita, M. T., Heko, L., Grion, I. C., Festti, J., Mezzaroba, A. L., & Grioncor, C. M. C. (2018). The effect of support surfaces on the incidence of pressure injuries in critically ill patients: A randomized clinical trial. *Critical Care Research and Practice*, 2018, 3712067. <https://doi.org/10.1155/2018/3712067>
- Demarré, L., Van Lancker, A., Van Hecke, A., Verhaeghe, S., Grypdonck, M., Lemey, J., Annemans, L., & Beeckman, D. (2015). The cost of prevention and treatment of pressure ulcers: A systematic review. *International Journal of Nursing Studies*, 52(11), 1754–1774. <https://doi.org/10.1016/j.ijnurstu.2015.06.006>
- Deng, X., Yu, T., & Hu, A. (2017). Predicting the risk for hospital-acquired pressure ulcers in critical care patients. *Critical Care Nurse*, 37(4), e1–e11. <https://doi.org/10.4037/ccn2017548>
- Donovan, E. A., Manta, C. J., Goldsack, J. C., & Collins, M. L. (2016). Using a lean six sigma approach to yield sustained pressure ulcer prevention for complex critical care patients. *Journal of Nursing Administration*, 46(1), 43–48. <https://doi.org/10.1097/NNA.0000000000000291>

- Driscoll, A., Grant, M. J., Carroll, D., Dalton, S., Deaton, C., Jones, I., Lehwaldt, D., McKee, G., Munyombwe, T., & Astin, F. (2018). The effect of nurse-to-patient ratios on nurse-sensitive patient outcomes in acute specialist units: A systematic review and meta-analysis. *European Journal of Cardiovascular Nursing*, 17(1), 6–22. <https://doi.org/10.1177/1474515117721561>
- Edsberg, L. E., Black, J. M., Goldberg, M., McNichol, L., Moore, L., & Sieggreen, M. (2016). Revised national pressure ulcer advisory panel pressure injury staging system. *Journal of Wound, Ostomy and Continence Nursing*, 43(6), 585–597. <https://doi.org/10.1097/WON.000000000000281>
- Emma, L. Y., & Rita, W. C. (2018). *How pressure ulcers can be prevented in intensive care unit (ICU) patients: A descriptive literature review [Master's thesis]* [Lishui University]. <http://www.diva-portal.org/smash/get/diva2:1223418/FULLTEXT01.pdf>
- EPUAP, NPIAP, & PPIA. (2019). *Prevention and treatment of pressure ulcers/injuries: Quick reference guide 2019* (3<sup>rd</sup>). European Pressure Ulcer Advisory Panel, National Pressure Injury Advisory Panel & Pan Pacific Pressure Injury Alliance.
- Floyd, N. A., Dominguez-Cancino, K. A., Butler, L. G., Rivera-Lozada, O., Leyva-Moral, J. M., & Palmieri, P. A. (2021). The effectiveness of care bundles including the braden scale for preventing hospital acquired pressure ulcers in older adults hospitalized in icus: A Systematic review. *The Open Nursing Journal*, 15(1), 74–84. <https://doi.org/10.2174/1874434602115010074>
- Gage, W. (2015). Preventing pressure ulcers in patients in intensive care. *Nursing Standard*, 29(26), 53–61. <https://doi.org/10.7748/ns.29.26.53.e9657>
- Gill, C. (2015). Reducing hospital acquired pressure ulcers in intensive care. *British Medical Journal Quality Improvement*, 4(1), 1–5. <https://doi.org/10.1136/bmjquality.u205599.w3015>
- Gillespie, B. M., Chaboyer, W. P., McInnes, E., Kent, B., & Whitty, J. A. (2012). Repositioning for pressure ulcer prevention in adults. *Cochrane Database of Systematic Reviews*, 4. <https://doi.org/10.1002/14651858.cd009958>
- Girard, R., Baboi, L., Ayzac, L., Richard, J. C., & Guérin, C. (2014). The impact of patient positioning on pressure ulcers in patients with severe ARDS: Results from a multicentre randomised controlled trial on prone positioning. *Intensive Care Medicine*, 40(3), 397–403. <https://doi.org/10.1007/s00134-013-3188-1>
- Gomes, F. S. L., Bastos, M. A. R., Matozinhos, F. P., Temponi, H. R., & Velásquez-Meléndez, G. (2011). Risk assessment for pressure ulcer in critical patients. *Revista Da Escola de Enfermagem*, 45(2), 313–318. <https://doi.org/10.1590/S0080-62342011000200002>
- Gómez, S. L., Viana, T. S., Ruíz, J. M. G., & Rodríguez, J. Á. (2017). Validity of the current risk assessment scale for pressure ulcers in intensive care (EVARUCI) and the Norton-MI scale in critically ill patients. *Applied Nursing Research*, 38, 76–82. <https://doi.org/10.1016/j.apnr.2017.09.004>
- Greenhalgh, T., Jeremy, H., Iain, C., Paul, G., Carl, H., Alessandro, L., Ivan, M., Bob, P., & Hazel, T. (2011). OCEBM levels of evidence working group\*. "The oxford levels of evidence 2". In *Oxford Centre for Evidence-Based Medicine* (Vol. 38, pp. 33–36). <https://www.cebm.ox.ac.uk/resources/levels-of-evidence/ocebmllevels-of-evidence>
- Haesler, E., Kottner, J., & Cuddigan, J. (2017). The 2014 International pressure ulcer guideline: methods and development. *Journal Advanced Nursing*, 73(6), 1515–1530. <https://doi.org/10.1111/jan.13241>
- Ham, W., Schoonhoven, L., Schuurmans, M., & Leenen, L. (2017). Pressure ulcers in trauma patients with suspected spine injury: A prospective cohort study with emphasis on device-related pressure ulcers. *International Wound Journal*, 14(1), 104–111. <https://doi.org/10.1111/iwj.12568>
- Hanonu, S., & Karadag, A. (2016). Prospective, descriptive study to determine the rate and characteristics of and risk factors for the development of medical device-related pressure ulcers in intensive care units. *Ostomy Wound Manage*, 62(2), 12–22.
- He, M., Tang, A., Ge, X., & Zheng, J. (2016). Pressure ulcers in the intensive care unit: An analysis of skin barrier risk factors. *Advances in Skin and Wound Care*, 29(11), 493–498. <https://doi.org/10.1097/01.ASW.0000494779.66288.c9>

- Higgins, J., Lasserson, T., Chandler, J., Tovey, D., Thomas, J., Flemyng, E., & Churchill, R. (2021). *Methodological Expectations of Cochrane Intervention Reviews (MECIR). Standards for the conduct and reporting of new Cochrane intervention reviews, reporting of protocols and the planning, conduct and reporting of updates* (Issue February, pp. 2–127). Cochrane Methods.
- Huang, L., Woo, K., Liu, L., Wen, R., Hu, A. S., & Hi, C. (2015). Dressings for preventing pressure ulcers: A meta-analysis. *Advances Skin Wound Care*, 28(6), 267–273. <https://doi.org/10.1097/01.ASW.0000463905.69998.0d>
- Hyun, S., Vermillion, B., Newton, C., Fall, M., Li, X., Kaewprag, P., Moffatt, B. S., & Lenz, E. R. (2013). Predictive validity of the Braden scale for patients in intensive care units. *American Journal Critical Care*, 22(5), 514–520. <https://doi.org/10.4037/ajcc2013991>
- Jackson, C. (1999). The revised Jackson/Cubbin pressure area risk calculator. *Intensive and Critical Care Nursing*, 15(3), 169–175. [https://doi.org/10.1016/S0964-3397\(99\)80048-2](https://doi.org/10.1016/S0964-3397(99)80048-2)
- Joanna Briggs Institute. (2017). *Joanna Briggs Institute reviewers' manual: 2017 edition*. Joanna Briggs Institute Reviewer's Manual. <https://https://jbi.global/critical-appraisal-tools>
- Karadag, A., & Özdemir, H. (2008). Prevention of pressure ulcers: A descriptive study in 3 intensive care units in Turkey. *Journal of Wound, Ostomy and Continence Nursing*, 35(3), 293–300. <https://doi.org/10.1097/01.WON.0000319128.06607.ac>
- Kim, E., Choi, M., Lee, J., & Kim, Y. A. (2013). Reusability of EMR data for applying cubbin and Jackson pressure ulcer risk assessment scale in critical care patients. *Healthcare Informatics Research*, 19(4), 261–270. <https://doi.org/10.4258/hir.2013.19.4.261>
- Kim, J. Y., & Lee, Y. J. (2018). Medical device-related pressure ulcer (MDRPU) in acute care hospitals and its perceived importance and prevention performance by clinical nurses. *International Wound Journal*, 16(1), 51–61. <https://doi.org/10.1111/iwj.13023>
- Krupp, A. E., & Monfre, J. (2015). Pressure ulcers in the ICU patient: an update on prevention and treatment. *Current Infectious Disease Reports*, 17(11). <https://doi.org/10.1007/s11908-015-0468-7>
- Langer, G., & Fink, A. (2014). Nutritional interventions for preventing and treating pressure ulcers. *Cochrane Database of Systematic Reviews*, 2014(6), 1–76. <https://doi.org/10.1002/14651858.CD003216.pub2>
- Lavallée, J. F., Gray, T. A., Dumville, J., Russell, W., & Cullum, N. (2017). The effects of care bundles on patient outcomes: A systematic review and meta-analysis. *Implementation Science*, 12(1), 1–13. <https://doi.org/10.1186/s13012-017-0670-0>
- Lee, E., Kim, J., & Lee, J. (2019). Risk factors for newly acquired pressure ulcer and the impact of nurse staffing on pressure ulcer incidence. *Journal of Nursing Management*, 00, 1–9. <https://doi.org/10.1111/jonm.12928>
- Lewicki, L. J., Mion, L. C., & Secic, M. (2000). Sensitivity and specificity of the braden scale in the cardiac surgical population. *Journal of Wound, Ostomy and Continence Nursing*, 27(1), 36–41. <https://doi.org/10.1097/00152192-200001000-00016>
- Lewis, P., Coyer, F., & Tayyib, N. (2015). Saudi Arabian adult intensive care unit pressure ulcer incidence and risk factors: A prospective cohort study. *International Wound Journal*, 13(5), 912–919. <https://doi.org/10.1111/iwj.12406>
- Lewis, P., Coyer, F., & Tayyib, N. (2016). Implementing a pressure ulcer prevention bundle in an adult intensive care. *Intensive and Critical Care Nursing*, 37, 27–36. <https://doi.org/10.1016/j.iccn.2016.04.005>
- Lin, F., Wu, Z., Song, B., Coyer, F., & Chaboyer, W. (2020). The effectiveness of multicomponent pressure injury prevention programs in adult intensive care patients: A systematic review. *International Journal of Nursing Studies*, 102, 103483. <https://doi.org/10.1016/j.ijnurstu.2019.103483>
- Liu, Y., Wu, X., Ma, Y., Li, Z., Cao, J., Jiao, J., Liu, G., Li, F., Song, B., Jin, J., Liu, Y., Wen, X., Cheng, S., & Lin, F. (2019). The prevalence, incidence, and associated factors of pressure injuries among immobile inpatients: A multicentre, cross-sectional, exploratory descriptive study in China. *International Wound Journal*, 16(2), 459–466. <https://doi.org/10.1111/iwj.13054>

- Loudet, C. I., Marchena, M. C., Maradeo, M. R., Fernández, S. L., Romero, M. V., Valenzuela, G. E., Herrera, I. E., Ramírez, M. T., Palomino, S. R., Teberobsky, M. V., Tumino, L. I., González, A. L., Reina, R., & Estenssoro, E. (2017). Reducing pressure ulcers in patients with prolonged acute mechanical ventilation: A quasi-experimental study. *Revista Brasileira de Terapia Intensiva*, 29(1), 39–46. <https://doi.org/10.5935/0103-507X.20170007>
- Lupe, L., Schmidt, S., Cano, A., Lopez, J., Stamp, H., Young, D., Joaquin, F., & Anglade, D. (2015). Improving outcomes by implementing a pressure ulcer prevention program (PUPP): Going beyond the basics. *Healthcare*, 3(3), 574–585. <https://doi.org/10.3390/healthcare3030574>
- Lyder, C. H., Yu, C., Emerling, J., Mangat, R., Stevenson, D., Empleo-Frazier, O., & McKay, J. (1999). The braden scale for pressure ulcer risk: Evaluating the predictive validity in black and latino/hispanic elders. *Applied Nursing Research*, 12(2), 60–68. [https://doi.org/10.1016/S0897-1897\(99\)80332-2](https://doi.org/10.1016/S0897-1897(99)80332-2)
- Mallah, Z., Nassar, N., & Kurdahi, L. (2015). The effectiveness of a pressure ulcer intervention program on the prevalence of hospital acquired pressure ulcers: Controlled before and after Study. *Applied Nursing Research*, 28(2), 106–113. <https://doi.org/10.1016/j.apnr.2014.07.001>
- Manzano, F., Colmenero, M., Pérez-Pérez, A. M., Roldán, D., Jiménez-Quintana, M. del M., Mañas, M. R., Sánchez-Moya, M. A., Guerrero, C., Moral-Marfil, M. Á., Sánchez-Cantalejo, E., & Fernández-Mondéjar, E. (2014). Comparison of two repositioning schedules for the prevention of pressure ulcers in patients on mechanical ventilation with alternating pressure air mattresses. *Intensive Care Medicine*, 40(11), 1679–1687. <https://doi.org/10.1007/s00134-014-3424-3>
- McGinnis, E., Greenwood, D. C., Nelson, E. A., & Nixon, J. (2014). A prospective cohort study of prognostic factors for the healing of heel pressure ulcers. *Age and Ageing*, 43(2), 267–271. <https://doi.org/10.1093/ageing/aft187>
- McInnes, E., Jammali-Blasi, A., Bell-Syer, S. E. M., Dumville, J. C., Middleton, V., & Cullum, N. (2015). Support surfaces for pressure ulcer prevention. *Cochrane Database of Systematic Reviews*, 2015(9), 1–121. <https://doi.org/10.1002/14651858.CD001735.pub5>
- Mehta, C., Ali, M. T., Mehta, Y., George, J. V., & Singh, M. K. (2019). MDRPU -an uncommonly recognized common problem in ICU: A point prevalence study. *Journal of Tissue Viability*, 28(1), 35–39. <https://doi.org/10.1016/j.jtv.2018.12.002>
- Munn, Z., Tufanaru, C., & Aromataris, E. (2014). Data extraction and synthesis. *American Journal of Nursing*, 114(7), 49–54. <https://doi.org/10.1097/01.NAJ.0000451683.66447.89>
- Novelia, S., Sia, W. S., & Songwathana, P. (2017). Surgical site infection among women post caesarean section: An integrative review. *Nurse Media Journal of Nursing*, 7(1), 46–55. <https://doi.org/10.14710/nmjn.v7i1.15127>
- Ohura, N., Ichioka, S., Nakatsuka, T., & Shibata, M. (2005). Evaluating dressing materials for the prevention of shear force in the treatment of pressure ulcers. *Journal of Wound Care*, 14(9), 401–404. <https://doi.org/10.12968/jowc.2005.14.9.26831>
- Ozyurek, P., & Yavuz, M. (2015). Prevention of pressure ulcers in the intensive care unit: A randomized trial of 2 viscoelastic foam support surfaces. *Clinical Nurse Specialist*, 29(4), 210–217. <https://doi.org/10.1097/NUR.0000000000000136>
- Padula, W. V., Mishra, M. K., Makic, M. B. F., Wald, H. L., Campbell, J. D., Nair, K. V., & Valuck, R. J. (2015). Increased adoption of quality improvement interventions to implement evidence-based practices for pressure ulcer prevention in U.S. academic medical centers. *Worldviews on Evidence-Based Nursing*, 12(6), 328–336. <https://doi.org/10.1111/wvn.12108>
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., ... & Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *The British Medical Journal*, 372, 1–9. <https://doi.org/10.1136/bmj.n71>



- Reilly, R., Evans, K., Gomersall, J., Gorham, G., Peters, M. D. J., Warren, S., O'Shea, R., Cass, A., & Brown, A. (2016). Effectiveness, cost effectiveness, acceptability and implementation barriers/enablers of chronic kidney disease management programs for Indigenous people in Australia, New Zealand and Canada: A systematic review of mixed evidence. *BMC Health Services Research*, 16(1). <https://doi.org/10.1186/s12913-016-1363-0>
- Repić, G., & Ivanović, S. (2014). Pressure ulcers and their impact on quality of life. *Acta Medica Medianae*, 75–80. <https://doi.org/10.5633/amm.2014.0412>
- Richardson, A., Peart, J., Wright, S. E., & McCullagh, I. J. (2017). Reducing the incidence of pressure ulcers in critical care units: A 4-year quality improvement. *International Journal for Quality in Health Care*, 29(3), 433–439. <https://doi.org/10.1093/intqhc/mzx040>.
- Riemenschneider, K. J. (2018). Prevention of pressure injuries in the operating room: A quality improvement project. *Journal Wound Ostomy Continence Nurs*, 45(2), 141–145. <https://doi.org/10.1097/WON.0000000000000410>.
- Rivera, J., Donohoe, E., Deady-Rooney, M., Douglas, M., & Samaniego, N. (2020). Implementing a pressure injury prevention bundle to decrease hospital-acquired pressure injuries in an adult critical care unit: An evidence-based, pilot initiative. *Wound Management Prevention*, 66(10), 20–28.
- Rogenski, N. M. B., Borghardt, A. T., Thiago Nascimento do, P., Thiago Moura de, A., & Maria Edla de Oliveira, B. (2015). Evaluation of the pressure ulcers risk scales with critically ill patients: A prospective cohort study. *Revista Latino-Americana de Enfermagem*, 23(1), 28–35. <https://doi.org/10.1590/0104-1169.0144.2521>
- Rutherford, C., Brown, J. M., Smith, I., McGinnis, E., Wilson, L., Gilberts, R., Brown, S., Coleman, S., Collier, H., & Nixon, J. (2018). A patient-reported pressure ulcer health-related quality of life instrument for use in prevention trials (PU-QOL-P): Psychometric evaluation. *Health and Quality of Life Outcomes*, 16(1), 1–11. <https://doi.org/10.1186/s12955-018-1049-x>
- Saghaleini, S. H., Dehghan, K., Shadvar, K., Sanaie, S., Mahmoodpoor, A., & Ostadi, Z. (2018). Pressure ulcer and nutrition. *Indian Journal Critical Care Medicine*, 22(4), 283–298. <https://doi.org/10.4103/ijccm>
- Saragih, N. P. (2018). Effect of olive oil administration in prevention of decubitus in stroke patients in ICU room at Murni Teguh Memorial Hospital in 2019. *Scientific Journal of Maksitek*, 5(3), 150–154.
- Seongsook, J., Ihnsook, J., & Younghee, L. (2004). Validity of pressure ulcer risk assessment scales; Cubbin and Jackson, Braden, and Douglas scale. *International Journal of Nursing Studies*, 41(2), 199–204. [https://doi.org/10.1016/S0020-7489\(03\)00135-4](https://doi.org/10.1016/S0020-7489(03)00135-4)
- Setyawati, R., Suyanto, S., & Noor, M. A. (2015). Effect of mobilization and use of VCO (virgin coconut oil) against deubitus ulcers in post-stroke motor function disorders. *Nurscope: Jurnal Penelitian dan Pemikiran Ilmiah Keperawatan*, 1(1), 1–7. <https://doi.org/10.30659/nurscope.1.2.1-6>
- Shi, C., Dumville, J. C., & Cullum, N. (2018). Skin status for predicting pressure ulcer development: A systematic review and meta-analyses. *International Journal of Nursing Studies*, 87(June), 14–25. <https://doi.org/10.1016/j.ijnurstu.2018.07.003>
- Siracusa, G. K., & Schrier, L. (2011). Use of an intervention bundle to eliminate pressure ulcers in critical care. *Journal of Nursing Care Quality*, 26(3), 216–225. <https://doi.org/10.1097/NCQ.0b013e31820e11be>
- Slawomirski, L., Auraaen, A., & Klazinga, N. S. (2020). *The economics of patient safety from analysis to action* (p. 55). OECD Better Policies For Better Lives. <https://www.oecd.org/health/health-systems/Economics-of-Patient-Safety-October-2020.pdf>
- Sood, A., Granick, M., & Tomaselli, N. (2014). Wound dressings and comparative effectiveness data. *Advances Wound Care*, 3(8), 511–529. <https://doi.org/10.1089/wound.2012.0401>
- Souza, M. F. C., Zanei, S. S. V., & Whitaker, I. Y. (2018). Risk of pressure injury in the ICU: Transcultural adaptation and reliability of EVARUCI. *Acta Paulista de Enfermería*, 31(2), 191–206. <http://doi.wiley.com/10.1111/nicc.12173>

- Suriadi, S., Sanada, H., Sugama, J., Kitagawa, A., Thigpen, B., Kinoshita, S., & Murayama, S. (2007). Risk factors in the development of pressure ulcers in an intensive care unit in Pontianak, Indonesia. *International Wound Journal*, 4(3), 208–215. <https://doi.org/10.1111/j.1742-481X.2007.00315.x>
- Swafford, K., Culpepper, R., & Dunn, C. (2016). Use of a comprehensive program to reduce the incidence of hospital-acquired pressure ulcers in an intensive care unit. *American Journal Critical Care*, 25(2), 152–155.
- Tam, S. F., Mobargha, A., Tobias, J., Schad, C. A., Okochi, S., Middlesworth, W., & Duron, V. (2019). Pressure ulcers in paediatric patients on extracorporeal membrane oxygenation. *International Wound Journal*, 16(2), 420–423. <https://doi.org/10.1111/iwj.13049>
- Tayyib, N., & Coyer, F. (2016). Effectiveness of pressure ulcer prevention strategies for adult patients in intensive care units: A systematic review protocol. *Worldviews on Evidence-Based Nursing*, 13(6), 432–444. <https://doi.org/10.1111/wvn.12177>
- Tayyib, N., Coyer, F., & Lewis, P. A. (2015). A two-arm cluster randomized control trial to determine the effectiveness of a pressure ulcer prevention bundle for critically ill patients. *Journal of Nursing Scholarship*, 47(3), 237–247. <https://doi.org/10.1111/jnu.12136>
- Tayyib, N., Mousa, Y. A., Danic, S., Sahi, S. L., Lasafin, J., Generale, L. F., Malubay, A., Vilorio, P., Palmere, M. G., Parbo, A. R., Aguilar, K. E., Licuanan, P. M., & Reyes, M. (2021). The effectiveness of the SKINCARE bundle in preventing medical-device related pressure injuries in critical care units: A clinical trial. *Advances in Skin & Wound Care*, 34(2), 75–80. <https://doi.org/10.1097/01.ASW.0000725184.13678.80>
- The World Bank. (2021). *Countries and economies*. <https://data.worldbank.org/country>
- Tweed, C., & Tweed, M. (2008). Intensive care nurses' knowledge of pressure ulcers: Development of an assessment tool and effect of an educational program. *American Journal Critical Care*, 17(4), 336–346. <https://doi.org/10.4037/ajcc2008.17.4.338>
- Uzun, Ö., Aylaz, R., & Karada, E. (2015). Reducing pressure ulcers in intensive care units at a Turkish medical center. *Dictionary of Statistics & Methodology*, 36, 404–411. <https://doi.org/10.4135/9781412983907.n1537>
- Vasconcelos, J. D. M. B., & Caliri, M. H. L. (2017). Nursing actions before and after a protocol for preventing pressure injury in intensive care. *Escola Anna Nery - Revista de Enfermagem*, 21(1), 1–9. <https://doi.org/10.5935/1414-8145.20170001>
- Vollman, K. M. (2013). Understanding critically ill patients hemodynamic response to mobilization: Using the evidence to make it safe and feasible. *Critical Care Nursing Quarterly*, 36(1), 17–27. <https://doi.org/10.1097/CNQ.0b013e3182750767>
- Wayunah. (2018). Effectiveness of sleep position change time to the occurrence of decubitus in stroke patients at Hospital X Indramayu Regency. *Jurnal Kesehatan Indra Husada*, 6(2), 51–59. <https://doi.org/10.36973/jkih.v6i2.147>
- Wei, M., Wu, L., Chen, Y., Fu, Q., Chen, W., & Yang, D. (2020). Predictive validity of the braden scale for pressure ulcer risk in critical care: A meta-analysis. *Nursing in Critical Care*, 25(3), 165–170. <https://doi.org/10.1111/nicc.12500>
- Weller, C. D., Team, V., & Sussman, G. (2020). First-line interactive wound dressing update: a comprehensive review of the evidence. *Frontiers in Pharmacology*, 11, 1–13. <https://doi.org/10.3389/fphar.2020.00155>
- Whitty, J. A., McInnes, E., Bucknall, T., Webster, J., Gillespie, B. M., Banks, M., Thalib, L., Wallis, M., Cumsille, J., Roberts, S., & Chaboyer, W. (2017). The cost-effectiveness of a patient centred pressure ulcer prevention care bundle: Findings from the INTACT cluster randomised trial. *International Journal of Nursing Studies*, 75, 35–42. <https://doi.org/10.1016/j.ijnurstu.2017.06.014>
- Wood, J., Brown, B., Bartley, A., Cavaco, A. M. B. C., Roberts, A. P., Santon, K., & Cook, S. (2019). Reducing pressure ulcers across multiple care settings using a collaborative approach. *British Medical Journal Open Quality*, 8(3), 1–9. <https://doi.org/10.1136/bmjopen-2018-000409>

- Zakaria, A. Y., Taema, K. M., Ismael, M. S., & Elhabashy, S. (2018). Impact of a suggested nursing protocol on the occurrence of medical device-related pressure ulcers in critically ill patients. *Central European Journal of Nursing and Midwifery, 9(4), 924–931*.  
<https://doi.org/10.15452/CEJNM.2018.09.0025>
- Zhang, X. (2021). Implementing a pressure injury care bundle in Chinese Intensive Care Units. *Risk Management and Healthcare Policy, 14, 2435–2442*.
- Zuo, X. L., & Meng, F. J. (2015). A care bundle for pressure ulcer treatment in intensive care units. *International Journal of Nursing Sciences, 2(4), 340–347*.  
<https://doi.org/10.1016/j.ijnss.2015.10.008>



Copyright © 2021 NMJN. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution-Share Alike 4.0 (CC BY-SA) International License (<https://creativecommons.org/licenses/by-sa/4.0>).

## Appendix 1.

Table 1. Data extraction

No	Author, Year	City/Country	Aim	Design	Sample & Setting	Intervention	Main/Results	Outcomes
1	Chaboyer et al., (2016)	Australian	To examine the effectiveness of InSPIRE protocol in reducing PI in critical care.	Pragmatic cluster randomized trial	1600 (200/hospital) 8 ICU hospital at Australia	Reposition (3), pressure injury assessment (1), nutrition (4), & education (6)	Incident pressure injury in the control group was 12% and in the intervention was 7.7%. The latest hazard pressure injury incidence ratio was 0.58 (95% CI; 0.25,1.33; p = 0.198). No adverse events were reported.	Incident & Intervention
2	Tayyib et al., (2015)	Saudi Arabia	To evaluate the effect of a prevention bundle on the reduction of PI in critical care.	Two-Arm Cluster Randomized Control Trial	140 ICU in Arab Saudi	Pressure injury assessment (1), skin care (2), reposition (3), support surface (5), education (6) & medical devices care (7)	The incidence of pressure injuries in the intervention group was 7.14% and the control group was 32.86% from 784 days of observations. Poisson regression reveal the incidence of pressure injuries in the intervention group was 70% lower. The intervention group experienced a significant decrease in stage 1 (p=0.002) and stage 2 (p=0.026).	Incident
3	Anderson et al., (2015)	Minneapolis, Minnesota	To investigate the effectiveness of the universal Pi prevention bundle along with the semi-weekly nurse round.	Pre-post quasi-experimental	327 (pre : 181 and post : 146) 3 ICU in Minnesota	Pressure injury assessment (1) and skin care (2) & support surface (5)	The incidence of pressure injuries decreased from 15.5% to 2.1%. Data analysis revealed a significant increase in adherence related to heel elevation (t = -3,905, df-325, p <0.001) and repositioning (t = -2.441, df-325, p<0.015). Multivariate logistic regression decreased significantly (p <0.001). Increased intervention of the Nagelkerke R-Square value of 0.099 (p <0.001) more than 0.297 (p <0.001), the final model value of 0.396 (p <0.001).	Incident & intervention
4	Amr et al., (2017)	Saudi Arabia	To evaluate the effectiveness of pressure ulcer prevention measures ("PRESSURE bundle") compared with standard care in reducing the incidence and prevalence of sacral pressure ulcers in critically ill patients in an ICU.	Pre-Post	690 (360 at intervention group and intervention group & 330 standard care group)	pressure injury assessment (1), reposition (3), skin care (2) & nutrition (4)	The incidence of pressure injuries in the control and intervention groups decreased by around 4.6% to 0.3%. There was a significant decrease of approximately (p<0.0001) in the incidence of pressure injuries in the sacral at 2 months of treatment (n=1, 0.3%) compared to the control group around 4.6% (n 16, 4.6%). There was a significant reduction in the incidence (p<0.001). The incidence of pressure injuries in the sacral area of the intervention group was 4.75%.	Incident, intervention & cost

Table 1. Continued

No	Author, Year	City/Country	Aim	Design	Sample & Setting	Intervention	Main/Result	Outcome
5	Avşar & Karadağ, (2018)	Ankara, Turkey	To determine the cost-effective and efficacy of evidence based nursing intervention on increased tissue tolerance by maintaining tissue integrity.	Quasi-experimental	154 (77 control group & 77 intervention group)	Pressure injury assessment (1), skin care (2) & reposition (3)	The incidence of pressure injuries in the control group was 54.5% and the intervention group was 18.3% ( $p < 0.05$ ). The incidence of pressures injuries in the intervention group with skin integrity was 13%, the incidence of MDRPU pressure injuries was 3.9%. While in the control group, the incidence of pressure injuries in skin integrity was 33.8% and MDRPU was 31.2% ( $p = 0.002$ ), he reposition time of the intervention group ( $x = 86.66 \pm 29.55$ min) is higher than the control group ( $x = 71.81 \pm 40.32$ min); the treatment time for the intervention group was longer ( $x = 31.57 \pm 15.44$ min, $p = 0.000$ ).	Incident intervention & cost
6	Mallah et al., (2015)	Lebanon	To determine the efficacy of multidisciplinary intervention and to assess which component of the intervention was most predictive the prevalence of HAPU in a tertiary setting in Lebanon	Controlled before and after prospective	468 respondents during 2 months	Reposition (3), nutrition (4), support surface (5), skin care (2), & pressure injury assessment (1)	The prevalence of pressure injuries decreased significantly from 6.63% to 2.47%. Multiple logistic regression found a prediction equation of two factors that significantly caused HAPU, namely risk assessment (Braden) OR 1.187 (CI = 1.031-1.546, $p = 0.03$ ), and skin care OR = 0.058 (CI = 0.036-0.092, $p = 0.04$ with $R^2 = 12$ ). The incidence of pressure injuries in coccyx sacrum (50%), heel (25%), ischial tuberosity (8%), occiput (8%) and earlobe (8%).	Incident & Intervention
7	Swafford et al., (2016)	United States	To evaluate the effectiveness a year-long PI prevention program	Prospective	2011= 461 2012 = 434 2013= 563	pressure injury assessment (1), skin care (2), reposition (3) & education (6)	The incidence of pressure injuries decreased 69% (from 45 patients around 10% to 17 patients around 3%). The incidence of pressure injures related to oral ETT in the intervention group was around 9/28, whereas in the control group 27/30 $p = 0.031$ , while the incidence of pressure injuries related to NGT in the control group was 35/45 with an incidence of 77.8%, in the intervention group 5/38 with $p = 0.012$ .	Incident & Intervention
8	Rogenski et al., (2015)	San Paulo, Brazil	To assess the impact of PI prevention protocol among critically ill patients	Prospective quasi experimental	78 respondent during 4 moth in ICU Brazil	pressure injury assessment (1), skin care (2), & reposition (3)	The reported incidence of pressure injuries was around 41.02%, decreasing around 23.1%. the incidence of pressure injuries in the 36.8% sacral region, calcaneus 42.1%, buttock 15.8% and trochanter 10.5. Most pressure injury events occurred in stages 2 and 3 (66.4%). Interpretation of the Braden scale logistic regression coefficient in the high risk category 3.24 with $p = 0.002$ , OR 25.50.	Incident & intervention
9	Uzun et al., (2015)	Turkey	To determine the effect of an educational intervention on the incidence of stage II Pus in adult patients in ICU in Turkish medical center	Prospective quasi experimental	186 respondent ICU medical in Turkey	pressure injury assessment (1), reposition (3), skin care (2), & support surface (5)	The incidence of pressure injuries in the control group was 37% and the interventions group was 17% with significant differences ( $\chi^2 = 8.86$ , $t = 0.593$ , $p = 0.554$ ), pressure injuries generally occurred in the sacrum 46%, trochanters 11% and in the heel 7%, interventions that decreased the occurrence of pressure injuries in this article is detection of pressure injuries, and repositioning.	Incident & intervention
10	Gage, (2015)	London, U.K	To prevention and management of pressure ulcers in intensive care units	Prospective quasi experimental	The study was conducted at the ICU for 22 months	pressure injury assessment (1), skin care (2), nutrition (4), support surface (5), & education (6)	The incidence of pressure injuries decreased significantly from 18 cases to 2 cases from 2011 to 2013.	Incident & intervention

Table 1. Continued

No	Author, Year	City/Country	Aim	Design	Sample & Setting	Intervention	Main/Result	Outcome
11	Vasconcelos & Caliri, (2017)	João Pessoa, Paraíba	To evaluate the actions of nursing professionals before and after using a protocol for preventing PI in an ICU	Prospective, comparison before and after	Pre: 38 respondent Post: 44 respondent for 18 months	assessment (1), reposition (3), skin care (2), & education (6)	The incidence of pressure injuries was not explained; the risk assessment of pressure injuries was recorded at around 57.9% in the pre phase and 77.3% in the post phase.	Incident & intervention
12	Coyer et al., (2017)	Australian	To test the effectiveness of a bundle combining best available evidence to reduce incidence of incontinence-associated dermatitis occurrence in critically ill patient	Comparison before and after	207 in the Australian ICU in the group before 66 patients for 733 days, while in the group after 80 for 768 days	Skin assessment and skin care (2) pressure injury assessment (1), & reposition (3)	The incidence of pressure injuries before being given an InSPIRE intervention was around 32%, whereas after being given the intervention, it was around 15% ( $p = 0.016$ ), ( $\chi^2 = 5.847$ , $df = 1$ , $p = 0.016$ ); there was a significant difference of 17%. There was a significant difference in the interventions for giving acrylate polymer based prophylactic in reducing the incidence of pressure injuries by about 94% in episodes of bathing patients in the intervention group.	Intervention
13	Siracusa & Schrier, (2011)	Pennsylvania	To design an evidence-based PI prevention bundle based and determine its effectiveness on reducing PI	Quasi-experimental	1199 respondents	Pressure injury assessment (1), reposition (3), skin assessment and skin care (2), & nutrition (4)	The incidence of pressure injuries in the quarter 1 control group was around 5.7%, quarter 2 was around 0.0%, quarter 3 was around 5.2%, quarter 4 was around 0.0% ( $p = 0.11$ ). The incidence of pressure injuries in the intervention group (PUB): Quarter 1 around 0.0%, quarter 2 around 0.9%, quarter 3 around 0.0% and quarter 4 around 0.0%, reducing the incidence of pressure injuries around 1%.	Incident
14	He et al., (2016)	Hangzhou, China	To determine whether skin barrier factors were associated with the common complication of PrUs in ICU	Single center (pre and post)	102 patients in postoperative ICU (54 men and 48 women)	Pressure injury assessment (1), reposition (3), skin care (2), & support surface (5)	The incidence of pressure injury incidence of 62.5% decreased by about 31.4% ( $p = 0.031$ ); this incident in male sex (33%) was more at risk of developing pressure injuries than women (29.2%) ( $p = 0.031$ ). The incidence of pressure injuries in the scapula was around 0.4% ( $p=0.058$ ), sacral around 0.5% ( $p<0.001$ ), hip 0.7% ( $p<0.001$ ), and heel 0.3% ( $p=0.062$ ). Braden scale has a significant difference between patients who have pressure injuries and patients who do not have pressure injuries ( $p<0.001$ ).	Incident
15	Lupe et al., (2015)	Miami	To identify the prevalence of HAPU at the institution and to implement interventions to reduce the incidence of HAPU	Retrospective with control group	305 respondent in Hill Room	Skin care (2), reposition (3), support surface (5), pressure injury assessment (1) & education (6)	The incidence of pressure injuries in April 2009 was around 11.7%, and decreased around 2.8% in September 2012.	Incident

No	Author, Year	City/Country	Aim	Design	Sample & Setting	Intervention	Main/Result	Outcome
16	Loudet et al., (2017)	Buenos Aires, Argentina	To determine the effectiveness of a quality management program in reducing the incidence and severity of pressure ulcers in critical care patients	Quasi experimental	154 (55 in the pre group and 69 post groups) in the ICU	Skin care (2), reposition (3), & support surface (5)	The incidence of pressure injuries from the pre 75% group decreased to 54% (p=0.016); In the post group using pressure-reducing mattresses increased from 48% to 85%; family participation increased from 9% to 39%.	Incident & intervention
17	Lewis et al., (2015)	Saudi Arabia	To identify PU incidence and risk factors that associated with Pu development in patients in two adults ICU in Saudi Arabia	Prospective cohort study	84 participants for 30 days	Pressure injury assessment (1), skin care (2), support surface (5), & reposition (6)	The cumulative incidence of pressure injuries was 39.3% (33/84). The incidence of pressure injuries in patients with medical devices was 8.39%; the incidence of pressure injuries in the sacrum area was 24.3% and heels 29.2%, and in the ear area was 37.5%.	Incident