

Effectiveness of a Pressure Ulcer Prevention Package (PUPP) for Patients Admitted in Intensive Care Units: An Experimental Study

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Abstract

Many critically ill patients admitted in ICUs sedated on mechanical ventilation are unable to change the position themselves. Therefore, these patients are at high risk of impaired skin integrity that leads to development of pressure ulcers. This study assessed the effectiveness of pressure ulcer prevention package in reducing the incidences of pressure ulcers among patients in ICUs. In this experimental design pre-test post-test control group study, 70 patients 35 each in experimental and control group from different ICUs of Dr RML Hospital, New Delhi were randomly allocated into two groups i.e. experimental and control groups. Experimental group received the intervention of pressure ulcer prevention package and the control group received routine skin care. Demographic and clinical data were collected by using demographic profile tool, standardised skin assessment tool and pressure ulcer staging tool. All the subjects were followed every third day from admission to discharge, death and up to a maximum 20 days. Data were analysed using STATA 11.1 with the level of significance at $p < 0.05$. Descriptive and inferential statistics were used. The sacrum and then heels were the most common areas of pressure ulcers among ICU patients. Pressure ulcer prevention package was significantly effective ($p < 0.001$) to delay the pressure ulcers-related adverse events among patients of experimental group. Pressure ulcers-related adverse events were developed earlier in control group i.e. 14 percent in experimental and 41 percent in control group. Number of pressure ulcers development were significantly ($p < 0.001$) lower in experimental group (08/35) compared to control group (20/35). The experimental group had significantly less Stage I and Stage II pressure ulcers development compared to control group ($p < 0.001$). Pressure ulcers prevention package was found to be significantly effective to reduce incidences, severity and total number of pressure ulcers among patients admitted in ICUs.

Pressure ulcers (PUs) have been identified as a worldwide problem that contribute significantly to increasing healthcare costs, the compromising of an individual's health, morbidity and in some cases mortality (Vollman, 2010). The worldwide prevalence of PUs in the ICU remains high and is documented between 3 percent and 50 percent (Berlowitz, 2014; Elliott, McKinley, Fox, 2008). PUs are internationally recognised as an important and mostly avoidable indicator of health care quality. 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 characterised by full thickness tissue loss and exposed bone, tendon or muscle tissue. PUs occur most frequently over bony prominences and the most common PU vulnerable locations include the sacrum, coccyx, heels and ear.

Review of Literature

Patients admitted to intensive care units (ICUs) are

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at a higher risk of developing PUs than patients admitted to general care. A review of ICU-related literature from 2000 to 2005 indicated PU prevalence in the ICU of 49 percent and an incidence of 40.4 percent (Shahin et al, 2008). The 2009 International Pressure Ulcer Prevalence Survey indicated that facility-acquired PU prevalence rates were highest (12.1%) in the medical ICU (MICU) (Krupp & Monfire, 2015). Various studies have reported an association between PUs and increased morbidity and mortality (Graves et al, 2005). PUs can also lead to serious infectious complications, like bacteremia and sepsis. Because of these factors, PUs have been reported to extend the duration of a hospital stay by a median of 4.31 days (Shahin et al, 2008). Due to the adverse effects associated with PUs, its prevention in the ICU is critically important.

Robb et al (2010) suggest that the care bundle approach is more effective than clinical guidelines. This may be because of the mandatory and audited nature of care bundles, whilst clinical guidelines are regarded as advisory. The term care bundle refers to the implementation of a set of three to six mandatory interventions that are targeted towards

a specific procedure, symptom, or treatment (Horner & Bellamy, 2012). A care bundle approach has been frequently used in clinical practice as it provides improvement in the delivery of evidence-based care and results in patient outcomes.

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.

While a number of studies reveal a positive link between the care bundle and patient outcomes in the ICU (Baldelli & Paciella, 2008), PU prevention guidelines/bundles for intensive care patients are not well defined. The intensive care context poses special challenges to preventing PU development due to the high acuity of patients and the highly invasive nature of interventions and therapies that critically ill patients receive. The existing PU care bundle was based on the best available evidence and guidelines i.e. the International guidelines and the guidelines of the Registered Nurses Association of Ontario (RNAO) (Coyer et al, 2014). The current review further develops and specialises the recommendations of the PU prevention care bundle for adult patients hospitalised in ICUs. This review identifies five key elements of PU prevention and care use of devices, securement of lines, education and training, positioning, nutritional therapy, skin care, skin assessment, risk assessment. These strategies can be grouped together in a bundle to reduce the incidence of PU development for critically ill patients in the ICU.

Need for the study: Given the high PU incidence and the evidence that suggests the benefits of a PU prevention bundle, use of a PU prevention bundle is likely to improve patient outcomes and reduce the morbidity and mortality rates of ICU patients.

Objectives

This study evaluated the effectiveness of a PU prevention bundle for patients admitted in ICUs to test the effectiveness of a PU prevention bundle in reducing incidence of PUs in critically ill patients.

Methodology

Experimental pre-test post-test control group design was used. All critically ill patients with different disease conditions admitted in intensive care units of Dr RML Hospital, New Delhi were enrolled. Ethical clearance for the study was obtained from Institute

Ethics Committee.

Sample and sampling technique: Total 70 subjects who met the eligibility criteria were randomly allocated to two groups: control group (35) and experiment group (35). Subjects in experimental group received Pressure Ulcer Prevention Package (PUPP) and subjects in control group received standard care.

Data was collected during April 2019 to November 2019. ICUs are specialist areas that deliver complex multi-system support for adults needing comprehensive intensive care and monitoring by specialist care staff. Patients admitted in ICUs have similar high acuity and medical diagnoses, including cardiovascular illness, respiratory diseases, cancer, renal dysfunction, burns, sepsis, and multi-trauma injuries such as head injury. Each ICU was staffed with approximately 30 nursing officers (NOs). All NOs who provide care for ICU patients have qualifications of bachelor of nursing degree with many also having a diploma in nursing. ICU staffing ratio is one NO to two or three mechanically ventilated patients and three senior nursing officers (SNOs) charge nurse per shift for each of the three 8 hours shifts per day.

All the subjects who were admitted during the study collection period were included in the study if they were 18 years of age or older and were expected to stay in the ICU for more than 24 hours. Those excluded were patients admitted to the ICU with an existing PU, those with a medical condition that contraindicated the bundle intervention and those diagnosed with any stage PU in the first 24 hours of admission to the ICU.

Demographic and clinical data: Demographic data like age, sex, nationality and clinical data like diagnosis on admission, co-morbidities, length of time in operating theatre prior to ICU admission, mechanical ventilation (Yes or No), ICU length of stay in days and ICU outcome were collected from participants admitted in ICUs.

Skin assessment tool: A tool to record a standardized approach to skin examination and assessment was designed by the researchers using a standard physical assessment technique and common areas for PU development.

PU staging: PUs were defined and staged according to EPUAP & NPUAP. PUs was identified as skin or mucosal ulcers. PU site was identified on the data collection form by drawing a circle over the relevant area in the body figure.

Intervention: Pressure ulcer prevention package: The PU prevention package was designed to reduce PU incidence or severity, to be suitable for NOs to deliver and to fit within the care delivery structure of the ICUs. Table 1 shows the comparison of PUPP which was provided to subjects of experimental group and standard care to control group.

Table 1: Comparison of PUPP versus standard care

Intervention	PUPP	Standard care
Risk assessment	Completion and documentation of Braden risk assessment scale within 24 hr of ICU admission and daily thereafter.	No PU risk assessment scale was used.
Skin assessment	Physical assessment of the patient's skin was undertaken and documented within 4 hr of admission and every 8 hr thereafter.	Physical assessment was done as per routine ICU policy.
Skin care	Bath once per day was given to the patients by using cleansing agent. Skin was treated with a topical moisturiser.	Bath once per day as per ICU care.
Nutritional therapy	Nutritional assessment and support was maintained by the nursing officers with the assistance of dietician.	Nutritional support was maintained as standard care.
Positioning	Patients were repositioned strictly 2 hourly and when required (SOS). Patients heels was elevated and supported. Drawsheet was used to transfer and lift patients. Where clinically possible patients was mobilised daily to sit out of bed on chair. Position was documented, including the time of repositioning and position adopted.	As per routine care. No documentation was done.
Use of devices	Pneumatic air mattress was used for all the patients	Air mattress might not be used for all the patients.
Securement of lines	All the invasive and non-invasive lines was secured properly	Securement was done adequately.
Education and training	Education and training was provided to Nursing officers who were caring patients	No additional training was given to Nursing Officers.

Process of Care: Nursing officers process of care performance based on the PU prevention package and standard skin care (Table 1) were measured using a checklist for compliance (Yes or No).

Endpoints: The primary endpoint of the study was ICU patient stay up to a maximum of 20 days. A 20-day endpoint was chosen based on the findings of a previous study showing mean time to develop a PU was 10.09 days in this patient population (median 9 days, SD 4.6195 days, range 5– 23 days; Tayyib et al, 2015). Secondary endpoints were death or discharge from the ICU prior to 20 days.

Procedure for Data Collection

Data was collected from April 2019 to November 2019. All critically ill patients admitted in ICUs of Dr RML Hospital and meeting the inclusion criteria were enrolled in study. Random assignment to either of the two groups: experimental and control groups, was done based on randomisation table. Demographic data was collected. The researcher attended each ICU every second day to screen, recruit, and collect data using the data collection tools. All patients were followed until discharge, death, or up to a maximum of 20 ICU days, whichever occurred first. For intervention group, the ICU nursing officers were informed about the study's PU prevention package and one-to-one bedside education provided by the researcher. The training and education programme consisted

of Powerpoint presentation with handout, consultation and clarification with the researcher, which continued throughout the study. The compliance to the intervention by nursing officers was supervised by senior nursing officers and feedback was provided. The control group received usual standard skin care and PU prevention practices were followed as per policies of the ICU.

Results

Demographic and Clinical Characteristics of Patients:

As shown in Table 2, the mean age of the subjects was 47 in experimental group and 52 in control group. Majority of the subjects were male in both the groups. Prior to admission of the patients in ICU, mean length of the time in operation theaters was 39 ± 23.12 in experimental group and 22 ± 13.65 in control group. Mean length of the time in emergency department was almost similar for both the groups 44 ± 29.37

and 47.9 ± 43.25 respectively. Most of the subjects in both the groups, had comorbid conditions like hypertension and diabetes. Majority of the subjects (57% and 60%) of both the groups were admitted in ICUs with medical-related illnesses. Mean length of stay in ICU was almost similar in the groups, 11.16 ± 8.9 days and 10.6 ± 7.58 days respectively. Approximately 58 percent of the subjects were discharged, 14 percent and 11 percent stayed for 20 days and 25 percent and 31 percent subjects of both the groups expired before endpoint. Similar 70 percent of the subjects of both the groups were on mechanical ventilation. Mean frequency of repositioning was 2 ± 2.13 hours in experimental group and 4.16 ± 1.33 hours in control group. There were no significant differences between either group in all demographic characteristics and all clinical characteristics, with the exception of time in the operation room (Table 2).

PU Prevention Bundle versus Standard Care: As shown in Table 3, 22 percent (8/35) subjects had PUs incidences after implementation of PUPP in experimental group and 65 percent (23/35) subjects had PU incidences with standard care in control group. Maximum one ulcer was found in 4 subjects of experimental group and in control group, one ulcer was found in 13 subjects and two ulcers were assessed in 6 subjects; 6 subjects had PU stage 1, 3 subjects had PU stage 2 and 1 subject had deep injury in experimental group. In control group, 15

Table 2: Demographic and clinical characteristics of patients

Variables	Experimental group (n = 35)	Control group (n = 35)	p-value
Age (mean $\pm$ SD)	47 $\pm$ 21	52 $\pm$ 19	0.169
Sex (number, %)			
Male	25 (71.4%)	24 (68.6%)	0.712
Female	10 (28.6%)	11 (31.42%)	
Length of the time in OT in minutes (mean $\pm$ SD)	39 $\pm$ 23.12	22 $\pm$ 13.65	0.018
Length of the time in ED in minutes (mean $\pm$ SD)	44 $\pm$ 29.37	47.9 $\pm$ 43.25	0.95
Comorbidities (number, %)			
Hypertension	14 (40%)	19 (54.2)	0.314
IDDM	11 (31.4)	15 (42.85)	
PVD	2.5 (7.1)	7.5 (21.42)	
Other	12 (17.1)	18 (51.42)	
Nil	12 (16)	9 (13)	
Diagnosis (number, %)			
Trauma	9 (25.71)	5 (14.28)	0.256
Medical-related illness	20 (57.14)	21 (60)	
Post-surgery	3 (8.6)	5 (14.28)	
Sepsis	3 (8.6)	4 (11.42)	
ICU length of stay in days (mean $\pm$ SD)	11.16 $\pm$ 8.9	10.6 $\pm$ 7.58	0.912
Outcome (number, %)			
Discharged	21(58.57)	20 (57.14)	0.407
Upto 20 days	5 (14.28)	4 (11.42)	
Death	9 (25.71)	11 (31.42)	
Mechanical ventilation (yes)	70%	72%	0.788
Frequency of repositioning in hours (mean $\pm$ SD)	2 $\pm$ 2.13	3.16 $\pm$ 1.33	0.11

subjects had PU stage 1, 12 had PU stage 2, 4 subjects had PU stage 3 and 4 and 4 subjects had deep injury. Majority of the subjects in both the groups, 5 in experimental group and 13 in control group had PUs at sacral area.

Results show that PUPP was significantly ($p < 0.004$) effective to reduce PUs incidences among subjects admitted in ICUs. Study results also found that number of PUs per patient were significantly ($p < 0.005$) low after implementation of PUPP. Skin stages of PUs was found significantly low ($p < 0.004$) with PUPP than standard PU care among ICU subjects.

Discussion

The results of this study support the effectiveness of the PU prevention package in adult ICU patients showing significant reduction in the incidence of hospital-acquired PUs (HAPUs) and total number of PUs per patient in the intervention group. The PU prevention package, based on the most recent available evidence of PU prevention strategies, combined several measures that targeted risk factors. Therefore, we could not estimate the effect of individual prevention measures (Horner & Bellamy, 2012). The package approach may be considered

successful because a marked reduction in PU incidence was recorded.

The incidence rate of PUs now is similar to that reported in other international studies (Gunningberg et al, 2012; Coyer et al, 2014). Our analyses revealed that the implementation of the PU prevention package has significantly reduced the severity of PUs. Further, the prevention package has been shown to be effective in other international studies, which reported that regular assessment of the patient's skin and mucous membranes around and underneath devices with regular repositioning of devices is essential to reduce PUs incidence. These findings confirmed that the PU prevention package results in improvement in patient outcomes in tertiary care setting.

The study by Weststrate & Heule (2001) found that there are no significant differences between the types of pressure reducing mattresses like low air loss and alternating pressure air mattresses in ICU patients. Additionally, there is limited evidence for low air loss mattresses in reducing the incidence of pressure ulcers in ICU patients. Moreover, one study suggested that low air loss beds are more effective than standard foam beds in preventing pressure ulcers for persons in ICU (Inman et al, 1993). The package approach is more efficient than a single intervention in changing practice (Horner & Bellamy, 2012). However, lack of compliance by Nursing officers can hinder the success of package.

Table 3: Clinical characteristics of patients with pressure ulcers (N = 70)

Variables	Experimental group (n=35)	Control group (n=35)	p value
Total number of PU incidences n (%)	8 (22.85)	23 (65.71)	0.004
Numbers of PUs per patient			
One (n)	4	13	0.005
Two (n)	3	6	
Three (n)	1	3	
Four (n)	0	1	
Stages of skin PUs (n)			
Deep Injury	1	4	0.002
PU Stage I	6	15	
PU Stage II	3	12	
PU stage III & IV	0	4	
Skin Ulcer Location (n)			
Elbow	0	1	0.004
Shoulder	1	2	
Ear	0	1	
Sacrum	5	13	
Buttock	2	4	
Heel	0	1	
Knee	0	1	

Soban et al (2011) suggested that successful reporting of the intervention (PU prevention package) should include the intervention's effect on patient's outcome (PU incidence) and process of care to understand the extent of conducting each intervention. This study showed increased compliance of most processes of care with implementation of the PU prevention package. Patients were repositioned more frequently, had an improvement in ongoing care, and the patients' heels were elevated and supported with greater frequency. Interestingly, this study found that control group delivery of the PU prevention processes of care were dependent on Nursing officers' clinical decision and provided no uniformity of care. Several studies argue that standardisation, high reliability and compliance of package implementation will improve PU prevention in the ICU (Chaboyer et al, 2013).

There is evidence that it is no longer sufficient to rely on Nursing Officers' clinical judgment in this area - the risk of variance in practice and key elements being omitted is too high. This study showed a high Nursing officers' compliance to delivery of the PU prevention package, thus enabling the PU prevention package to be successfully translated in the clinical practice. Further, using a package approach with extensive education and training, regular feedback of the performance and increased Nursing officers awareness about the extent of the problem will improve NO's compliance and the reduction of PUs in the ICU.

Limitations and Recommendations

This study was conducted in single setting with small sample size therefore generalisability of the findings are limited. Assessment of PU prevention package in a different organisational setting may be required for additional resources and training. Measuring prevalence and incidence of PUs regularly, increasing staff education and awareness about the problem, using PU prevention strategies and implementing evidence-based practice towards PU prevention will positively impact the quality of care and patient outcomes.

Implications: This package had significantly positive effects on reducing PUs especially incidence and severity of PUs. Utilising a package approach through skin assessment is essential for PU-related outcomes. Early identifying risk factors for PU development and high-risk patients and linking with relevant nursing interventions will achieve the desired outcome of PU reduction in the ICU, and consequently improve the quality of care and patient safety.

Conclusion

The results of this study showed significant improvements in reducing PUs and PU-related events through

the implementation of the PU prevention package in ICUs. It would appear that the use of the PU package can reduce PU incidence, severity and total number of PUs per patient. This evidence-based package on PU prevention strategies for skin or mucosal PUs should also be recognised as highly effective by increased staff awareness about PU prevention, staff training and education. Thus, it can also contribute to successful results in improving patient care.

References

1. Vollman KM. Introduction to progressive mobility. *Critical Care Nurse* 2010; 30 (2; Suppl): S3-S5
2. Berlowitz D. Incidence and prevalence of pressure ulcers. In: GA Compton & DR Thomas (ed), *Pressure Ulcers in the Aging Population: A Guide for Clinicians*, Vol 1, 2014; pp 19-26. Totowa, NJ: Humana Press
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): 71-79
4. Van Gilder 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): 293-97
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. Robb E, Jarman B, Suntharalingam G, Higgins C, Tennant, R, Elcock K. Quality improvement report using care bundles to reduce in-hospital mortality: Quantitative survey. *British Medical Journal* 2010; 340 (7751): 861-63
8. Horner DL, Bellamy MC. Care bundles in intensive care. Continuing education in anaesthesia, critical care & pain 2012; 12(4): 199-202
9. Baldelli P, Paciella M. Creation and implementation of a pressure ulcer prevention bundle improves patient outcomes. *American Journal of Medical Quality* 2008; 23(2): 136-42
10. Tayyib N, Coyer F, Lewis P. Saudi Arabian adult intensive care unit pressure ulcer incidence and risk factors: A prospective cohort study. Advance online publication. *International Wound Journal* 2015; doi:10.1111/iwj.12406
11. Gunningberg L, Donaldson N, Aydin C, Idvall E. Exploring variation in pressure ulcer prevalence in Sweden and the USA: Benchmarking in action. *Journal of Evaluation in Clinical Practice* 2012; 18(4): 904-10
12. Coyer F, Stotts N, Blackman V. A prospective window into medical device-related pressure ulcers in intensive care. *International Wound Journal* 2014; 11(6): 656-64
13. Weststrate JTM, Heule F. Prevalence of PU, risk factors and use of pressure ulcer-relieving mattresses in ICU patients. *World of Critical Care Nursing* 2001; 1(3): 77-82
14. Inman KJ, Sibbald WJ, Rutledge FS, Clark BJ. Clinical utility and cost-effectiveness of an air suspension bed in the prevention of pressure ulcers. *Journal of the American Medical Association (JAMA)* 1993; 269(9): 1139-43
15. Soban LM, Hempel S, Munjas BA, Miles J, Rubenstein LV. Preventing pressure ulcers in hospitals: A systematic review of nurse-focused quality improvement interventions. *Joint Commission Journal on Quality and Patient Safety* 2011; 37(6): 245-52
16. Chaboyer W, Chamberlain D, Hewson-Conroy K, Grealy B, Elderkin, et al. Safety culture in Australian intensive care units: Establishing a baseline for quality improvement. *American Journal of Critical Care* 2013; 22(2): 93-102