INTERNATIONAL JOURNAL OF NURSING SCIENCES 2 (2015) 340–347

HOSTED BY

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: http://www.elsevier.com/journals/international-journal-of-nursing-sciences/2352-0132

Original Article

A care bundle for pressure ulcer treatment in intensive care units

Xiao-Lin Zuo [a], *Fan-Jie Meng* [b,*]

[a] *Graduate School, Tianjin University of Traditional Chinese Medicine, Tianjin 300193, China*
[b] *School of Nursing, Tianjin University of Traditional Chinese Medicine, Tianjin 300193, China*

ARTICLE INFO

Article history:
Received 1 July 2015
Received in revised form
24 August 2015
Accepted 30 October 2015
Available online 7 November 2015

Keywords:
Pressure ulcer
Care bundle
Intensive care unit

ABSTRACT

Pressure ulcers (PUs) are localized injuries of the skin or underlying tissue caused by prolonged pressure, exposure to shear forces or friction. PUs represent a major concern for hospitalized patients and the health professionals responsible for their wellbeing. intensive care init (ICU) patients are at high risk of PU development, and the development of PUs can significantly extend the length of time a patient must remain in the ICU. Patients with PUs experience significantly increased morbidity, mortality and financial burden. A significant amount of evidence has accumulated indicating that PU prevention is an essential component of patient care. However, standardized guidelines and protocols for PU prevention in ICUs have not been universally implemented. This review aims to describe and analyze an optimized PU prevention care bundle based on the best available evidence and existing national guidelines. We distilled the available information into five main topics important for PU prevention: Risk Assessment, Skin Assessment, Support Surfaces, Nutrition and Repositioning. Further larger scale studies are needed to clinically verify the effectiveness of the care bundle.

1. Introduction

Pressure ulcers (PUs), also known as a pressure sores, decubitus ulcers and bed sores, are localized injuries of the skin or underlying tissue that most often occur over bony prominences and which can be caused by any combination of pressure, shear forces or friction [1]. PUs are internationally recognized as an important and mostly avoidable indicator of health care quality [2]. PU severity is described using a Stage I through IV classification system, with Stage I representing the earliest stages of PU formation, and Stage IV representing the severest grade of PUs that are characterized by full thickness tissue loss and exposed bone, tendon or muscle tissue [1]. PUs occur most frequently over bony prominences, and the most common PU vulnerable locations include the sacrum, coccyx, heels and ear. Compression of the soft tissues over the bony prominence causes tissue ischemia of the skin, muscle and fascia in the compressed region between the skin surface and bone. Tissue ischemia at the point of compression is largely the result of the

* *Corresponding author.*
E-mail addresses: 18222116589@163.com (X.-L. Zuo), mfj1127@126.com (F.-J. Meng).
Peer review under responsibility of Chinese Nursing Association.
http://dx.doi.org/10.1016/j.ijnss.2015.10.008

compression of small vessels in the compressed tissue, and this, in turn, blocks the local supply of oxygen and nutrients at the capillary interface as well as the venous return of metabolic wastes. If pressure is prolonged, metabolic wastes accumulate and induce a local vasodilatation response. The induction of the vasodilation response contributes to local edema, further compressing the small vessels in the affected region and increasing edema and ischemia in a positive feedback loop [2]. Ultimately, this cycle results in the local tissue death that culminates in the formation of a PU.

Patients admitted to intensive care units (ICUs) are at a higher risk of developing PUs than patients admitted to general care. A review of ICU related literature from 2000 to 2005 indicated a PU prevalence in the ICU of 4–49% and an incidence of 3.8–40.4% [3]. The 2009 International Pressure Ulcer Prevalence Survey indicated that facility-acquired PU prevalence rates were highest (12.1%) in the medical ICU (MICU) [4]. Studies have reported an association between PUs and increased morbidity and mortality [5]. PUs can also lead to serious infectious complications, like bacteremia and sepsis [6,7]. Because of these factors, PUs have been reported to extend the duration of a hospital stay by a median of 4.31 days [5]. Due to the adverse effects associated with PUs, PU prevention in the ICU is critically important.

PU prevention and treatment can consume limited resources in large quantities, including nursing care and money. In the United States, the economic cost of PUs ranges from 9.1 billion to 11.6 billion dollars per year [8]. In the UK, the total cost of PU care in the period from the years 1999–2000 ranged from 1.4 to 2.1 billion pounds per year, a cost representing 4% of the entire National Health Service expenditure [9]. In Australia, the cost of treating a single Stage IV ulcer has been estimated at more than $61,000 Australian dollars [10]. A recent systematic review argued that the cost of PU treatment per patient per day is much higher than prevention [11]. Therefore, PU prevention is a critically important element of patient care, and additional attention paid to PU prevention is likely to meaningfully improve patient care and reduce the economic costs associated with treatment in the ICU.

2. The PU prevention care bundle

2.1. *What is a care bundle?*

A "care bundle" is also sometimes referred as a bundle of care, a patient care bundle, a prevention bundle, or a nursing cluster bundle. These terms interchangeably refer to the practice of creating a series of evidence-based treatment and nursing measures to deal with incidental risks or refractory clinical [12]. Thus, a care bundle is a collection of quality of care management ideas that can be implemented in the ICU with the goal of promoting cooperation among different healthcare disciplines and promoting the translation of clinical guidelines to clinical practice.

A care bundle usually includes three to six elements, each of which is supported by evidence from randomized controlled trials (RCTs) or systematic reviews (SRs). All the interventions in the care bundle must be performed in patients continuously, and the bundle is being incorrectly applied if the health care practitioner is selecting only one or two measures from the bundle to perform. Care bundles are thought of as systems that are greater than the sum of their parts; only when the interventions are performed simultaneously can the care bundle achieve its maximum effect. Implementation of individual elements of the care bundle violates the spirit of the cluster intervention strategy and will not produce the desired results. Different cluster bundles have been specifically designed for the management of different diseases, and some common cluster bundle elements can be incorporated or eliminated to meet the specific challenges posed by individual diseases. In other words, there is no single compulsory therapeutic regime.

The existing PU care bundle was based on the best available evidence and guidelines: the International guidelines [1,13,14] and the guidelines of the Registered Nurses Association of Ontario (RNAO) [15]. These universal guidelines describe PUs, and include evidence-based recommendations incorporated from the results of RCTs and SRs. The current review further develops and specializes the recommendations of the PU prevention care bundle for adult patients hospitalized in ICUs. This review identifies five key elements of PU prevention and care: Risk Assessment, Skin Assessment, Support Surfaces, Nutrition and Repositioning.

2.2. *Quality of evidence and definitions*

Evidence quality was assessed according to the Grading of Recommendations Assessment, Development and Evaluation (GRADE) Working Group criteria. The GRADE criteria are increasingly being adopted by organizations worldwide, and this system for rating the quality of evidence and the strength of recommendations is explicit, comprehensive, transparent and pragmatic. The GRADE system classifies the quality of evidence in one of four levels [16]: 1) Very high quality, further research is very unlikely to change the consensus of confidence in the estimated effect; 2) High quality, further research is likely to have an important impact on the consensus of confidence in the estimated effect and may change the estimate; 3) Low quality, further research is very likely to have an important impact on the consensus of confidence in the estimated effect and is likely to change the estimate; 4) Very low quality, any estimated effect is very uncertain.

Evidence based on RCTs and SRs is frequently regarded as very high quality evidence; however, confidence in the evidence may decrease for several reasons. These reasons include: 1) Study limitations, 2) Inconsistent results, 3) Indirectness of evidence, 4) A lack of precision and 5) Reporting bias. Conversely, confidence in the evidence may be increased for several reasons, including: 1) A large effect, 2) Plausible confounding factors that could have opposed the effect and 3) Dose response grading [17].

3. Implementation process

3.1. *Preparation before intervention*

3.1.1. *The formation of a PUs quality control team*

For effective implementation of the preventative care bundle, a team should be assembled and practical measures or guides

should be developed within the department. The team should include the department's head nurse (who should also be the team leader), the head of the department, a PU therapist, a doctor, a clinical nurse specialist, and the department of infection control and management. The team leader should structure and organize comprehensive programs for the care bundle to educate all the ICU nurses and physicians. Furthermore, once education has been completed, testing should be performed to ensure every member of staff reached a standard level. Additionally, the teams clinical nurse specialist should have good communication and teaching skills, a high level of independence, and the ability and qualifications to eventually progress to the level of senior nurse.

3.1.2. *The development of quality management objectives and rules*

The assembled team should hold regular meetings to discuss and formulate objectives regarding infection and risk management and skin care according to the relevant policies of the ICU. Additionally, the team should draft management standards and reporting requirements. Hospital protocols for the prevention of PU development should be instituted. These policies should include standards for Risk Assessment, Skin Assessment, Support Surfaces, Nutrition and Repositioning.

3.1.3. *Assigning responsibility*

Prior to any intervention, the head nurse should monitor the implementation of the care bundle to make certain that the care bundle is put into effect in accordance with the established standards and to make any necessary corrections to procedure. The goal is to prevent problems and discover hidden dangers before any issues with care bundle implementation affect patients.

Clinical nurse specialists are responsible for recording patient's fundamental information and biochemical results. Additionally, the clinical nurse is responsible for collecting daily ICU records, including the patient numbers of newly admitted ICU patients, the total number of patients and the PU and skin status of all ICU patients.

Critical care nurses must identify the appropriate interventions to prevent PU development. They must also continuously educate themselves to ensure that they are knowledgeable concerning the manufacturer's recommendations for all devices used in the care of the patient. When suspecting that a patient has or is at risk of PUs, the nurse should promptly report this information to the responsible physicians, examine the patient and take appropriate measurements.

3.2. *Applying the care bundle*

The team leader must track the implementation of the care bundle each day to make certain that each of these measures are continuously monitored: Risk Assessment, Skin Assessment, Support Surfaces, Nutrition and Repositioning. The consistent implementation of these five elements can help nurses easily master the essentials of the care package. Additionally, use of the care package can ensure that nursing interventions for high-risk patients actively avoid potential adverse events and complications. Each patient has unique characteristics and health conditions, and many intrinsic and extrinsic factors have been associated with PU development. Therefore, when considering all PU risks, ICU nurses must account for each patient's individuality and special needs.

3.2.1. *Risk assessment*

3.2.1.1. Risk factors. Prompt and accurate identification of risk factors associated with PU development is the first step in effective prevention. There is no single factor that can account for PU risk in the ICU; rather there is a complex interplay of factors that can increase the probability of PU development. PUs develop because of extrinsic and intrinsic factors. The main extrinsic factors are decreased tissue perfusion due to pressure on the skin, shear stress or friction and maceration of the skin, which may remove epidermal layers and render the skin more vulnerable to further injury. Intrinsic factors patient specific factors that may exacerbate effects of extrinsic factors [18]. When evaluating intrinsic risk factors within the conceptual framework of PU etiology, three major intrinsic risk factors should always be considered: mobility (including mechanical ventilation and consciousness), tissue perfusion and patient age [19,20]. Even though they have only been examined by a small number of PU studies, the following factors may also be important: nutrition, severity of patient morbidity (including infection), hematological measures, skin moisture, body temperature and immunity. There is minimal evidence that race or gender are important risk factors for PU. Each of the major intrinsic risk factors is discussed in detail below.

Immobility is a significant PU risk factor. This is logical: people who are unable to reposition themselves are more likely to be exposed to prolonged external mechanical forces [21]. The risk is especially high for patients subjected to prolonged mechanical ventilation or the use of sedatives, and this is because these patients are likely to experience a lowered level of consciousness and decreased sensation [20].

Tissue perfusion related variables include edema, diabetes, vascular disease, circulation and blood pressure. The importance of these variables suggests that factors that impair circulation will increase the probability of PU development. Some medications that target these variables may act as protective and therapeutic factors; however, some of these medications may also reduce initiative mobility and intensify regional ischemia and hypoxia [22–24]. There is strong evidence that the use of vasoactive drugs, vasopressors and dopamine increases the probability of PU development [25]. One RCT reported that a mean blood pressure lower than 60–70 mmHg was associated with impaired skin condition [26].

Age is a significant variable in the ICU, and advanced age contributes to the risk of PU development. Elderly individuals have less subcutaneous fat, decreased dermal thickness and decreased sensory perception. The combination of these factors make elderly patients prone to rapid tissue injury and less likely than younger patients to respond to mechanical sensations as cues to change position. The elderly are more likely to develop PUs because of insensitivity, weakness and hypoimmunity. They are particularly likely to develop PUs of Stage I and II, which are the most common stages observed in the ICU [27]. The development of Stage I PU in an elderly patient is regarded as a strong warning that the patient is at high risk of

developing advanced stage PUs, and studies suggest that elderly patients with Stage I PUs deteriorate rapidly in the ICU [28].

Nutrition has been identified as a potential risk factor for PU risk. First, patients who are malnourished have more bony prominences and are therefore at greater risk for PUs. Additionally, poor nutritional status results in decreased protein, rendering tissue more susceptible to the effects of pressure.

Disease severity is also a risk factor for PU development, and this risk is factored into the Acute Physiology, Age, Chronic Health Evaluation (APACHE) III score [29]. The APACHE III model utilizes the worst values of 12 physiological variables during the first 24 h following ICU admission and an evaluation of the patient's chronic health and admission diagnosis to calculate the APACHE III predicted mortality score. The APACHE III model has been widely validated and is used by many ICUs to classify the severity of illness and predict hospital mortality. Higher APACHE III scores represent a higher risk of death [30,31]. Additionally, diagnoses of sepsis, *Acinetobacter baumannii* (Ab) or *Pseudomonas aeruginosa* (Pa) are considered important intrinsic risk factors in the ICU [32].

Hematological measures include measures of Protein, Albumin, Lymphopenia and Hemoglobin (Hb), and unusual results, including anemia and low serum albumin levels, may have bearing on PU risk [33]. In the cardiothoracic ICU, patients can also be highly unstable hemodynamically, and this deserves additional attention.

Moisture related variables include urinary incontinence, fecal incontinence, dual incontinence and urinary catheters. Moisture contributes to maceration, and this may make the damaged epidermal layers more vulnerable to further pressure related degradation.

3.2.1.2. *Risk assessment scales (RAS)*. Patient assessment using RAS should occur immediately following admission. Although imperfect, this tool provides a practical method of assessing PU risk and suggesting the appropriate interventions to reduce risk. The main assessment tools used in ICUs in the UK, Europe and North America are the Braden and Waterlow scales [34,35].

The Braden scale is a validated instrument for estimating PU risk in the ICU that examines six criteria: sensory perception, moisture exposure, activity levels, patient mobility, nutrition, and friction and shear force exposure [36]. When assessing a patient for the Braden scale, exposure of the skin to friction and shear forces is measured using a three-point scale, while the other five items are measured using a four-point scale. The sum of these measurements is the total score, and this score can range from 6 to 23. A higher Braden score indicates a lower PU risk, and patients are classified according to the Braden scale as follows: very high risk (score <9), high risk (score ranging from 10 to 12), moderate risk (score ranging from 13 to 14), low risk (score ranging from 15 to 18) and no risk (score ranging from 19 to 23) [37]. Depending upon the hospital making the assessment, the sensitivity of the scale (using a cut-off score of 16) ranges from 71% to 100% [38,39].

The Waterlow scale score is assigned based upon an assessment of each of the following 10 risk factors: body weight, continence, skin condition, nutritional status/appetite, age, sex, mobility, recent surgery, tissue perfusion and neurological status. Adult scores on the Waterlow scale range from 2 to 90. Low scores (<10) indicate a low risk of PU. A patient with a score between 10 and 15 is considered at risk, a patient with a score between 15 and 19 is at high risk and a patient with a score greater than 20 is at very high risk. In a recent study of 698 ICU patients, the best balance between sensitivity (64.4%) and specificity (48.8%) was achieved at a cut-off of 30 [40].

3.2.2. *Skin assessment*

Skin inspection and assessment should occur once during each shift in the ICU, or more frequently in patients at an elevated risk of PU development. The Institute for Clinical Systems Improvement suggests that a risk assessment and skin assessment be performed upon admission, and that existing wounds be documented and treatment goals be established at this time [41]. If a patient is considered to be at risk for PU development, or if a patient has an existing PU, the appropriate referrals to nutrition services and wound care specialists should be initiated. ICU staff should also perform a complete skin assessment as part of the risk screening of patients in the ICU. During the regular skin assessment performed during each ICU shift, any changes in skin condition should be recorded, and the frequency of assessment should increase if any alteration in skin condition is noticed [1]. The presence of a Stage I PU increases the odds of advancement to a Stage II PU by two to three fold; therefore, patients with Stage I PUs should be very closely monitored. PUs often occur over bony prominences such as the heels, occiput, sacrum and ischial tuberosities [42,43], and the sacrum and heels are the most frequent locations of PU occurrence [44].

Trunk wounds have historically been labeled as PUs; however, confusion exists between incontinence-associated dermatitis (IAD) and superficial PUs [45]. Therefore, it is essential that staff training incorporate lessons concerning the differentiation of IAD from PUs.

Incontinence is a common and difficult problem to manage in the intensive care setting. In addition to odor, embarrassment and discomfort, incontinence increases the risk of skin contamination, and this fecal exposure increases the patient's PU risk. Factors associated with fecal matter, including moisture, enzymes, bacteria and pH disruption may promote skin maceration and epidermal erosion. The duration of enteral feeding, the severity of disease and low albumin levels are the main risk factors for incontinence among ICU patients. Proper incontinence management is a highly important factor for patient health in the ICU, and a number of recent studies have been conducted in an attempt to reduce the frequency of fecal skin contamination in the ICU. Topical skin barriers may assist in providing a barrier between moisture and skin. Low quality evidence suggests that a pH-balanced cleanser may have benefits when compared with soap and water to reduce the incidence of Stage I or II PUs in patients with urinary or fecal incontinence; however, overly frequent cleansing of the skin because of diarrhea may damage the protective skin barrier. Fecal containment devices are an effective way to prevent skin damage due to moisture and enzyme action on perianal tissues [19]. Reynolds MG recently reported [46] that

the Flexi-Seal Faecal Management System (FMS©) is useful for preventing fecal skin contamination, but more studies are required to ensure that it is safe and effective for patient use.

3.2.3. *Surface support*

Frequent turning and shifting of patient weight can help manage the duration for which any given region of skin is exposed to pressure, and high quality evidence indicates that intelligently designed surfaces can also be used to help minimize the exposure of patient's skin to potentially damaging levels of pressure [47]. The current standard of practice includes the use of pillows and wedges for the support, bridging and suspension of bony prominences off bed surfaces. However, constant low-pressure surfaces, such as foams, air, water and elastomeric mattresses, have been reported to outperform conventional hospital mattresses in preventing ulcer formation in the ICU [48].

A systematical review [19] concluded that there was low quality evidence supporting the use of an alternative foam mattress to produce a relative risk reduction (RRR) of 69% for PUs when compared with a standard hospital mattress. Another study reported the low quality evidence of a statistically non-significant difference in the incidence of grade 2 PUs between persons using an alternating pressure mattress and those using an alternating pressure overlay. Another low quality evidence study reported that the use of an air suspension bed in the ICU for stays of at least three days produced a statistically significant RRR of 76% in the incidence of PUs when compared with a standard ICU bed.

3.2.4. *Nutrition*

Low albumin levels are an indicator of malnutrition (normal levels fall between 36 and 52 g/L), and prealbumin levels (normal levels fall between 16 and 35 mg/dL) may be a reflection of current nutritional status. Albumin and prealbumin levels should be routinely assessed (weekly or biweekly) to reveal trends in the adequacy of nutritional therapy. Decreasing or low serial albumin or prealbumin levels should alert the intensive care nurse to inform the physician or nutritionist of a potential need to alter the current nutritional therapy. Nurses should identify the nutrition status of patients upon admission and advocate for the earliest possible nutrition supplementation when necessary. Ensuring adequate nutrition is particularly difficult in patients receiving vasopressors because the vasoconstrictive action of vasopressors constricts the gastric mucosa, preventing absorption of nutrients. Additionally, enteral nutrition often causes loose stools, and if patients are unable to indicate the need for a bedpan, they must rely on frequent nursing assessment of continence status. A recent study reported that among ICU patients who received an enteral nutritional formula enriched with fish oil containing ω-3 light-chain polyunsaturated fatty acids (PUFAs) and micronutrients, the incidence of new PUs was significantly reduced [49,50]. This evidence is consistent with that reported in the study by Theilla M [51].

3.2.5. *Repositioning*

Repositioning of the patient to off-load areas of high pressure is an important component of PU prevention. A very high quality evidence-based analysis [19] recently recommended turning the patient at least once every 2 h on standard foam mattress and once every 4 h on pressure redistribution mattress; however, this recommendation was not supported as a standard of care and it was suggested that the patient be turned every 2 h, alternating from a lateral to a supine position [2]. It remains unclear which repositioning protocols are the most effective for PU prevention. In two systematic reviews [52,53], researchers reported that there was insufficient evidence to recommend any specific turning regimens for patients.

Continuous bedside pressure mapping (CBPM) has been used to assist PU prevention strategies in ICU patients by identifying the magnitude of pressure experienced by various body pressure points and helping to improve the positioning of the body to minimize pressure. The technology empowers clinicians with real-time feedback on repositioning strategies and helps to off-load the at-risk body surface areas after turning [54,55].

When repositioning, the patient's body should be turned laterally 30° and the head of the bed elevated no higher than 30° to prevent pressure on the coccyx. However, this position may promote ventilator-associated pneumonia (VAP) in intubated patients and patients receiving enteral feeding. To prevent VAP in at risk patients, it is suggested that the head of the bed be elevated higher than 30°. Frequently, intubated patients may be restrained or treated with sedatives to prevent removal of the endotracheal tube. These precautions prevent the patient from changing position; however, caution should be exercised if the patient is also hemodynamically unstable, as he or she may not tolerate lateral position changes [56]. There is a clear need for high quality, adequately powered trials to assess the effects of patient position and optimal frequency of repositioning on PU incidence.

3.3. *Evaluation after intervention*

To ensure compliance with the care bundle, the adherence of doctors and nurses to the protocols described above should be periodically audited. Furthermore, statistical comparisons of PU incidence before and after implementation of the care bundle are essential to assess care bundle efficacy. The most important factor for successful implementation of the care bundle is the participation of whole team, only if physicians and nurses work together and faithfully perform their duties as described by the protocols of the care bundle can PUs be effectively prevented.

3.4. *Quality improvement program*

A quality improvement program is an essential element of the long-term success of a PU care bundle. An effective quality improvement program must emphasize the value of using quality approaches to implement practice improvement and incorporate new evidence into practice. The widespread adoption of a multifaceted approach of providing information together with actual outcome data has resulted in a significant change in culture [57]. The nurses who implement the care bundle have been granted the responsibility and empowered to adapt the care bundle to ensure that the correct aspects of

care are given the appropriate priority to reduce the prevalence of PUs in ICUs.

Many recently published quality improvement articles have indicated that unit-based quality assurance projects are particularly helpful in identifying the prevalence of PUs, assessing the effectiveness of preventive measures and preventing PUs in patients [58,59]. Unit-based quality initiatives that document the number of days that have passed between occurrences of hospital-acquired PUs are one method of communicating this success in PU prevention. A two-nurse handoff report and assessment on admission and shift change, including the conduction of a skin assessment, enforces individual accountability for consistently carrying out interventions designed to prevent the development of PUs. These activities have demonstrated success in identifying pressure areas before they develop into Stage I or greater PUs [41].

3.5. *Other PU management experiences and suggestions*

Gunningberg [60] concluded that most patients with or at risk for PUs did not receive an appropriate preventive care bundle in the ICU. Their conclusion implies that variations in real world practice might be a greater issue than originally suspected, and they suggested the adoption of the standardized nursing-terminology-based electronic nursing record (ENR) system to document patient problems, nursing diagnoses, nursing interventions/activities and nursing outcomes.

Two studies have suggested that every unit should identify a staff member who focuses on the PU preventive care bundle. This staff member is referred to as the "skin champion." The skin champion collaborates with the physician and consults with a wound ostomy and continence (WOC) nurse to improve patient monitoring, management and treatment recommendations [61].

An analysis of 28 studies [62] concluded that higher staffing levels were associated with lower patient mortality in ICUs. However, the nurse-to-patient and physician-to-bed ratios do not make sense without including controls for the throughput of the unit as well as the amount of care that each patient needs. The ICU managers should improve the staffing ratio, reform nursing shift arrangements and utilize existing human resources effectively to improve care bundle quality.

4. Conclusions

The evidence-based care bundle includes five core measures: Risk Assessment, Skin Assessment, Support Surfaces, Nutrition and Repositioning. Each of these elements is essential in clinical practice. For effective execution of the care bundle, a team including nurses and doctors should be assembled and given the appropriate education and training to execute the care bundle in their ICU. For care bundle success, compliance with all the requirements of the care bundle must be strictly observed. A heightened awareness of each patients' PU risk and unit pride contribute to highly effective implementation of these preventive measures. However, even with effective care bundle implementation, not all PUs can be prevented in long-term care settings. Interventions used in ICUs sometimes conflict with good skin care practices. Patient repositioning, for instance, can be difficult in combination with certain ICU treatments. Therefore, there is a clear need for high-quality, adequately powered trials to assess the effects of position and the optimal frequency of repositioning to prevent PU occurrence. Additional larger scale studies should also be conducted to clarify the effectiveness of the preventive care bundle approach to PU prevention.

Conflicts of interest

The authors have no conflicts of interest to declare.

REFERENCES

[1] National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance. Prevention and treatment of pressure ulcers: clinical practice guideline. In: Haesler Emily, editor. Osborne Park, Western Australia: Cambridge Media; 2014.
[2] National Pressure Ulcer Advisory Panel. Pressure ulcers: avoidable or unavoidable? Results of the National Pressure Ulcer Advisory Panel Consensus Conference. Ostomy Wound Manage 2011;57(2):24–37.
[3] Shahin ES, Dassen T, Halfens RJ. Pressure ulcer prevalence and incidence in intensive care patients: a literature review. Nurs Crit Care 2008;13(2):71–9.
[4] VanGilder C, Amlung S, Harrison P, Meyer S. Results of the 2008–2009 International Pressure Ulcer Prevalence Survey and a 3-year, acute care, unit-specific analysis. Ostomy Wound Manage 2009;55(11):39–45.
[5] Graves N, Birrell F, Whitby M. Effect of pressure ulcers on length of hospital stay. Infect Control Hosp Epidemiol 2005;26(3):293–7.
[6] Krupp AE, Monfre J. Pressure ulcers in the ICU patient: an update on prevention and treatment. Curr Infect Dis Rep 2015;17(3):468.
[7] Fu Wei, Lu Lianfang, Wei Lili, Li Guizhi, Wang Shuyun, Wang Huifang. Investigation of prevalence rate and management in hospital pressure ulcer. Nurs J Chin PLA 2015;32(8):16–20 [in Chinese].
[8] Berlowitz D, Lukas CA, Parker V, Silver J, Logan C. Preventing pressure ulcers in hospitals: a toolkit for improving quality of care. Rockville (MD): Agency for Healthcare Research and Quality; 2011.
[9] Bennett G, Dealey C, Posnett J. The cost of pressure ulcers in the UK. Age Ageing 2004;33(3):230–5.
[10] Hodgkinson B, Nay R, Wilson J. A systematic review of topical skin care in aged care facilities. J Clin Nurs 2007;16(1):129–36.
[11] Demarré L, Van Lancker A, Van Hecke A, Verhaeghe S, Grypdonck M, Lemey J, et al. The cost of prevention and treatment of pressure ulcers: a systematic review. Int J Nurs Stud 2015;52(11):1754–74.
[12] Robb E, Jarman B, Suntharalingam G, Higgens C, Tennant R, Elcock K. Using care bundles to reduce in hospital mortality: quantitative survey. BMJ 2010;340(15):861–3.
[13] Michel JM, Willebois S, Ribinik P, Barrois B, Colin D, Passadori Y. As of 2012, what are the key predictive risk factors for pressure ulcers? Developing French guidelines for clinical practice. Ann Phys Rehabil Med 2012;55(7):454–65.

[14] International guidelines. Pressure ulcer prevention: prevalence and incidence in context. A consensus document. London, England: MEP Ltd; 2009.
[15] Registered Nurses' Association of Ontario. Risk assessment and prevention of pressure ulcers [Internet]. Toronto, ON: The Association; 2009.
[16] Atkins D, Best D, Briss PA, Eccles M, Falck-Ytter Y, Flottorp S, et al. Grading quality of evidence and strength of recommendations. BMJ 2004;328(7454):1490.
[17] Gopalakrishna G, Mustafa RA, Davenport C, Scholten RJ, Hyde C, Brozek J. Applying Grading of Recommendations Assessment, Development and Evaluation (GRADE) to diagnostic tests was challenging but doable. J Clin Epidemiol 2014;67(7):760–8.
[18] Eberlein-Gonska M, Petzold T, Helaß G, Albrecht DM, Schmitt J. The incidence and determinants of decubitus ulcers in hospital care: an analysis of routine quality management data at a university hospital. Dtsch Arztebl Int 2013;110(33–34):550–6.
[19] Coleman S, Gorecki C, Nelson EA, Closs SJ, Defloor T, Halfens R, et al. Patient risk factors for pressure ulcer development: systematic review. Int J Nurs Stud 2013;50(7):974–1003.
[20] Manzano F, Navarro MJ, Roldán D, Moral MA, Leyva I, Guerrero C, et al. Pressure ulcer incidence and risk factors in ventilated intensive care patients. J Crit Care 2010;25(3):469–76.
[21] Moore Z, Cowman S. Pressure ulcer prevalence and prevention practices in care of the older person in the Republic of Ireland. J Clin Nurs 2012;21(3–4):362–71.
[22] Salgado DR, Favory R, Goulart M, Brimioulle S, Vincent JL. Toward less sedation in the intensive care unit: a prospective observational study. J Crit Care 2011;26(2):113–21.
[23] Ülker Efteli E, Yapucu Günes Ü. A prospective, descriptive study of risk factors related to pressure ulcer development among patients in intensive care units. Ostomy Wound Manage 2013;59(7):22–7.
[24] Nijs N, Toppets A, Defloor T, Bernaerts K, Milisen K, Van Den Berghe G. Incidence and risk factors for pressure ulcers in the intensive care unit. J Clin Nurs 2009;18(9):1258–66.
[25] Pokorny ME, Koldjeski D, Swanson M. Skin care intervention for patients having cardiac surgery. Am J Crit Care 2003;12(6):535–44.
[26] Curry K, Kutash M, Chambers T, Evans A, Holt M, Purcell S. A prospective, descriptive study of characteristics associated with skin failure in critically ill adults. Ostomy Wound Manage 2012;58(5):36–8. 40–3.
[27] Schuurman JP, Schoohoven L, Keller BP, van Ramshorst B. Do pressure ulcers influence length of hospital stay in surgical cardiothoracic patients? A prospective evaluation. J Clin Nurs 2009;18(17):2456–63.
[28] Tayyib N, Coyer F, Lewis P. Saudi Arabian adult intensive care unit pressure ulcer incidence and risk factors: a prospective cohort study. Int Wound J 2015. http://dx.doi.org/10.1111/iwj.12406.
[29] Knaus WA, Wagner DP, Draper EA, Zimmerman JE, Bergner M, Bastos PG, et al. The APACHE III prognostic system. Risk prediction of hospital mortality for critically ill hospitalized adults. Chest 1991;100(6):1619–36.
[30] Ozyurek P, Yavuz M. Prevention of pressure ulcers in the intensive care unit: a randomized trial of 2 viscoelastic foam support surfaces. Clin Nurse Spec 2015;29(4):210–7.
[31] Bours GJJW, De Laat E, Halfens RJ, Lubbers M. Prevalence, risk factor and prevention of pressure ulcers in Dutch intensive care units. Results of a cross-sectional survey. Intensive Care Med 2001;27(10):1599–605.
[32] Cooper KL. Evidence-based prevention of pressure ulcers in the intensive care unit. Crit Care Nurse 2013;33(6):57–66.
[33] Theaker C, Mannan M, Ives N, Soni N. Risk factors for pressure sores in the critically ill. Anaesthesia 2000;55(3):221–4.
[34] Braden BJ, Bergstrom N. Predictive validity of the Braden scale for pressure sore risk in a nursing home population. Res Nurs Health 1994;17(6):459–70.
[35] Waterlow J. A policy that protects. The waterlow pressure sore prevention/treatment policy. Prof Nurse 1991;6(5). 258,260,262–4.
[36] Serpa LF, Santos VL, Campanili TC, Queiroz M. Predictive validity of the Braden scale for pressure ulcer risk in critical care patients. Rev Lat Am Enfermagem 2011;19(1):50–7.
[37] Ayello EA, Braden B. How and why to do pressure ulcer risk assessment. Adv Skin Wound Care 2002;15(3):125–33.
[38] Chan WS, Pang SM, Kwong EW. Assessing predictive validity of the modified Braden scale for prediction of pressure ulcer risk of orthopaedic patients in an acute care setting. J Clin Nurs 2009;18(11):1565–73.
[39] Baris N, Karabacak BG, Alpar ŞE. The use of the Braden scale in assessing pressure ulcers in Turkey: a systematic review. Adv Skin Wound Care 2015;28(8):349–57.
[40] Yurtsever S, Sayar S, Demirkan F, Taşdelen B. Response to Kottner, Commentary on Sayar S, Turgut S, Doğan H, Ekici A, Yurtsever S, Demirkan F, Doruk N & Taşdelen B (2009) Incidence of pressure ulcers in intensive care unit patients at risk according to theWaterlow Scale and factors influencing the development of pressure ulcers. Journal of Clinical Nursing 18, 765–774. J Clin Nurs 2010;19(23–24):3591–2.
[41] Perry D, Borchert K, Burke S, Chick K, Johnson K, Kraft W, et al. Institute for Clinical Systems Improvement. Pressure ulcer prevention and treatment protocol [Updated January 2012].
[42] Guan Xin, Wang Lei, Shao Xin. The incidence and risk factors of pressure ulcer in the intensive care unit patients. Chin J Nurs 2014;49(7):840–3 [in Chinese].
[43] Liu Fang. Using the care bundle to prevent pressure ulcer in ICU. J Clin Med 2014;1(12):2240–1 [in Chinese].
[44] Huang Yuanling, Xiong Xiaoling, Ma Aiping, Deng Shaojun, Tong Yajuan, Shao Yajuan. Application of intervention bundle in the prevention of pressure ulcers in ICU patients. Mod Clin Nurs 2013;12(4):28 [in Chinese].
[45] Beeckman D, Woodward S, Rajpaul K, Vanderwee K. Clinical challenges of preventing incontinence-associated dermatitis. Br J Nurs 2011;20(13):784–6. 788, 790.
[46] Reynolds MG, van Haren F. A case of pressure ulceration and associated haemorrhage in a patient using a faecal management system. Aust Crit Care 2012;25(3):188–94.
[47] Sprigle S, Sonenblum S. Assessing evidence supporting redistribution of pressure for pressure ulcer prevention: a review. J Rehabil Res Dev 2011;48(3):203–13.
[48] McInnes E, Jammali-Blasi A, Bell-Syer SE, Dumville JC, Cullum N. Support surfaces for pressure ulcer prevention. Cochrane Database Syst Rev 2011;13(4). CD001735.
[49] Singer P, Theilla M, Fisher H, Gibstein L, Grozovski E, Cohen J. Benefit of an enteral diet enriched with eicosapentaenoic acid and gamma-linolenic acid in ventilated patients with acute lung injury. Crit Care Med 2006;34(4):1033–8.
[50] Theilla M, Singer P, Cohen J, Dekeyser F. A diet enriched in eicosapentanoic acid, gamma-linolenic acid and antioxidants in the prevention of new pressure ulcer formation in critically ill patients with acute lung injury: a randomized, prospective, controlled study. Clin Nutr 2007;26(6):752–7.
[51] Theilla M, Schwartz B, Cohen J, Shapiro H, Anbar R, Singer P. Impact of a nutritional formula enriched in fish oil and

micronutrients on pressure ulcers in critical care patients. Am J Crit Care 2012;21(4):e102–9.
[52] Reddy M, Gill SS, Rochon PA. Preventing pressure ulcers:a systematic review. JAMA 2006;296(8):974–84.
[53] Moore ZE, Cowman S. Repositioning for treating pressure ulcers. Cochrane Database Syst Rev 2015;1. CD006898.
[54] Sakai K, Sanada H, Matsui N, Nakagami G, Sugama J, Komiyama C, et al. Continuous monitoring of interface pressure distribution in intensive care patients for pressure ulcer prevention. J Adv Nurs 2009;65(4):809–17.
[55] Cremasco MF, Wenzel F, Zanei SS, Whitaker IY. Pressure ulcers in the intensive care unit: the relationship between nursing workload, illness severity and pressure ulcer risk. J Clin Nurs 2013;22(15–16):2183–91.
[56] Burk RS, Grap MJ. Backrest position in prevention of pressure ulcers and ventilator-associated pneumonia: conflicting recommendations. Heart Lung 2012;41(6):536–45.
[57] Li Jieqiong, Guo Cheng, Wang Xueliang, Zhao Xiaoli, Liu Meili. Cluster nursing strategies in patients with pressure ulcer in ICU. Chin J Pract Nurs 2012;28(15):36–7 [in Chinese].
[58] Ballard N, McCombs A, Deboor S, Strachan J, Johnson M, Smith MJ, et al. How our ICU decreased the rate of hospital acquired pressure ulcers. J Nurs Care Qual 2008;23(1):92–6.
[59] Crumbley DR, Kane MA. Development of an evidence-based pressure ulcer program at the National Naval Medical Center: nurses' role in risk factor assessment, prevention and intervention among young service members returning from OIF/OEF. Nurs Clin North Am 2010;45(2):153–68.
[60] Gunningberg L. Are patients with or at risk of pressure ulcers allocated appropriate prevention measures? Int J Nurs Pract 2005;11(2):58–67.
[61] Anderson M, Finch Guthrie P, Kraft W, Reicks P, Skay C, Beal AL, et al. Universal pressure ulcer prevention bundle with WOC nurse support. J Wound Ostomy Continence Nurs 2015;42(3):217–25.
[62] Kane RL, Shamliyan TA, Mueller C, Duval S, Wilt TJ. The association of registered nurse staffing levels and patient outcomes: systematic review and meta-analysis. Med Care 2007;45(12):1195–204.