Applied Nursing Research 28 (2015) 106–113

Contents lists available at ScienceDirect

Applied Nursing Research

journal homepage: www.elsevier.com/locate/apnr

The Effectiveness of a Pressure Ulcer Intervention Program on the Prevalence of Hospital Acquired Pressure Ulcers: Controlled Before and After Study

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ARTICLE INFO

Article history:
Received 14 February 2014
Revised 15 July 2014
Accepted 16 July 2014

Keywords:
Pressure ulcers
Prevention
Predictors
Lebanon

ABSTRACT

Background: Pressure Ulcers (PUs) are associated with high mortality, morbidity, and health care costs. In addition to being costly, PrUs cause pain, suffering, infection, a lower quality of life, extended hospital stay and even death. Although several nursing interventions have been advocated in the literature, there is a paucity of research on what constitutes the most effective nursing intervention.
Objectives: To determine the efficacy of multidisciplinary intervention and to assess which component of the intervention was most predictive of decreasing the prevalence of Hospital acquired pressure ulcers (HAPU) in a tertiary setting in Lebanon.
Design: An evaluation prospective research design was utilized with data before and after the intervention. The sample consisted of 468 patients admitted to the hospital from January 2012 to April 2013.
Results: The prevalence of HAPU was significantly reduced from 6.63% in 2012 to 2.47. Sensitivity of the Braden scale in predicting a HAPU was 92.30% and specificity was 60.04%. A logistic multiple regression equation found that two factors significantly predicted the development of a HAPU; skin care and Braden scores.
Conclusion: The multidisciplinary approach was effective in decreasing the prevalence of HAPUs. Skin care management which was a significant predictor of PUs should alert nurses to the cost effectiveness of this intervention. Lower Braden scores also were predictive of HAPUs.

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1. Introduction

Pressure ulcers (PrUs) are prevalent yet underrated among hospitalized patients and serve as an indicator of the quality of care at an institution (Cox, 2011; Gunningberg, Stotts, & Idvall, 2011). The incidence of PrU varies between 0.4% to 12% in acute care settings and from 2.2% to 23.9% in long term care settings (Bergquist-Beringer, Dong, He, & Dunton, 2013; Lyder et al., 2012; Niederhauser et al., 2012) while prevalence rates range between 12–18% in acute care settings range and between 8.8 to 53.2% in chronic care settings (Gallagher et al., 2008; Moore, Johansen, & van Etten, 2013; Petzold, Eberlein-Gonska, & Schmitt, 2014; Shahin, Dassen, & Halfens, 2009). The rates vary depending on the countries where data were collected, the settings in which they were reported and the methods used in reporting (e.g. whether prevalence was calculated at admission or only during hospitalization). The National Pressure Ulcer Advisory Panel (NAUAP) reports wide ranges of prevalence among patients in the United States (US) estimated to be 1.3 to 3 million with projected costs at $2.2–$3.6 billion a year (Russo, Steiner, & Spector, 2008). In addition to being costly, the workload on nursing is increased, and patients with PrUs experience pain, infection, a lower quality of life, and can even die (Graves, Birrell, & Whitby, 2005; Leshem-Rubinow, Vaknin, Sherman, & Justo, 2013; Saha et al., 2013).

A PrU is defined as a "localized injury to the skin and/or underlying tissue usually over a bony prominence, as a result of pressure, or pressure in combination with shear" (NPUAP (2009) and the European Pressure Ulcer Advisory Panel (EPUAP, 2009)). PrUs are staged form 1 to IV; stage I "is intact skin with non-blanchable redness of a localized area", stage II is "Partial thickness loss of dermis presenting as a shallow open ulcer with a red or pink wound bed, without slough", stage III, is full thickness tissue loss where subcutaneous fat may be visible but bone, tendon or muscles are not exposed and stage IV is full thickness tissue loss with exposed bone, tendon or muscle (NPUAP-EPUAP, 2009). Two additional stages are recognized by the NPUAP and are unstageable which is full thickness tissue loss in which actual depth of the ulcer is completely obscured by slough and suspected deep tissue injury which is of unknown depth with a purple or maroon localized area of discolored intact skin or blood-filled blister due to damage of underlying soft tissue from pressure and/or shear. A hospital-acquired PrU (HAPU) is defined as any ulcer noted 24 or more hours after hospital admission. Because pressure ulcer staging is dependent on visible skin characteristics, a great potential for misclassifying pressure-related injury exists. Deep tissue injury (DTI) can remain undetected for days or weeks before

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http://dx.doi.org/10.1016/j.apnr.2014.07.001
0897-1897/Published by Elsevier Inc.

a purple discoloration of the skin appears. In patients with very dark skin, a DTI may not be visible at all, especially in the area of the gluteal fold where skin color is darker. Thus, often a patient may be in the hospital for several days and develop an HAPU even though it was most likely present underneath on admission (Gefen, Farid, & Shaywitz, 2013). Studies suggest that deep tissue is more susceptible than superficial tissue to injury caused by externally applied pressure; clinically superficial skin injuries induced by pressure tend to be associated with deep tissue damage; and superficial injuries appear to be caused by factors other than pressure. The cause and development of a DTI is multifactorial with recent evidence that biomechanical forces, morphological changes and inflammation together with ischemia and aging, play a role in pressure ulcer pathogenesis (Berlowitz & Brienza, 2007; Stojadinovic et al., 2013).

Since 2009, the Centers for Medicare & Medicaid Services considered pressure sores reasonably preventable and halted reimbursement for the treatment of hospital-acquired pressure ulcers (HAPUs) stages II to IV, unless they was determined to have been present at admission or within 2 days after admission. However, clinicians argue that some PrUs are unavoidable and will occur even when all the necessary interventions are implemented. Examples of these conditions are hemodynamic instability requiring pharmacologic or mechanical support which diminish perfusion, severe protein-energy malnutrition which alters tissue tolerance, or skin breakdown in terminally ill individuals (Black et al., 2011). In addition, because PrUs are preventable in most situations, they have resulted in litigation, with settlements often favoring patients. Based on these facts, most hospitals in developed countries have established protocols and interventions for preventing or lessening the severity of PrUs (e.g. Asimus, Maclellan, & Li, 2011; Saha et al., 2013; Sullivan & Schoelles, 2013).

Despite a variety of prevention and treatment modalities for PrUs, there is limited consensus on the best interventions, with a paucity of randomized clinical trials (RCTs) to provide conclusive clinical practice guidelines [EPUAP, 2009; Australian Wound Management Association (AWMA, 2012); Ontario Health Technology Assessment Series (OHTAS, 2009; McElhinny and Hooper, (2008)]. Extensive interventions for the prevention of PrUs in the past 5 to 10 years in most developed countries have resulted in significant decreases in HAPUs (e.g. Asimus et al., 2011; He, Staggs, Bergquist-Beringer, & Dunton, 2013; Mathiesen, Nørgaard, Andersen, Møller, & Ehlers, 2013; Stotts, Brown, Donaldson, Aydin, & Fridman, 2013; Sullivan & Schoelles, 2013). However, similar decreases in prevalence rates (including patients with a PrU at the time of hospital admission and in long term facilities have not been achieved (Gunningberg et al., 2011; Kottner, Doris-Dassen, & Lahman, 2009; Leijon, Bergh, & Terstappen, 2013). The following interventions have been used to prevent PrUs to date.

1.1. Patient Repositioning

Repositioning is a basic tenet of nursing care used in most health care facilities to prevent pressure ulcers. Most policies, based on recommendations written in the mid 60s (e.g. Kosiak, 1966), and supported by current best practice guidelines (Australian Wound Management Association, 2012; EPUAP, 2009; Krapfl & Gray, 2008), recommend repositioning the bed ridden patient every 2 hours to help eliminate interface pressure. While a widespread intervention, only five randomized controlled trials have assessed the efficacy or the timing for repositioning (Bergstrom et al., 2014; Defloor, De Bacquer, & Grypdonck, 2005; Moore, Cowman, & Posnett, 2013; Vanderwee, Grypdonck, De Bacquer, & Defloor, 2007; Young, 2004). A recent large multisite study (Bergstrom et al., 2014) found no difference in PrU incidence when patients were repositioned every 2, 3 or 4 hours while a Cochrane review concluded that there is limited empirical evidence of the effect of positioning on the prevention of PrUs (Gillespie et al., 2014).

1.2. Nutrition and Vitamins

The benefits of nutritional supplementation were assessed in few RCTs, with mixed results (Banks, Graves, Bauer, & Ash, 2013; Bourdel-Marchasson et al., 2000; Houwing et al., 2003). A review on the benefits of nutritional support on the development of PrUs in intensive care units (ICUs), by Theilla (2013) concluded that " the paucity of RCTs focusing on intensive care unit (ICU) nutrition in the support of wound healing and the prevention of pathologic healing precludes formulation of evidence-based guidelines for clinicians"(p. 186).

1.3. Support Surfaces

The use of special beds, mattresses, sheets and overlays designed to redistribute pressure, have been widely used to prevent PrUs since the mid-1980s. Several RCTs found that using special mattresses or sheets significantly reduce the incidence of PrUs (e.g. Coladonato et al., 2012; Demarré et al., 2013; Huang, Chen, & Xu, 2013). A Cochrane review concluded that individuals at high risk for developing PrUs could benefit from special alternating pressure mattresses although more RCTs are needed (McInnes, Jammali-Blas, Bell-Syer, Dumville, & Cullum, 2011).

1.4. Skin Care

In the presence of pressure and shear forces both excess moisture and dryness can exacerbate skin breakdown, making a patient more susceptible to a PrU (Sibbald, Goodman, Norton, Krasner, & Ayello, 2012). While some studies report the efficacy of special creams and barriers (e.g. Torra, Bou, Segovia Gomez, Verdu Soriano, et al., 2005; Hunter et al., 2003), the evidence remains weak (Moore & Webster, 2013; Ontario Health Technology Assessment series & Medical Advisory Secretariat, 2009; Saha et al., 2013). A recent systematic review (Clark et al., 2014) found only one high-quality randomized controlled trial (RCT) nevertheless, based on descriptive and cohort studies, they concluded that dressings such as hydrocellular, hydrocolloid or silicone foam dressings as part of pressure ulcer prevention may help reduce pressure ulcer incidence associated with medical devices and in immobile ICU patients.

1.5. Risk Assessment

Many hospitals around the world have adopted risk assessment tools to evaluate patients at risk for developing a PrU. A recent meta-analysis of 57 studies using different risk assessment scales found that the Braden, Norton, EMINA (mEntal state, Mobility, Incontinence, Nutrition, Activity), Waterlow, and Cubbin-Jackson scales showed the highest predictive capacity (Garcia-Fernandez, Pancorbo-Hidalgo & Agreda, 2014), while a Cochrane review found only 2 RCTs and concluded that there is no reliable evidence to suggest that the use of structured, systematic pressure ulcer risk assessment tools reduces the incidence of pressure ulcers (Moore & Cowman, 2014). The three most widely used instruments are the Braden, the Norton and the Waterlow scales with the Braden scale having the highest pooled predictive capacity followed by the Norton scale and the Waterlow scale. The Braden scale has documented sensitivities of 38-100% and specificities of 44-100% in predicting a PrU formation (Kallman & Lindgren, 2014; Kottner & Doris-Dassen, 2010; Suttipong & Sindhu, 2011; Yatabe et al., 2013) with lower predictive values in ICU settings and surgical patients (Chou et al., 2013; Cohen et al., 2012; Cox, 2012; Chan, Pang &, Kwong, 2009; Kottner & Doris-Dassen, 2010; He, Liu, & Chen 2012; Webster et al., 2010).

1.6. Multiple Interventions

There is growing research evidence describing the benefits of multipronged, interventions in reducing PrUs in acute care settings

and long-term-care facilities (e.g. McGuinness et al., 2012; Shannon, Brown, & Chakravarthy, 2012; Niederhauser et al., 2012; Soban, Hempel, Munjas, Miles, & Rubenstein, 2011). However, the evidence remains moderate, and it is difficult to ascertain which modality resulted in the prevention of a PrUs as most studies do not focus on the effectiveness of a specific intervention (Sullivan & Schoelles, 2013).

Considering the high cost, incidence and prevalence of PrUs it is astounding how little research with good methodology has been conducted in this area (Coleman et al., 2013). Most publications and current practices are based on the best clinical information available and consensus based recommendations (AWMA, 2012; Moore, Johanssen, & van Etten, 2013b). Black et al. (2011) concluded that most recommendations for PrU prevention were rated as valid but had B- or C-level evidence, suggesting the need for research to replace opinion. The majority of RCTs have focused on the use of support surfaces (McInnes, Jammali-Blasi, Cullum, Bell-Syer, & Dumville, 2013) with less attention to nursing interventions such as the precise assessment of patients, skin care and repositioning (Sullivan & Schoelles, 2013). Based on several recommendations by researchers to build the evidence base for implementing best practices and the limited number of good quality studies, the objectives of this study were two fold:

1) to determine the effects of implementing a multimodal intervention program on the rates of HAPUs, 6 months before and 6 months after the introduction of the intervention (defined as the number of hospital inpatients having at least one pressure ulcer grade I to IV with the two additional stages added by NPUAP (2009) on a 1-day point dived by the number of a patients assessed multiplied by 100 (NDNQI, 2009), and
2) to assess which variables (Braden scores, age, gender and length of stay (LOS), PrU prevention documentation, skin care, pressure redisribution mattress, nutrition and repositioning) were predictors of the rate of an HAPU.

The model used to reduce HAPUs was Plan, Do, Study, Act (PDSA) which has been used in many studies to improve patient outcomes such as operating room errors, post surgical infections as well as PrUs (Lyder, Grady, Mathur, Petrillo, & Meehan, 2004; Witter, Lawson, & Ferrell, 2014). The PDSA model has an advantage in that it measures progress at set time intervals and the opportunity to make changes accordingly.

1.7. Research Questions

1. What is the prevalence rate of HAPUs before and after implementing the intervention?
2. What is the predictive value of the Braden scale in an inpatient acute care setting?
3. What risk factors are associated with HAPU rates?
4. Which component of the multi-model intervention (s) along with patient risk factors are determinants of an HAPU?

2. Materials and Methods

2.1. Design

A prospective descriptive research design was utilized with 6 months pre and 6 months post data used.

2.2. Setting

Data were collected on nineteen inpatient units at a tertiary medical center in Lebanon which has 300 beds, was Magnet designated in 2009 and has 600 nurses, 90% of whom have a bachelor degree in nursing. The nurse to patient ratio is one nurse to 5 patients in open units and one nurse to one or two patients in the critical care units (CCUs). The units included; medical, surgical, oncology, bone marrow transplant, and five CCUs.

2.3. Sample

The sample consisted of 486 inpatients surveyed from January 2012 to April 2013 in the above mentioned units and who agreed to participate in the study. A sample size of 150 was sufficient to detect a significant reduction in PrUs based on a similar study completed in long-term care by Lyder et al. (2004) where an intervention program reduced PrU from 13.2% to 1.7%, $p = 0.02$. Significance was set at [alpha] = .05, with power set at 1 - [beta] = 0.80. Thus, a sample of 486 was more than sufficient to detect significance before and after the intervention.

2.4. The Intervention

The intervention program consisted of a multi-model program including:

1) The use of the Braden Scale to assess all patients upon admission to the hospital (Braden & Bergstrom, 1994). The Braden Scale was selected as it is the most used and validated PrU risk assessment instrument (Chan et al., 2009; García-Fernández et al., 2014). The Braden scale was developed in the late 1980s and consisted of 6 variables: activity, mobility, nutritional status, sensory perception, moisture, and friction and shear. Each variable is rated 1 to 4, except for the friction and shear variable, which is rated from 1 to 3, thus generating a maximum score of 23. A higher score corresponds with a lower risk of a PrU development. A score at or below 18 indicates the need for evidence-based interventions designed to maintain or restore skin integrity (Braden & Bergstrom, 1994).
2) The accurate staging based on the NPUAP- EPUAP (2009) guidelines.
3) Selection of twenty nurse champions based on more than 3 years of bedside nursing experience and successful completion of a training workshop followed by competency validation on PrU prevention and management. The training consisted of 4 modules: 1) assessment of all patients upon admission using the Braden scale, 2) staging of PrUs and differentiating between PrUs and other types of wounds, 3) data collection procedures and 4) PrU prevention strategies (repositioning, nutritional support, skin care, and pressure redistribution surfaces (The National Database of Nursing Quality Indicators (NDNQI), 2014). The tasks of the champions were:
   a. Act as resource persons in assessing patients using the Braden scale and in applying preventive measures according to an updated policy based on latest evidence.
   b. Participate in data collection, monitor and compare rates with the NDNQI rates as a benchmark.
   c. Identify weaknesses and implement action plans specific to the unit or patient population.
   d. Audit the nurses for their adherence to the policies regarding skin assessment, PrU staging, and prevention/management of impaired skin integrity using a checklist on a monthly basis.
4) The education of the all registered nurses (RNs) on the new protocols and policies. This included workshops, hands on training and competency validation through hands on demonstrations and testing (NDNQI, 2014).
5) The introduction of electronic reporting of PrU prevalence as a quality indicator.
6) The implementation of a Bundle for the Prevention of HAPU outlined in Table 1.

2.5. Data Collection

The data were collected by the champions who received training based on the NDNQI manual and who were tested for inter-rater reliability of over 90% on the Braden scale and on PrU staging. The data also included whether the PrU was present on admission or not, its

Table 1
INTACT: Bundle for the prevention of HAPUs.

I	Incontinence · Clean skin regularly and keep it dry · · Offer toileting regularly · · Use fecal/urinary collection systems · · Use barrier films/creams over perineal area · · Assess & change diapers frequently ·
N	Nutrition · Consult dietitian & ensure optimal nutritional intake · · Follow up any recent weight loss · · Maintain adequate hydration unless contraindicated ·
T	Turning · Turn patient every 2 hours and when needed while in bed · · Shift patient's weight when in chair every: - 1 hour when patient needs assistance - 15 minutes when patient can move freely · Relieve pressure points over bony prominences · · Do not drag patient · · Elevate head of bed, hands, & heels ·
A	Assessment · Assess patient's skin upon admission & every shift · · Assess risk for impaired skin integrity · · Assess bed sheets for wrinkles & soiling · · Avoid hypothermia · · Avoid positioning patient on existing pressure ulcer & over tubes ·
C	Consultation · Consult physical therapist · Charting · Chart skin & risk assessment findings, prevention interventions, & education ·
T	Teaching · Teach patient/family to: - Inspect susceptible body prominences - Perform appropriate prevention measures - Avoid aggressive massaging & rubbing over bony prominences

location, severity and on which unit it occurred). Data were collected on the specified units by the champions, the certified wound care specialist, and two NDNQI quality managers at a one point in time each month which is defined by NDNQI (2014) as the proportion of individuals with a given disease at a given time. The patient's skin was assessed, the Braden scale was completed, and preventive strategies were recorded. If there was a disagreement about the pressure ulcer grade, the decision was made by consensus agreement of three members of the team. Demographic characteristics of patients collected included age, gender, diagnosis, and LOS.

2.6. Ethical Considerations

The study was approved by the medical and nursing directors and was exempt from the institution review board of the university as it was part of nursing care parameters recorded during routine patient care. Patients were asked to provide verbal consent to be examined.

2.7. Data Analysis

Data were entered in SPSS 22. Univariate analysis was first used to describe the sample, with percentages for categorical variables and means and standard deviations (SD) for continuous variables. The rates of HAPU were compared before and after the intervention using the χ^2 test. Sensitivity and specificity analysis was done for the Braden scale. Sensitivity which is the percentage of patients with an HAPU who were correctly identified as having the condition was calculated as: true positives/true positives + false negatives, and specificity which are the percentage of patients who were correctly identified as not having an HAPU was calculated as: true negatives/true negatives + false positives. T-tests and univariate analysis were done to compare the potential risk factors for those who developed an HAPU and those that did not and whose Braden scores were < 18 ($N = 210$) at admission. The dependent variable was the presence of an HAPU coded as 1 and the absence of an HAPU coded as 0. The potential risk factors included: age, LOS, Braden scores, gender, critical care versus non critical care units, documentation of preventive measures, repositioning every 2 hours, skin care, nutritional support and the use of a pressure redistribution mattress (the latter 5 variables were documented as "yes" for done and "no" for not done). Finally, multivariate logistic regression analysis was used to evaluate the impact of the potential risk variables that were significant in the univariate analysis on the development of HAPU. The Hosmer and Lemeshow goodness-of-fit statistic chi-square test was used to validate the model, where values of p near 1 indicate a good fit and values near 0 indicate a poor fit (Lemeshow & Hosmer, 1982).

3. Results

3.1. Descriptive Statistics of the Study Variables

The number of patients approached initially were 542; 31 refused to participate, 12 were in the process of going for a diagnostic tests, and 13 were very ill or in critical condition to be moved and assessed resulting in a sample size of 486. The characteristics of the 486 patients surveyed are found in Table 2.There were slightly more males, the mean age was 54.6 (SD ± 20.85), and the LOS was 21.95 (SD ± 68.67). Of those assessed as at risk ($N = 201$), 80.59% had a documented PrU prevention strategy, 75.62% had repositioning done every 2 hours, 77.61% had skin care (85% of those had protective dressings applied), 87.06% had nutritional support and 73.13 were placed on a pressure redistribution mattresses. Mean Braden scale scores for the total sample was 18.08 (SD ± 7.57), for those who did not develop an HAPU ($N = 190$) it was 15.56 (SD ± 3.69), and for those that developed an HAPU ($N = 12$) it was11.47 (SD ± 5.46) (Table 3). In patients who developed an HAPU, 23.5% had scores between 15 and 18, 38.3% had scores between 13 and 14, 14.6% had scores between 10 and 12 and 23.6% had scores less than 9. The critical care units had the highest numbers of HAPUs [($n = 6$ (50%)] followed by the medical and surgical units [$n = 4$, (33%)], and the oncology units had 2 HAPUs (17%). The most common locations for the HAPUs were the: coccyx sacrum [$n = 6$ (50%)] heel ($n = 3$ (25%)], ischial tuberosity [$n = 1$ (8%)], occiput [$n = 1$ (8%)] and ear [$n = 1$ (8%)].

3.2. What is the Rate of HAPUs Before and After Implementing the Intervention?

In the first two quarters of 2012 prior to the implementation of the multimodal intervention, the average rate of HAPUs was 6.63% while the last quarter of 2012 and the first quarter of 2013, the rate was reduced to

Table 2
Characteristics of the sample $N = 420$.

	n	%	Mean (SD)
Gender			
Male	244	58.1	
Female	176	41.9	
Age			44.69 (30.07)
LOS			26.93 (98.56)
Units			
Medical–Surgical	196		
Oncology	41		
Pediatrics	48		
ICUs	135		
Braden Score on admission	415	98.5	
Patient documented at risk (yes)	150	35.7	
PU prevention in use for risk patients	272	64.8	
Repositioning for risk patients	302	65.2	
Moisture management for risk patients	300	71.4	
Redistribution mattress for risk patients	305	72.6	

Table 3
Spearman Correlation between study variables.

	Age	Length of stay	Admission	Patient at risk	Mattress	PU prevention	Position	Nutrition	Moisture	HAPA
Age	1	−.07	−.29**	−.34**	−.32**	−.34**	−.36**	−.34**	−.34**	.06
Length of stay	−.07	1	−.20**	−.21*	−.22**	−.20**	−.24**	−.20**	−.22**	.02
Braden Admission Score	−.29**	−.21**	1	.62**	.58**	.62**	.58**	.66**	.59**	−.12*
Patient at risk	−.34**	−.21**	.62**	1	.82**	.98**	.84**	.94**	.88**	−15*
Redistribution mattress*	−.32**	−.22**	.58**	.82**	1	.83**	.87**	.84**	.95**	−.17*
PU prevention in use for	−.34**	−.20**	.62**	.98**	.83**	1	.97**	.97**	.85**	−.13*
Positioning	−.36*	−.24**	.58**	.84**	.87**	.97**	1	.84**	.85**	−.22**
Nutritional support	−.34**	−.20**	.66**	.94**	.84**	.97**	.84**	1	.85**	−.14*
Skin care	−.34*	−.22**	.59**	.88**	.95**	.85**	.85**	.85**	1	−16*
HAPU	.06	.02	−.12*	−.15*	−.17*	−.14*	.22**	−.14*	−16*	1

• Care assist beds with Accumax VC AD mattress were used.
* $p < 0.05$.
** $p < 0.01$.

2.09% and 2.47%. Fig. 1 shows the reduction from the first quarter till the last quarter which was significant at $\chi^2 = 7.64$, $p < 0.01$.

3.3. What is the Predictive Value of the Braden Scale in an Inpatient Acute Care Setting?

Two hundred and one patients (41.35%) were considered at risk for developing a pressure ulcer based on the Braden scale scores, which was recorded on 99.79% of the patients within 24 hours of admission. Eleven (5.23%) of the 201 at risk patients developed an HAPU and one patient (0.03%) who was not deemed to be at risk developed an HAPU. Based on previous studies (e.g. Källman & Lindgren, 2014; Chan et al., 2009), sensitivity which is the percentage of patients who developed an HAPU and were assessed as being at risk was 92.30%, and specificity which is the percentage of patients who did not develop a pressure ulcer and who were assessed as being not at risk for developing an ulcer was 60.04%.

3.4. What Risk Factors are Associated With HAPU Rates?

The independent variables that were significantly associated with the development of an HAPU were; LOS, $t = 2.06$, $p = 0.032$, Braden scores on admission, $t = 4.55$, $p = 0.023$), and all the prevention strategies (Table 3). Age and gender were not related to the development of HAPU (Table 3).

3.5. Which Component(s) of the Multi-Model Intervention (s) along With Patient Risk Factors are Determinants of an HAPU?

A multiple logistic regression equation where the 8 factors associated with the development of an HAPU were entered into the equation found that two factors remained significant; the Braden scores OR 1.187 (CI =1.031–1.546, $p = 0.03$) and skin care OR = .058 (CI =0.036–0.092, $p = 0.04$) with an R_2 of 0.12. None of the remaining variables remained significant. The goodness-of-fit statistics for the overall model found that the model was not significant ($\chi^2 = 4.45$, $p = 0.98$). This indicates that the model was well calibrated and a good fit (Table 4).

4. Discussion

The results indicate that 5.5% of patients considered at risk, developed an HAPU which is consistent with a recent review of 1,419 hospitals from across the United States with 710,626 patients where 7.9% developed an HAPU from those at risk (Bergquist-Beringer et al., 2013). The majority of patients at risk received prevention strategies, with nutritional support being the intervention most employed and repositioning every 2 hours the least employed. The fact that the compliance with repositioning every 2 hours was the least intervention carried out can be explained by the fact that it is not an easy nursing intervention that requires manpower, effort and time. The CCUs had the highest rates of HAPUs which is supported by previous research (Petzold et al., 2014; Sayar et al., 2009). The body locations of the HAPUs

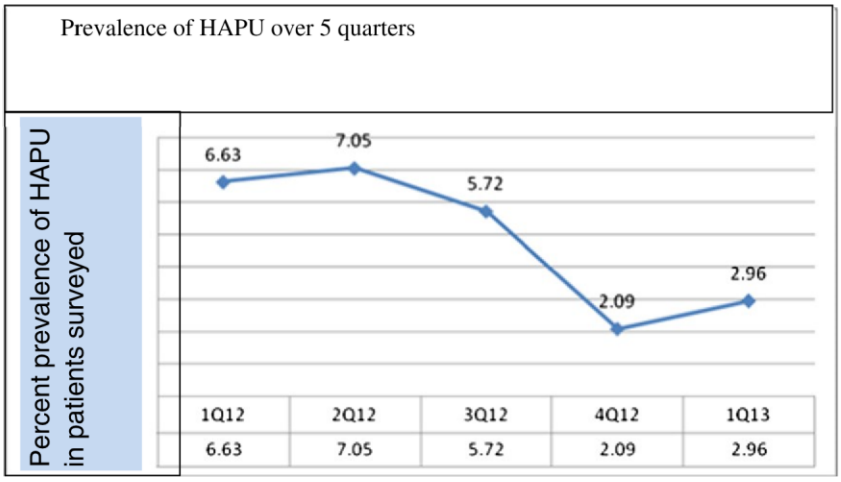

Fig. 1. Prevalence of HAPU over 5 quarters.

Table 4
Logistic regression analysis ($N = 150$).

Variable	B	Standard error	Standardized COEFFICIENTS BETA	t	p
Braden Admission Score	−.01	.01	−.09	−1.6	.10
Patient at risk	.20	.30	.20	.68	.49
PU prevention in use	.43	.39	.44	1.1	.26
Redistribution mattress	.14	.25	.13	.57	.56
Repositioning	.18	.23	.17	.78	.43
Nutritional support	−.64	.42	−.64	−1.5	.07
Skin care	−.55	−.23	−.54	−2.6	.00

Dependent variable: HAPU.

are also consistent to what is reported in earlier studies (Bååth, Idvall, Gunningberg, & Hommel, 2014; Leijon et al., 2013; Shahin et al., 2009).

In line with previous studies the use of a multi-model intervention or "bundle" based on the best evidence for PrU prevention, the reliance on specially trained PrU champions and an emphasis on staff education were beneficial in reducing the rates of HAPU (Coleman et al., 2013; Niederhauser et al., 2012). Although several earlier studies measured HAPU rates before and after implementation of a quality improvement project, few reported the association between each component of the intervention and the development of an HAPU. In this study, the rates of HAPUs did not reach zero probably due to the fact that there are multiple additional factors that contribute to the development of HAPUs in hospitalized patients. These factors are often beyond the control of the nursing/medical staff. These may include a multiplicity of comorbidities, extended hospital stays and inadequate staffing (Bry, Buesher, & Sandrik, 2012; Cremasco, Wenzel, Zanei, & Whitaker, 2013). Bry et al. (2012) noted that 80% of patients with a single HAPU had six or more comorbid factors, while an additional two-thirds exhibited at least one organ system failure. This study did not document co-morbidities; however, LOS which may be an indirect measure of patient complexities did not remain a significant contributor to the development of an HAPU in the multiple regression analysis. As noted in Fig. 1, the trajectories of the quarterly HAPU reflect some seasonality trends with higher rates in the winter months when patient volume is higher and the number of elderly patients is also higher, a finding noted earlier in a study by He et al. (2013).

The sensitivity of the Braden scale in predicting the development of a pressure ulcer in this study was 92.30% with a specificity of 60.04%. While some studies have documented lower sensitivities, most have found that the total Braden Scale scores are highly predictive of an HAPU (Tescher, Branda, Byrne, & Naessens, 2012). A recent study comparing 4 risk assessment scales reported sensitivities of 38–100% with sensitivities of 44–100% on the Braden scale (Källman & Lindgren, 2014). Likewise, a study by Cox (2011) with 347 acute care patients in of whom 65 (18.7%) developed a PU, a sensitivity of 100% was reported. High specificity helps to cost-effectively and correctly allocate resources to patients at risk of pressure ulcer development (Chan et al., 2009).

In this study, no relationship was found between age and gender and the development of an HAPU. Previous studies have reported inconsistent findings for example, Defloor et al. (2005) found no relationship between age and PUs while Cox (2011) found that age was a significant predictor of PUs. Although most studies do not report a relationship between gender and PrUs (e.g. Cox, 2011; Tescher et al., 2012), a recent cohort study of 1914 patients in a university hospital Germany found that gender was a determinant of a PrU development (Petzold et al., 2014). The discrepancy in results warrant further attention and could be due to the size of the samples studied and the setting where the study was conducted. Length of hospital stay, patients in the critical care units and 5 of the preventive measures were significantly related to the development of an HAPU in the univariate analysis which is supported by previous studies (Cohen et al., 2012; Cox, 2011).

Unlike most previous studies, this study assessed which component of the multi-model or "bundle" interventions in addition to patient characteristics was most likely to be associated with the prevalence rates of HAPUs. The two factors that remained significant in the logistic regression analysis were skin care and Braden scores. It is worth noting that 85% of the patients with documented skin care had protective dressings applied over bony prominences (Foam and Hydocolloid dressings) which may have been a protective factor in preventing the development of an HAPU. A recent systematic review of 21 studies by Clark et al. (2014) concluded that prophylactic dressings may reduce pressure ulcer incidence. Lower Braden scores were also associated with HAPUs in this study, a finding well supported by previous studies where lower scores are more predictive of PrUs (Källman & Lindgren, 2014; Shahin et al., 2009; Sving, Idvall, Högberg, & Gunningberg, 2013; Tescher et al., 2012). However, the findings of this study have to be interpreted with caution, as there were only 12 patients who developed an HAPU. Based on a systematic review by Coleman et al. (2013), 10 pressure ulcers are required per variable. Thus, for generalizations to be made over 100 pressure ulcers are required with a sample of over 4000. This would not be possible in a single institution. Nevertheless, one could argue that providing good skin care and applying prophylactic dressings could be a cost effective method in preventing HAPUs (Baranoski & Ayello, 2012).

Positioning was not found to be a predictive factor in the development of an HAPU in the logistic regression analysis. Only five earlier RCTs compared the efficacy of repositioning patients with a recent Chochrane review concluding that there is limited empirical evidence to the efficacy of turning patients at 2–3 or4 hour intervals (Gillespie et al., 2014). The hospital policy for this study mandates repositioning every 2 hours. This translates to extensive nursing hours spent on turning patients, which may not be advantageous or necessary, especially for patients on special mattresses. Based on limited research in this area, further RCTs are acutely needed. Likewise, the use of pressure redistribution surfaces and nutritional support were not predictive of HAPUs in the logistic regression analysis. This finding indicates that, while nutritional support and pressure redistribution surfaces were associated with the development of HAPU in the univariate analysis, they lose their significance when combined with other factors.

5. Limitations

There were several limitations attached to the study, despite the strengths including having a powered sample size, the documentation of the intervention by the champions, and the adherence to the NDNQI guidelines. The first limitation was the descriptive design of the study rather than an experimental design, which would have provided more strength to the findings. The second limitation is the fact that there are several risk factors such as staffing ratios, impaired mobility, impaired perfusion or other co-morbidities which may have predicted the prevalence of HAPU and which were not assessed in this study. Third, the study relied on nursing notes to document the preventive measures applied to at risk patients; however, this does not confirm that these measures were actually applied. Fourth, this study assessed the rate of HAPU rather than the incidence, which may provide a more accurate picture of the efficacy of the intervention. Finally, the study was conducted in one university hospital with the occurrence of only 12 HAPU, and as such the results cannot be generalized to other institutions.

6. Conclusion

Preventing HAPUs is an important nursing concern for hospitalized patients. Consistent with previous research, this study applied a multi-model intervention which was based on the latest evidence in the literature to decrease the rate of HAPUs. These interventions are multifaceted and include: administrative support with active involvement of nursing staff at the patient care level, developing a bundle of care which is infused into routine care practice, and accurate documentation (Soban et al., 2011). However, most of these interventions are based on clinical judgment and consensus rather than on

sound research. It is contended that it is time to test these prevention practices using RCTs.

The fact that HAPUs were best predicted by skin care management and lower Braden scores should alert nurses to these cost effective measures. Though several studies have documented the benefits of the Braden scores in predicting the development of an HAPU, this may be the first study to report the significance of skin care in preventing HAPUs. It is also important to note, while these measures were the best predictors of HAPUs in this study, other institutions may not find similar results. As such, further studies are encouraged, and initiatives should be customized to the needs of professionals in each institution. It is also important that successful initiatives be maintained and sustained to ensure that the changes are embedded into practice.

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