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Psychometric Evaluation of a New Pressure Ulcer Skin Risk Assessment Scale for the Pediatric Burn Patient

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Psychometric Evaluation of a New Pressure Ulcer Skin Risk Assessment Scale for the Pediatric Burn Patient

by

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Dedication

To Jeff, who makes all things possible

and

To Byron, Andrew, Michael, and Trisha for your encouragement and support

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Psychometric Evaluation of a New Pressure Ulcer Skin Risk Assessment Scale for the Pediatric Burn Patient

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Prevention of pressure ulcers is a primary goal in nursing practice, and achievement implies excellence in clinical care. One component of prevention is to understand the risk for pressure ulcer development. The benefit of knowing risk is to initiate pressure ulcer preventive interventions. Pressure ulcers are a significant problem in the pediatric burn patient population. Unfortunately, no skin risk assessment scale exist that capture the unique risk indices of the burn injury, thus the Pressure Ulcer Skin Risk Assessment Scale (PrUSRAS) was developed. The purpose of this study was to evaluate the validity, reliability and predictability of scores from the PrUSRAS. One hundred sixty-three burn patients from three pediatric burn Shriners Hospitals (Galveston, Cincinnati and Sacramento) were assessed with the PrUSRAS and followed to determine if pressure ulcers developed. The pressure ulcer incidence rate was 24.6%. Demographic data revealed significant findings: children who developed pressure ulcers had a higher mean percent burn injury (53%), increased number of mean hours in the operating room (>9 hours) and had a longer mean length of stay (46.7 days) compared to those children who did not develop pressure ulcers. Two estimates of reliability of PrUSRAS scores were computed: the intraclass correlation coefficient (ICC) and Cronbach's coefficient alpha. The ICC calculation was 1.0. Cronbach's coefficient alpha was low at 0.559. An exploratory factor analysis was used to assess construct validity. The analysis identified a 4-factor model, which was not readily interpretable. Logistic regression was used to predict the occurrence of pressure ulcers. Only three of the PrUSRAS items were significant predictors of pressure ulcers in the pediatric burn patients—percent burn, number of splints and prior or current pressure ulcers. The PrUSRAS is better at

predicting children who will not get a pressure ulcer (95%) than it is at predicting those who will get a pressure ulcer (54%). Although this study did not provide evidence the PrUSRAS can identify risk of pressure ulcers in the pediatric burn patient the three significant pressure ulcer risk factors can be used in clinical practice to screen.

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CHAPTER ONE: INTRODUCTION

INTRODUCTION

This chapter presents an introduction to pressure ulcers, including a discussion of the background and significance of the problem. An introduction to skin risk assessment scales and pressure ulcer risk factors unique to the pediatric burn population are also discussed. In addition, a description of the concepts and variables of the study are outlined, followed by the specific aims and related hypotheses.

Children comprise 30% of all burn injured patients every year (Saffle et al., 1995). Many pediatric burns are major and require hospitalization with extensive treatment. The average hospital length of stay for burn patients is 1 day per percentage burn injury. Although it is not clearly articulated in the literature, many of burn patients are at high risk for the development of pressure ulcers. While pressure ulcers have been studied as a consequence of adult patients who are chronically or terminally ill, little work has been done regarding pressure ulcers that occur as a result of burn injuries in either pediatric or adult patients.

Maintenance of skin integrity is a clinical indicator of quality nursing care. Pressure ulcer incidence rates (defined as the failure to maintain skin integrity) have become a benchmark for quality improvement that enables hospitals to identify best clinical practices for improved clinical outcomes. A Joint Commission 2007 National Patient Safety Goal is to prevent health care-associated pressure ulcers (Joint Commission, 2007). The Joint Commission recommends that health providers assess and reassess each patient's risk for developing a pressure ulcer, and that action should be taken to remedy any identified risk. It is important to know which patients are at risk and what factors place them at risk. Knowing these risk factors will provide a foundation for developing an effective plan for the prediction, prevention and early treatment of pressure ulcers. Furthermore, identification of and taking preventative measures for pressure ulcer

risk could potentially decrease the length of hospital stays, thereby reducing the associated hospital costs.

The National Pressure Ulcer Advisory Panel (NPUAP, 1989) defines pressure ulcers as areas of unrelieved pressure over a region of skin that result in ischemia, cell death and tissue necrosis. Attributes of pressure and its effect on skin integrity include pressure duration, location, intensity and tissue tolerance to pressure. The areas of the body most prone to suffer these effects are the bony prominences such as heels, sacrum, occiput and elbows.

The populations thought to be at highest risk for development of pressure ulcers are the chronically sick and terminally ill; patients receiving mechanical ventilation (Pender & Susan, 2005); the elderly; and patients with amputations, recent fractures, multiple trauma, spinal cord injuries and strokes (Allman et al., 1995; Baggerly & DiBlasi, 1996; Berlowitz & Wilking, 1989; Ross & LaPluma, 1990). Traditionally, pressure ulcer concerns have been relegated to the geriatric population or patients with mobility problems (Allman et al., 1995; Bergstrom & Braden, 1992; Berlowitz & Wilking, 1989; Fritsch et al., 2001; Meehan, 1994). Moreover, burn patients are not described in the literature as being a high-risk population for the development of pressure ulcers.

Patients involved in burn injuries typically are middle-aged individuals (48.2%) or pediatric patients (34.5%) in previously good states of health (Saffle et al., 1995). Geriatric populations in burn centers are relatively low, averaging approximately 6% or less of burn cases (Saffle et al., 1995). Unfortunately, there are no national statistics on the incidence and prevalence rates of pressure ulcers in burn patients. Most burn units do not track the incidence of pressure ulcers or manage ulcers in the same way burn wounds are managed. Nonetheless, one burn unit in Ohio reported the incidence of pressure ulcers to be 4.1% (Fritsch et al., 2001).

Although little attention has been given to the risk of pressure ulcers in patients with burn injuries, burn patients may be at a higher risk for the development of pressure ulcers because of the pathophysiology of the burn injury and the requirements for managing post-operative skin grafts.

In the pediatric burn patient, hypovolemic shock occurs initially as blood flow is shunted away from the skin to preserve vital organ function. Additional injuries (e.g., inhalation injury) that require intubation and use of paralytic agents to manage the airway may increase one's risk of developing pressure ulcers. As fluid resuscitation is begun, massive edema in both burned and unburned areas may occur. The edema is maximized at about two to three days post-burn, which also decreases the blood flow to the skin and adds weight to all parts of the body.

Maintaining systemic hydration can continue to be a problem long after the child has received adequate resuscitation for burn shock. Continued fluid therapy to replace fluid loss through the burn wound is essential. If systemic hydration is not maintained, even normal skin may be at risk for pressure ulcers. To complicate this situation, the quantity of fluid lost through the burn wound may increase the moisture of normal skin adjacent to the burn wound, causing normal skin to break down and predisposing the skin to further compromise.

Most burn-injured children have numerous surgical excisions of the burn wound, with associated grafting taken from unburned areas on the body. These procedures may require the patient to be anesthetized for long periods of time. As a result, children are at risk for pressure ulcers in the operating room, necessitating the use of pressure-reducing devices. Likewise, during these operative procedures the patient may lose large quantities of blood or may develop hypovolemic/septic shock, resulting in decreased tissue perfusion. Vasopressors, antibiotics and fluid resuscitation are the usual treatment course for septic shock. The low flow states and the use of vasopressors also may result in decreased tissue perfusion and add to the risk of pressure ulcer formation.

Post-surgery, the pediatric patient is often immobilized with large bulky wet dressings and splints to protect the graft. These dressings are applied with enough pressure to stop the bleeding from the grafted wound and the donor site. But if the dressings are applied too tightly, or if edema develops after dressing application, the dressings may cause increased pressure on the skin.

Throughout the acute phase of care, the burn patient is predisposed to pain and anxiety. Pain from the burn wound or the fear of pain may cause the patient to lie still. The immobilization that comes as a result of this fear may cause the patient to lie in one

place, causing prolonged pressure on a bony prominence. Antibacterial soaks are used to maintain moisture in the grafted wound and aid in decreasing bacterial wound colonization. This moisture, when in contact with adjacent normal skin, may increase the risk of tissue breakdown.

Inadequate nutrition prior to or after the burn injury may pose a significant problem. The hyper metabolic response in the burn-injured patient leads to protein malnutrition if caloric intake is compromised. Enteral hyperalimentation is most frequently used and the patient is fed by nasogastric or nasojejunal tubes to reduce the risks of systemic infection and to promote wound healing.

Clearly, the physiology of the burn injury combined with many of the therapies and treatments during hospitalization increases the pediatric burn patient's risk for pressure ulcers. Two recommendations made by the AHCPR show great promise for the prevention of pressure ulcers. These recommendations are a) the use of skin risk assessment scales for identifying patients who are at risk for pressure ulcer development, and b) the protection against the adverse effects of external mechanical forces such as pressure, friction, and shear (AHCPR, 1992, 2000).

While there are risk assessment scales that provide a means of improving the identification of patients at risk for pressure ulcers (Abruzzese, 1985; Gosnell, 1973; Moolten, 1972), and there exist published guidelines for prevention and management of pressure ulcers in 2003 (WOCN, 2003), these scales and guidelines have not been effective for the pediatric burn injury patient. The exact reasons of this inadequacy are unclear; much of the failure to examine pressure ulcers in the pediatric burn patient may be due, in part, to the lack of adequate skin risk assessment instruments.

The development of skin risk assessment scales is intended to capture factors that comprise the risk for pressure ulcer development. Such a scale should be easy to use and contain predictive qualities with high sensitivity and specificity. The two most popular skin risk assessment scales are the Braden and the Braden Q. Recent studies by Gordon and colleagues (2002, 2004a, 2004b) show that neither the Braden Scale nor the Braden Q Scale predicts pressure ulcers in the pediatric burn population. Because of the complexity of pressure ulcer development and the many factors involved in risk assessment, instruments that readily assess and ultimately prevent the problem from

occurring are needed. Unfortunately, the current literature is devoid of research to guide pediatric burn nursing practices in skin risk assessment and pressure ulcer prevention (Gordon, 2004a).

While it is possible to develop new instruments to assess skin risks in the pediatric population, it is necessary that data from these instruments are valid, that is, the data must reflect the construct under consideration (which, in this case, is risk for pressure ulcers). Further, it is important that instruments provide reliable data and consistent measurements each time an assessment is conducted. Ultimately, it is important that the measurements derived from these instruments can be used to predict changes that may occur after the burn injury, and thus prevent pressure.

STATEMENT OF PURPOSE

The purpose of this study was to evaluate the psychometric properties (validity and reliability) of a novel, investigator-developed Pressure Ulcer Skin Risk Assessment Scale (PrUSRAS), which is intended to predict pressure ulcer risk in pediatric burn patients. The specific aims and hypotheses of the study are described below.

Aim 1: To identify the interrater, internal consistency and internal structure estimates of the PrUSRAS.

Hypothesis 1.1: Interrater and internal consistency estimates of the PrUSRAS will be at least 0.70.

Hypothesis 1.2: In a confirmatory factor analysis, the PrUSRAS will show unidimensionality

Aim 2: To determine the ability of the PrUSRAS to predict pressure ulcer development.

Hypothesis 2: In a logistic regression model, the total PrUSRAS score will predict the occurrence of pressure ulcers.

SIGNIFICANCE

Critically ill children are more at risk for pressure ulcer development than the general pediatric population (Curley, 2000; Escher-Neidig, 1989; Hickey, 2000; Schmidt, 1998). However, the literature is devoid of research to guide pediatric burn nursing practices in skin risk assessment and pressure ulcer prevention (Gordon, 2004a). The

potential complications of pressure ulcers in children are numerous and include life-threatening infection, osteomyelitis, pain and disfigurement that may affect the child's body image. To date there have been no instruments to assess burn patients at risk for the development of these ulcers. Therefore, it is essential to provide clinicians and researchers with an instrument to assess risk so that pressure ulcer prevention intervention can be implemented with high-risk pediatric patients and pressure ulcers can be prevented.

If the goals of this research are accomplished, clinicians will have a valid and reliable instrument for use with pediatric burn patients that can be incorporated into daily practices of skin risk assessment and pressure ulcer prevention. Additionally, researchers will have an instrument that can be used in clinical studies for the prediction of skin outcomes in pediatric burn patients as well as a measurement available for examining outcomes in intervention studies. The ultimate clinical impact of the research is to decrease the incidence and prevalence rates of pressure ulcers in pediatric burn patients.

DELIMITATIONS

The scope of the study is defined by time, setting and sample. The study was conducted in 2007 and 2008, which means that the findings of the study are limited to the standard of care of that time. The setting for data collection was in three pediatric Shriners Burn Hospitals, located in Galveston, TX, Cincinnati, OH and Sacramento, CA. Thus, the results are limited to the care provided by these institutions. The instrument was tested in children ranging in age from one day to 18 years. The children were English- and Spanish-speaking, had 1% to 85% burns with some portion of third degree burns and required at least one surgical excision and skin grafting procedure during the initial acute burn hospital stay. These variables set the boundaries for the study.

Definition of Terms

For the purposes of this study, the main variables of interest are defined below.

1) Percentage Total Body Surface Area Burned – Percentage burn as recorded on the Lund and Browder chart at time of admission.

2) Number of splints in place – The total number (simple count) of individual splints held in place with ace wraps during the 24 hours prior to data collection.

3) Prior/current pressure ulcers – Evidence of any previous or current stage pressure ulcer during current hospitalization..

4) Increased prominence of bones – bones that are readily visible in a very thin person.

5) Activity/mobility – Assessment of the patient's level of mobility (fully mobile, partially mobile, and bed rest).

6) Unburned skin exposed to wetness – unburned skin described as wet or moist from perspiration, drainage or wet dressings.

7) Low mean systolic blood pressures – Birth: <1 mos. (< 60 mmHg); 1-12 mos. (<70 mmHg), 13 mos.-10 yrs. (70mmHg + age in yrs x 2); >10 yrs. (<90mmHg).

8) Calorie intake – Based on the previous 48 hours of nutritional intake (tube feeds, TPN, oral foods), the level of calorie intake (i.e., meets > 90% of estimated nutrition needs or < 89% of estimated nutrition needs).

9) Urine or stool in contact with unburned skin – count the number of incontinent bowel and/or bladder episodes during past 24 hours.

10) Validity – "the degree to which an instrument measures what it is intended to measure" (Polit & Beck, 2008).

11) Reliability – "the degree of consistency or dependability with which an instrument measures the attribute it is designed to measure" (Polit & Beck, 2008).

12) Interrater reliability – "the degree to which two raters or observers, operating independently, assign the same ratings or values for an attribute being measured or observed" (Polit & Beck, 2008).

13) Internal consistency – "the degree to which the subparts of an instrument are all measuring the same attribute or dimension, as a measure of the instrument's reliability" (Polit & Beck, 2008).

14) Predictability – "the degree to which an instrument can predict a criterion observed at a future date" (Polit & Beck, 2008).

Acronyms

The following acronyms are used in this study.

1. WOCN - The Wound, Ostomy and Continence Nurses Society
2. AHCPR - Agency for Health Care Policy and Research
3. TEN - Toxic Epidermal Necrolysis
4. ICU – Intensive Care Unit
5. NPUAP - National Pressure Ulcer Advisory Panel
6. PrUSRAS- Pressure Ulcer Skin Risk Assessment Scale

Organization of the study

The remainder of this study is organized into four chapters, followed by appendices and references. Chapter Two presents a review of the literature and an introduction to the major concepts of the study including pressure ulcers, pressure ulcers in children, skin risk assessment scales and evidence-based pressure ulcer prevention strategies. Chapter Three presents the research design and methodology of the study, including an introduction to the purpose and study design, description of the sampling techniques, sample determination and criteria, subject recruitment and consent procedures, data collection, storage and analysis, responsibilities and training procedures. Additionally, study assumptions, supervision of researcher, facility attributes and protection of human subjects are discussed. Chapter Four presents the study findings, while Chapter Five contains a discussion of the findings, summary, conclusions, implications and recommendations for further research.

CHAPTER TWO: LITERATURE REVIEW

INTRODUCTION

This chapter presents the foundational literature for the research study and focuses on pressure ulcer risk assessment as a strategy for prevention of pressure ulcers in the pediatric burn patient. Relevant areas to be addressed include defining pressure ulcers; discussion of pressure ulcers; and a description of the characteristics, causes, complications, costs, and incidence of pressure ulcers in the pediatric population. This chapter will also review literature that details the susceptibility of various patient populations to developing pressure ulcers. Further, current evidence-based practice guidelines for pressure ulcer prevention will be presented as well as the value of using risk scales to predict risk. Finally, this chapter will detail methods of prevention for pressure ulcers, which is an especially relevant issue now that hospital reimbursement to manage nosocomial pressure ulcers is being phased-out.

PRESSURE ULCERS

The National Pressure Ulcer Advisory Panel (NPUAP, 2007) defines pressure ulcers as "localized injury to the skin and/or underlying tissue usually over a bony prominence, as a result of pressure, or pressure in combination with sheer and/or friction". In this study, the NPUAP redefined the original four stages of pressure ulcers and added two stages of deep tissue injury (NPUAP, 2007). These stages are described as stages I, II, III, IV, suspected deep tissue injury and unstageable. *Stage I* is best described as a localized area over a bony prominence and includes intact skin that has non-blanchable redness. Individuals with dark pigmentation may not have blanching but may show a difference in the color of the skin surrounding the area. *Stage II* ulcers, on the other hand, present as shallow open ulcers with a red or pink wound bed and with sloughing. Partial thickness loss of the dermis is evident, and some individuals may have intact or ruptured serum-filled blisters. Individuals with *Stage III* ulcers present with full

thickness tissue loss and may show subcutaneous fat; however, bone tendon or muscles are not exposed. Moreover, while sloughing may be present, it does not obscure the depth of tissue loss, although undermining and tunneling may be present. *Stage IV* ulcers may present with sloughing or eschar and will have full-thickness tissue loss with exposed bones, tendon or muscles; undermining and tunneling are also evident. Individuals with *Suspected Deep Tissue Injury* will have purple or maroon localized areas of discolored intact skin or blood-filled blisters due to damage of underlying soft tissue from pressure or shearing. The suspected area may be preceded by tissue that is painful, firm, mushy, boggy, warmer or cooler when compared to adjacent tissue. *Unstageable Injury* consists of full thickness tissue loss in which the base of the ulcer is covered by slough (yellow, tan, gray, green or brown) or eschar (tan, brown or black) in the wound bed.

Along with these definitions, researchers (basic scientists as well as nurse scientists) have examined the attributes of pressure and its effect on skin integrity. These attributes include duration, location, intensity, and tissue tolerance, with bony prominence (e.g., heels, sacrum, occiput, elbows) being more prone to ulcer development.

Attributes of Pressure Ulcers in Basic Science Literature

The general consensus is that pressure ulcers result from conditions that reduce blood flow to an area of skin. One provocative study showed that increases in skin blood flow, as well as the lack of blood flow, may determine whether a pressure ulcer occurs. Herrman et al. (1999) examined the relationship between the magnitude of surface pressure and skin perfusion in the development of pressure ulcers in a rat model. Skin perfusion was measured as a function of increasing skin surface pressure and pressure ulcer formation. Force was applied to the greater trochanters of the animals with the application of long-term pressure for 5 hours. The skin perfusion response to pressure was divided into 5 stages. Stage 1 had an initial increase in perfusion followed by decreasing perfusion as surface pressure continued to increase (surface pressure increased in 3.7 mmHg increments). The maximum point of skin perfusion (14 mmHg) was labeled Stage 2, the minimum value of perfusion (no perfusion), ~58 mmHg, was designated as Stage 3. After zero perfusion was established, the surface pressure was rapidly decreased

to the initial level of pressure (3.7 mmHg), which resulted in a reactive hyperemic response three times greater than the control. Maximum perfusion during the hyperemic response was Stage 4. The final stage, Stage 5, occurred after the recovery period and after the return of a steady state of skin perfusion. Skin temperature was monitored during the experiment and found to gradually increase from the beginning of the control period through the pressure application phase. After the pressure was released, the temperature decreased about 1°C as perfusion recovered. The ischemic-induced changes in perfusion suggest compromised vasodilator mechanism(s). The potential implication of this study in clinical practice is the detectable changes in skin perfusion and how they affect a nonblanchable erythema Stage1 pressure ulcer (i.e., healing or becoming a deeper pressure ulcer).

Although numerous factors have been linked to pressure ulcer formation, the most important is unrelieved pressure (Defloor, 2000; Herrman et al., 1999; Stinson et al., 2003). Both low and high pressures can lead to pressure ulcer development, depending on the duration of the pressure. Seminal animal studies have described inverse parabolic relationships between pressure and time. Specifically, high pressure exerted over short periods of time and lower pressures over longer periods of time can lead to deep tissue damage (Kosiak, 1959). Stinson et al. (2003) note that other researchers suggest that any load greater than 32 mmHg is harmful because it occludes capillary blood flow. However, (Springle, 2000) emphasizes that 32 mmHg is a misinterpretation of a 1930 study by Landis (Stinson et al., 2003), and that no specific threshold has been established as harmful. Stinson et al. (2003) investigated the relationship between interface pressure and gender as well as body mass index (BMI) and seating positions, and found a positive correlation between average pressure and BMI, but no correlation between average pressure and height or weight. Likewise, they found no link between gender and pressure ulcer development nor was there a correlation between pressure and BMI categories. There was, however, a reduction in the average interface pressure when the seat was reclined by 30° and the feet elevated on a stool. In summary, it is accepted that pressure monitoring at the interface is an important assessment parameter.

Pressure ulcers occur most often over bony prominences covered only by a small amount of muscle and subcutaneous tissue (Kosiak, 1959). If the tissue interface pressure over bony prominences is held at a constant force (i.e., the patient's weight), the pressure can significantly increase as the area of actual support decreases. Thus, pressures over bony prominences are high because of the small area over which the force is applied. Pressure at this point is more damaging to tissue than a force of identical magnitude over a larger area of the body. Recognizing that bony prominences are high-risk areas for pressure ulcer development, Edsberg et al. (2000) evaluated the micro-structural effects of static versus cyclic pressures on normal skin. Edsberg found that the alignment of the connective tissue bundles parallel to one another and parallel to the compressed surface could suggest the beginning of matrix breakdown, which can lead to a pressure ulcer. Additionally, tissue at or adjacent to Stage IV pressure ulcers (long term) is micro structurally and mechanically different from healthy tissue (Edsberg et al., 2000).

Detecting changes in skin color, e.g., nonblanchable erythema with Stage 1 pressure ulcer, in darkly pigmented skin has been a concern in clinical practice for many years. Tissue reflectance spectroscopy (TRS) has been used successfully to characterize the presence of erythema due to reactive hyperemia (Matas et al., 2001; Riordan et al., 2001). The clinical impact of TRS to detect erythema (tissue tolerance to pressure) in people with different skin pigment levels is important because it will allow timely interventions to prevent progression of the Stage 1 pressure ulcer.

Prevention of pressure ulcers has not led to a significant reduction of the problem, partly because of the limited fundamental knowledge related to the etiology of pressure ulcers (Bouten et al., 2003). Thus, prevention and risk assessment techniques are primarily outdated, misinterpreted, based on small amounts of data and largely subjective. Some animal studies, researchers suggest that pressure ulcers can develop (Bouten et al., 2003) either superficially or from within the deep tissue, depending on the nature of the surface loading. The superficial ulcers form on the skin, with maceration and separation of superficial skin layers. Deep ulcers arise in deep muscle layers covering bony prominences and are mainly caused by unrelieved pressure. The deep ulcers develop at a faster rate and yield more tissue damage, and by the time a deep pressure ulcer becomes visible, the window for clinical intervention has passed. While we know

deep ulcers occur, the underlying pathways whereby mechanical loading leads to tissue breakdown are poorly understood. It is not clear how global, external loading conditions are transferred to local stresses inside the tissues, or how this ultimately leads to tissue breakdown. One interesting observation is that surface pressures are not representative of the mechanical conditions inside the tissue. More research is needed to understand the pathophysiology of mechanical loading and tissue breakdown before successful interventions in clinical practice can be identified (Bouten et al., 2003).

In summary, the basic science literature describes the defining attributes of pressure to be duration, intensity and location of pressure. The effects of pressure on the skin depend on interface pressures, skin perfusion and tissue tolerance of the skin.

Attributes of Pressure Ulcers in Nursing Literature

A conceptual schema for two major factors responsible for pressure ulcer development was designed by Braden and Bergstrom (1987). The schema identifies 1) the intensity and duration of pressure; and 2) the tolerance of the skin and its supporting structure as the primary contributors to pressure ulcer development (Braden & Bergstrom, 1987). A 20% prevalence rate of pressure ulcers in mechanically ventilated patients in a medical ICU was found, but there was no relationship to perfusion (e.g., mean arterial pressures, heart rate, urinary output) or oxygenation (arterial blood gases). This population suffered from impaired mobility, increased risk for infection and poor nutritional status. The nursing implication of this study is that mechanically-ventilated patients are at a higher risk for developing pressure ulcers.

Patients with impaired circulation due to immobility are at a greater risk for developing pressure ulcers (Moody et al., 2004). Capillary closing pressure has been established at 32 mmHg in healthy adults. A standard hospital mattress has an interface pressure of 100 mmHg, which can occlude capillaries even in healthy adults. The primary goal of pressure ulcer prevention is the removal or reduction of pressure to the skin, thus allowing for increased blood flow to the area. The principle behind the use of pressure relief mattresses is to diffuse the pressure load at the site where the body comes in contact with the supporting surface. Defloor (2000) measured the interface pressures of 62

healthy volunteers on two different mattresses and in 10 different positions. The 30° semi-fowlers position caused the lowest pressure on both mattresses. The 90° lateral positions caused the greatest pressure on both mattresses. He found that a polyethylene-urethane mattress reduced interface pressure up to 30% in comparison with a regular mattress. The implications of this study are that the type of mattress, position in bed, and turning interventions affect blood flow to pressure points in contact with a mattress.

A study by Sae-Sia et al. (2005) with neurologically impaired patients provided evidence that elevated temperature (Ts) in the sacral area is related to pressure ulcer development. The study offers two possible mechanisms: 1) prolonged pressure between bony prominences and support surface can occlude blood flow, leading to tissue hypoxia, ischemia, tissue inflammation and local elevations in skin temperature; and 2) convective heat accumulation between the bony prominence and support surface can increase skin temperature. Thus, it is possible to hypothesize that elevated temperature in the sacral area may be an early indicator of pressure ulcer development.

Differences in response to short-term pressure loading of skin have also been reported. Tissue sites with greater resting levels of blood flow might be at a greater risk of breakdown when weighted to levels that significantly decrease blood flow (Mayrovitz et al., 2002).

In summary, the nursing literature describes the defining attributes of pressure to be interface pressures, blood flow and elevated skin temperature. Also, the position of the patient in bed and the contribution of the illness and treatment to the risk status are attributes of tissue tolerance to pressure. It is interesting that both basic science and nursing literature identify the same attributes, but discuss them from divergent perspectives.

POPULATIONS CONSIDERED HIGH RISK FOR PRESSURE ULCER DEVELOPMENT

It is important to know whether a patient is at risk for developing pressure ulcers so that preventive interventions can be implemented early enough to avoid the occurrence of a pressure ulcer. Patients may be high risk for pressure ulcer development due to a specific disease entity or they may have certain risk factors (Pallija et al., 1999). The populations considered to be high risk for the development of pressure ulcers include the chronically sick and terminally ill, patients receiving mechanical ventilation (Pender, 2005), the elderly patients with amputations, recent fracture, multiple trauma, spinal cord injuries and strokes (Allman et al., 1995; Baggerly & DiBlasi, 1996; Berlowitz & Wilking, 1989; Ross & LaPluma, 1990). Frequently, pressure ulcer concerns have been relegated to the geriatric population or patients with mobility problems (Allman et al., 1995; Berlowitz & Wilking, 1989; Bergstrom & Braden, 1992; Fritsch et al., 2001; Meehan, 1994). Burn patients are not typically described in the literature as being at high-risk for the development of pressure ulcers. However, patients with burn injuries may be at a higher risk for the development of pressure ulcers for reasons beyond those usually associated with other patient populations because of the pathophysiology of the burn injury and the requirements of managing post-operative skin grafts. Characteristics of adult burn patients who develop pressure ulcers include those who have a major burn injury, those who had concurrent injuries or an infectious process, those who had several surgical procedures and those who are older (Fritsch et al., 2001).

Critically ill children are more at risk for pressure ulcer development than the general pediatric population (Curley, 2000; Escher-Neidig, 1989; Hickey, 2000; Pallija et al., 1999; Schmidt, 1998; Zollo et al., 1996). For example, children with myelomeningocele and spinal cord injury were found to have high rates of skin breakdown (Hickey, 2000; Okamoto et al., 1983). Likewise, diagnoses of extreme prematurity, severe allergic reaction, acute debilitating illness, failure to thrive and head injury are also known to increase the risk of pressure ulcer development (Pallija et al., 1999). These diagnoses may be further compromised by high risk factors such as uticaria, obesity, edema, trauma, surgical incisions, paralysis, insensate areas, immobility, poor nutrition, incontinence, decreased consciousness levels and impaired cognition (Pallija et al., 1999; Samaniego, 2004; Willock, 2005; Willock et al., 2007). Furthermore, it is

known that pediatric patients after cardiac surgery are especially prone to ulcer development if they are less than 36 months of age, have ventricular septal defect repairs, are intubated for more than 7 days or have an ICU stay more than 8 days (Escher-Neidig, 1989). Other pediatric populations thought to be as risk for ulcer development, especially occipital pressure ulcers, are children and neonates supported by extracorporeal membrane oxygenation (ECMO) or with hypoxia-hypoperfusion not supported by ECMO (Gershan & Esterly, 1992). In essence, any disease, surgical or medical procedure or risk factor that causes inactivity or immobilization predisposes children to pressure ulcer development.

Physiology of the Burn Injury and Its Relationship to Pressure Ulcers

Burn-injured patients have many risk factors that predispose them to the development of pressure ulcers. Initially, hypovolemic shock occurs as blood flow is shunted away from the skin to preserve vital organ function. Additional injuries, such as inhalation injury, requiring intubation and use of paralytic agents to manage the airway may add to the increased risk for pressure ulcers. As fluid resuscitation is begun, massive edema in both burned and unburned areas may occur. The edema is maximized at about two to three days post-burn, which also decreases the blood flow to the skin and adds weight to all parts of the body.

Maintaining systemic hydration can continue to be a problem long after the patient has received adequate resuscitation for burn shock. Continued fluid therapy to replace fluid loss through the burn wound is essential. If systemic hydration is not maintained, even normal skin may be at risk for pressure ulcers. To complicate this situation, the quantity of fluid lost through the burn wound may increase the moisture on normal skin adjacent to the burn wound. This moisture may cause the normal skin to break down and predispose the skin to further compromise.

Many burn-injured patients will make repeated trips to the operating room for surgical excision of the burn wound and grafting, with graft taken from unburned areas. These procedures may require the patient to be anesthetized for long periods of time. Patients are at risk for pressure ulcers in the operating room, which necessitates the use of

pressure-reducing devices. Likewise, during these operative procedures the patient may lose large quantities of blood or may develop hypovolemic/septic shock, resulting in decreased tissue perfusion. Vasopressors, antibiotics and fluid resuscitation are the usual treatment for septic shock. The low flow states and the use of vasopressors may also result in decreased tissue perfusion and increased risk of pressure sore formation.

Post-surgery, the burn patient is often immobilized with large bulky wet dressings and splints to protect the graft. These dressings need to be applied with enough pressure to stop the bleeding from the grafted wound and the donor site. But if the dressings are applied too tightly, or if edema develops after dressing application, the pressure from the dressings may cause increased pressure on the skin.

Throughout the acute phase of care, the burn patient is predisposed to pain and anxiety. Pain and fear of pain cause patients to lie still. Patients are medicated frequently to control background pain, but at the same time encouraged to change positions while lying in bed. Patients must avoid being overmedicated because it can cause them not to recognize the uncomfortable sensation of pressure when lying in the same position.

Soaks are used frequently to maintain moisture in the grafted wound and to aid in decreasing wound colonization with bacteria. Contact of this moisture with adjacent normal skin may increase the risk of tissue breakdown.

Inadequate nutrition prior to or after the burn injury may pose another significant problem. The hyper metabolic response in the burn injured patient leads to protein malnutrition if caloric intake is compromised. Enteral hyperalimentation is most frequently used to reduce the risks of systemic infection and to promote wound healing, , so the patient is fed by nasogastric or nasojejunal tubes.

In summary, the physiology of the burn injury combined with many of the therapies and treatments during hospitalization impacts burn patients' risk for pressure ulcers. Burn patients are among the high-risk populations for pressure ulcer development.

Complications of Pressure Ulcers

Complications of pressure ulcers in adults can be devastating to the patient and family. The most common complication is infection, which may, depending on the severity, cause sepsis, osteomyelitis and even death (AHCPR, 1992, 2000). Potential

complications of pressure ulcers in children are numerous and include life-threatening infection, osteomyelitis and death in addition to pain and disfigurement that may affect body image. A variety of surgical options may be necessary to achieve wound closure for pressure ulcers Stage III or greater (Ratliff & Rodehaver, 1999).

The existing literature describes the magnitude of the pressure ulcer problem in adults; but little attention has been paid to the problem in children. The number of adult patients who have pressure ulcers is estimated to be 1.3 – 3 million, and 60,000 of these patients die each year from hospital-acquired pressure ulcers. The cost of treatment is $500 to $40,000 per ulcer, and the total cost for treatment of pressure ulcers in the United States is estimated at $11 billion per year (Duncan, 2007). Hospital-acquired pressure ulcers can be a costly condition requiring medical intervention. On February 8, 2006, President George W. Bush signed the Deficit Reduction Act (DRA) of 2005. Section 5001 (c) of the DRA requires the Secretary of Health to identify, by October 1, 2007, at least two conditions that (a) are high cost or high volume or both, (b) result in the assignment of a case to a DRG that has a higher payment when present as a secondary diagnosis, and (c) could reasonably have been prevented through the application of evidence-based guidelines. Several conditions were selected, including pressure ulcers. This Act impacts how the Center for Medicare and Medicaid Services will reimburse hospitals. For discharges occurring on or after October 1, 2008, hospitals will not receive additional payment for cases in which one of the selected conditions was not present on admission. That is, the case would be paid as though the secondary diagnosis (pressure ulcer) were not present. Due to the new reimbursement legislation and Medicare's subsequent refusal to pay hospitals for nosocomial pressure ulcers, hospitals are beginning to focus on pressure ulcer prevention. Prevention begins with assessment of the patient's risk for pressure ulcer development.

Incidence of Pressure Ulcers in Children

Minimal information exists about the magnitude of the pressure ulcer problem in children (Baldwin, 2002). In fact, Baldwin (2002) reports that pressure ulcers in children are presumed to be uncommon and that no general incidence or prevalence data can be found in the literature. However, pressure ulcers do occur in pediatric patients,

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particularly in burned children (Tables 2.1 and 2.2). The most common location for pressure ulcers in children is the occiput, which is the largest bony prominence in the child's body (Escher-Neidig, 1989; Huffiness & Lodgson, 1997; Willock et al., 2000). Pressure ulcer incidence rates from acutely ill pediatric populations were reported at 0.29 – 27% (Baldwin, 2002; Dixon & Ratliff, 2005; Escher-Neidig, 1989; Quigley & Curley, 1996; Schmidt, 1998; Zollo et al., 1996). Pressure ulcers in some special populations of children (e.g., open heart surgery, myelomeningocele) have been studied more than others (Escher-Neidig, 1989; Okamoto et al., 1983; Samaniego, 2004). For example, Samaniego (2004) reported a 14.6% incidence of pressure ulcers in the outpatient pediatric population with the diagnosis of myelodysplasia. Pallija et al. (1999) reported alarming pressure ulcer incidence rates of 20% – 43% in children with spina bifida and spinal cord injuries. However, all of these studies report the limitation of small sample sizes, which prevents generalization of the findings.

In 2007, 500,000 people with burn injuries received medical treatment; 25,000 of these patients were admitted to hospitals with specialized burn centers (ABA, 2007). The cause of the burn injury was 46% fire/flame, 32% scald, 8% hot object contact, 4% electrical, 3% chemical, and 6% other (ABA, 2007). Burn patients typically are middle-aged individuals (48.2%) or pediatric patients (34.5%) in previously good states of health (Saffle et al., 1995). Geriatric populations in burn centers are relatively low, averaging approximately 6% or less (Saffle et al., 1995). Although the incidence of pressure ulcers in adult burn patients is reported as 4.1% (Fritsch et al., 2001), no national statistics are available on the incidence of pressure ulcers in the pediatric burn patient.

The Shriners burn pressure ulcer study group (located in Galveston, Texas, Cincinnati, Ohio, and Sacramento, California) represents the burn service line of patients treated at Shriners Hospitals. They have studied pressure ulcer prevalence and incidence rates during the past 3 years (Tables 2.1 and 2.2). Point prevalence rate is the total number of cases of a disease in a given population at a specific time (American Heritage Medical Dictionary, 2007). Pressure ulcer point prevalence rates are performed the same point in time (certain day of each month). The period prevalence rate is the average of the monthly point prevalence rates during the 12 months. The incidence rate is the rate of

new cases of a disease in a specified population over a defined period (Mosby's Medical Dictionary, 2009).

Table 2.1. Period Prevalence Rates in Three Burn Shriners Hospitals by Site

Sites	2005	2006	2007
Galveston Burn	53.3%	16%	32%
Sacramento	9.5%*	9.8%	16%
Cincinnati Burn	21.1%	13%	10%

*Sacramento 2005 included 6 months

Table 2.2. Pressure Ulcer Incidence Rates in Three Burn Shriners Hospitals by Site

Sites	2005	2006	2007
Galveston	30%	13%	11%
Sacramento	8%*	3%	4%
Cincinnati	9%	36%	2%

*Sacramento 2005 included 6 months

In summary, the rates of burn pressure ulcer are high, and because these Shriners hospitals treat the majority of all pediatric burn patients in the U.S., there is a need for more research to identify evidence-based practice interventions to reduce pressure ulcer rates, which will in turn benefit all critically-ill patients.

Zero Tolerance for Pressure Ulcers/Excellence in Clinical Practice

Maintenance of skin integrity is a clinical indicator of quality nursing care. Absence of pressure ulcers is used as a benchmark for quality improvement that enables hospitals to identify best clinical practices for improved clinical outcomes. These incidence rates have also become one of the Joint Commission 2007 National Patient Safety Goals (Joint Commission, 2007) to prevent health care-associated pressure ulcers. The Joint Commission recommends that health providers assess and reassess each patient's risk for developing a pressure ulcer and take action to address any identified

risks. It is important to know at risk and what factors place them at risk. Pressure ulcers continue to be problematic in all heath care settings; an effective plan for the prediction, prevention, and early treatment of pressure ulcers is recommended.

Pressure Ulcer Prevention

Most of the prevention interventions for pressure ulcers in children have been extrapolated from adult studies, which were not intended to guide pediatric clinical practice (Baharestani & Ratliff, 2007; Zollo et al., 1996). In fact, use of adult protocols and products for pediatrics raises serious clinical concerns in addition to questions about the safety and effectiveness of the practice (Baharestani & Ratliff, 2007). The AHCPR has published 25 recommendations (AHCPR, 1992, 2000) to prevent pressure ulcer development. Only two interventions had been determined to have good research evidence. One intervention is the use of skin risk assessment scales for identifying patients who are at risk for pressure ulcer development. The second recommendation is to protect against the adverse effects of external mechanical forces such as: pressure, friction and shear. Any individual in bed who is assessed to be at risk for developing pressure ulcers should be repositioned at least every 2 hours if consistent with overall patient goals. A written schedule for systematically turning and repositioning the individual should be used (AHCPR, 1992, 2000; WOCN, 2003).

According to the National Pressure Ulcer Advisory Panel (NPUAP, 1989), risk assessment is an important component of any program to reduce pressure ulcer incidence and prevalence rates. As part of the Institute of Healthcare Improvement's *5 Million Lives Campaign*, prevention of pressure ulcers is one of the 12 interventions to protect patients from medical harm in hospitals from December 2006 and December 2008 (IHI, 2006). Their recommendations include two major steps: identifying patients at risk and reliably implementing prevention strategies for all patients identified as at risk.

The Joint Commission (2006) added a new National Patient Safety Goal in 2006 referred to as pressure ulcer prevention. The Commission recommends using a validated risk assessment tool such as the Braden or Norton scale to identify patients who are at risk for developing pressure ulcers.

A recent meta-analysis of nine studies reported a significant decrease in the pressure ulcer incidence/prevalence rates after implementation of a policy of risk assessment (Comfort, 2008). The Braden scale (Bergstrom, 1987) was implemented on all new adult admissions followed by a pressure relief intervention, i.e., specialized support surfaces. Investigators also reported cost savings due to a decreased need to rent expensive beds, yet the Braden scale has not proven effective for pediatric patients.

Skin Risk Assessment Scales

Risk assessment scales have provided a means of improving the identification of patients who are at risk for pressure ulcer development (Abruzzese, 1985; Gosnell, 1973; Moolten, 1972). The Wound, Ostomy and Continence Nurses Society (WOCN) published the current guidelines for prevention and management of pressure ulcers (2003). Many of the guidelines in the WOCN publication were also in the original Agency for Health Care Policy and Research (AHCPR) guideline publication (1992, 2000). The recommendations from both agencies are to use a skin risk assessment scale to identify patients who are at risk for pressure ulcer development.

The development of skin risk assessment scales is intended to capture factors that comprise the risk for pressure ulcer development. The scales should be easy to use and contain predictive qualities with high sensitivity and specificity. The two most popular skin risk assessment scales today are the Braden (adult scale) and the Braden Q (pediatric scale). The Braden scale was developed for the adult population and has six subscales: mobility, activity, sensory perception, skin moisture, friction and shear, and nutrition. The lowest score for each item is 1, which indicates high risk for pressure ulcer development. The highest score for each item is 3 or 4, which indicates low risk. The cutoff score for high risk in acutely ill adult patients, is 16-18 (Bergstrom et al., 1987). When compared to the Norton and Waterlow scales (also adult scales), the Braden scale has higher sensitivity and specificity (Pang & Wong, 1998). Nonetheless, none of the scales has sufficient predictive validity and reliability (Papanikolaou et al., 2007).

Ten pediatric pressure ulcer risk scales are identified in the literature (Bames, 2004; Bedi, 1993; Curley et al., 2003; Garvin, 1997; Huffiness & Lodgson, 1997; Olding & Patterson, 1998; Pickersgill, 1997; Quigley & Curley, 1996; Waterlow, 1998; Willock

et al., 2007). Quigley and Curley (1996) adapted the Braden scale for use in the acute care pediatric setting. The Braden Q scale consists of seven subcategories: six categories from the Braden scale and one new category: tissue perfusion and oxygenation. The definitions of the six categories from the Braden scale were altered to reflect pediatric criteria for scoring. The scoring of the items in the Braden Q is the same as Braden: the lower the total score, the higher the risk for pressure ulcer development. A total cutoff score of 16 on the Braden Q also represents high risk for pressure ulcer development. The sensitivity of the Braden Q was reported to be 83%, and its specificity was 58% (Quigley & Curley, 1996). Studies by Gordon and colleagues (Gordon et al., 2002; Gordon et al., 2004b) indicate that neither the Braden Scale nor the Braden Q Scale predicted risk for pressure ulcers in the pediatric burn population. The literature highlights the complexity of pressure ulcer development and the myriad factors involved in the risk assessment. Perhaps because of the complexity of the issue, there is a dearth of research to guide pediatric burn nursing practices in skin risk assessment and pressure ulcer prevention (Gordon et al., 2004a).

Each risk assessment scale has unique risk factors, although some of the same risk factors are common in other scales. In some cases the description of the risk factor is unclear and difficult to understand (Papanikolaou et al., 2007). A common risk factor, like nutrition, is defined differently by each risk scale (Haalboom et al., 1999). Ayello and Lyder (2007) point out that the total risk assessment score is the only indication of high risk, but that pressure ulcer prevention can be targeted for a patient with a low score on any risk factor. The majority of scales tend to over-predict risk, which, it should be noted, is better than under-predicting risk (Bolton, 2007); there is disagreement in the literature regarding the recommended high risk cut-off scores with the Norton, Waterlow and the Braden scales (Papanikolaou et al., 2007)

Some investigators report that there has not been enough randomized control trials to support the use of any risk scale, and that none are any better than clinical judgment alone (Cullum et al., 1996; Papanikolaou et al., 2007). Others suggest that pressure ulcer risk assessment is abstract and complex and is not a direct measurement technique, and therefore not recommended (Balzer et al., 2007). There are many factors associated with pressure ulcer development, and although they are closely related, it is

nearly impossible to determine the magnitude of the contribution for each risk factor. The risk scales used today have an equal weighting technique, which is the simplest approach, but they lack consideration that some risk factors are more important than others, and therefore should contribute more to the overall risk (Papanikolaou et al., 2007).

Published research on the predictability of the different scales lacks discussion of the standards of care utilized in the study, which makes it difficult to distinguish whether the applied preventive measures are effective, or if the predictive validity of the risk scale decreased (Defloor et al., 2005). Some clinicians support a simpler approach to risk assessment by using a valid screening tool to identify risk for pressure ulcers. The screening tool would contain risk factors that are linked to the pathophysiology of pressure ulcers: restricted mobility, shear, and friction (Dijkstra et al., 1996). Once risk has been identified, a holistic individualized prevention plan could be put in place to meet the needs of each particular patient.

Today, the standard of care is to use a risk assessment scale to target patients who are at risk for pressure ulcers and implement prevention strategies, preferably evidence-based. Selection of a risk assessment scale should be based on whether the scale captures risk in target patient population. The initial risk assessment should be done on admission and the assessment should be repeated on a regular basis. The recommended frequency of reassessment depends on the setting and condition of the patient, although there is no valid and reliable instrument to make these assessments in the pediatric burn patient.

Because of this obvious need for such an instrument for these patients, a pressure ulcer skin risk assessment scale (PrUSRAS) was developed by Shriners Hospital nurse researcher, Mary Gordon (Principle Investigator), to assess risk for pressure ulcers in the pediatric burn patient. The purpose of this current study is to evaluate the validity, reliability and predictability of that scale in order to provide context and clarity of the current study, outcomes on the development of the instrument up to the point are described.

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Development of Pediatric Burn Pressure Ulcer Skin Risk Assessment Scale (PrUSRAS)

The PrUSRAS instrument was developed in 2005 by a group of Shriners Hospital burn nurses through the help of a multicenter research grant funded by Shriners Hospital. The nurses were from three Shriners burn units: Galveston, TX, Cincinnati, OH, and Sacramento, CA. The project began by sending a letter to each nurse member of the American Burn Association to explain the project and ask nurses with experience in pediatric burn nursing to apply for membership on the Expert Panel. The letter provided instructions for the nurse to visit a web site and answer the Professional Practice Survey questions. Twenty-two nurses responded to the letter. Selection of nurses for the panel focused primarily on years of nursing experience, level of nursing education and research experience. The expert panel was composed of 15 pediatric burn nurses. The panel of experts successfully generated risk factors for pressure ulcer development in pediatric burn patients by participating in 3 rounds of a modified Delphi research technique.

The modified Delphi research technique began with a list of risk factors compiled from the literature and the investigators' clinical experiences. The Delphi technique consisted of 3 sequential web-based surveys sent to the panel of experts.

The Burn Panel of Experts identified risk factors associated with pressure ulcer development in the pediatric burn patients through the Modified Delphi research technique. Six of the 17 major variables had a mean score of 6.50 or higher. These were immobility (6.9), burn injury 40-59% TBSA (6.6), burn injury 60-79% TBSA (7.0), burn injury >80% TBSA (7.0), unrelieved external pressure (6.9) and lack of adequate nutritional and fluid and electrolyte management (6.5). Nine of the 66 minor variables had a mean score of 6.50 or higher. The nine minor variables included: burn injury (6.5), unconsciousness (6.5), inhalation injury (6.5), sepsis (6.6), increasing prominence of bones (6.6), inappropriate application of splints, wraps, or orthotic devices (6.8), failure to meet caloric needs for age and condition (6.5), skin maceration due to wetness and chemical irritation (6.6) and chemical paralysis (6.5). Consensus was reached among the research team to combine three ranges of percentage burn variables and one minor variable (burn injury) into one, which was the actual percent burn injury on the risk scale. Immobility was another major category that had other categories collapsed into it:

unrelieved external pressure, unconsciousness, chemical paralysis and inhalation injury, since immobility is the outcome of each variable. Inappropriate application of splints was changed slightly due to the difficulty of the determining this factor. The increased risk of splint application is determined by assessing the total number of splints in place on the patient. The more splints applied to the patient, the higher the risk of pressure ulcer. Another difficult variable to assess and quantify was sepsis. Therefore, the consensus of the team was to capture the sepsis variable with blood pressure changes reflect sepsis. Failure to meet caloric needs for age and condition was combined with lack of adequate nutritional and fluid and electrolyte management. Bowel and bladder incontinence, unburned skin exposed to wetness and increased prominence of bones were variables maintained by the team. Prior or current pressure ulcer also was added to the burn risk scale. Therefore, the final Burn PrUSRAS had nine risk factors for pressure ulcers (Appendix 1).

The PrUSRAS pilot was tested by two nurses who assessed 20 pediatric patients for the intraclass correlation (ICC). The results are included in Tables 2.3 and 2.4.

Table 2.3   Intraclass Correlation 1

	Burn ($n = 20$)	
Score	*Ave.*	*Single*
TOTAL	1.00	.99
Sub1	1.00	1.00
Sub2	.92	.86
Sub3	1.00	1.00
Sub4	.96	.94
Sub5	.65	.48
Sub6	.88	.78
Sub7	.84	.73
Sub8	.58	.41
Sub9	.85	.73

Note: "Ave." ICC refers to the interrater reliability of two raters combined. "Single" ICC refers to the reliability of one nurse.

Assuming a minimum acceptable ICC of .80, five of the burn items were unacceptable (#5 activity/mobility, #6 unburned skin exposed to wetness, # 7 number of low systolic blood pressures in past 24 hours from right now, # 8 calorie intake, # 9 urine or stool in contact with unburned skin).

Researchers from the three burn hospitals revised the five items and worked to improve clarity of the categories (Appendix 2). Another round of reliability assessment (ICC) was performed on the revised scale, with two nurses assessing 20 patients with the five revised items on the scale. The results are as follows:

Table 2.4   Intraclass Correlation 2

Score	Burn ($n = 20$)	
	Ave.	*Single*
TOTAL	.99	.98
Sub5	1.00	1.00
Sub6	1.00	1.00
Sub7	1.00	1.00
Sub8	.95	.90
Sub9	1.00	1.00

After the pilot of the revised instrument, the researchers decided that PrUSRAS was a reliable instrument and ready for further psychometric evaluation.

Testing Instruments

The reliability and validity indicators assess the performance of a scale. Reliability is the consistency of the measurement technique. Intraclass correlation (ICC) is an estimation of interrater reliability, while internal consistency provides insight into the internal structure of an instrument. Validity is the degree of accuracy with which the instrument measures the concept, i.e., risk for pressure ulcer development. Sensitivity (the ability of the scale to predict those patients who will get pressure ulcers), specificity (the ability of the scale to predict those patients who will not get pressure ulcers) and

predictability are measures of validity (Burns & Grove, 2003). It is interesting to note that pressure ulcer prevention strategies employed when based on a high risk score actually impact the sensitivity and specificity data of the risk scale, particularly if the strategies prevent a pressure ulcer from occurring. Therefore, the recommendation by DeFloor is to include a discussion of the prevention strategies in articles that are written to describe the psychometrics of the scale (Defloor et al., 2004).

Summary

This chapter outlines the literature as it relates to pressure ulcers in adults and children and the potential impact of these ulcers on the health outcomes of these patients. Special attention was given to the need for excellence in clinical practice, with the need for the ability to assess development of ulcers as the cornerstone. While there are several scales that are used with assessment of pressure ulcers, especially in adults, there are no scales that accurately measure pressure ulcer development in the pediatric burn patient, thus the need to develop such an instrument. The steps used in developing the items for the current instrument are discussed. The next chapter describes the design, methods, sample and the procedures for data collection. In addition, the strategies for data analysis are outlined for testing the validity, reliability and predictability of the instrument.

CHAPTER THREE: RESEARCH DESIGNS AND METHODS

This chapter describes the research design, sampling methods, data collection and data analysis procedures for this study. Limitations and assumptions are also addressed.

This study is part of a larger multicenter nursing research project funded by Shriners Hospitals Tampa, 2004-2005 and 2007-2008. During the initial phase of the multicenter study in 2005, the investigator and nursing research colleagues used a panel of experts in pediatric burn nursing to develop a new pressure ulcer skin risk assessment scale (PrUSRAS) for the pediatric burn patient. The current research project investigated the psychometric properties of the scale by assessing the reliability and validity of the scale and its ability to predict pressure ulcers in pediatric burn patients. Details regarding the multicenter study and the development of the PrUSRAS are described in this chapter.

METHODS

Design

A quasi-experimental predictive correlation design was used to examine the type and strength of relationships between nine risk factors and the occurrence of pressure ulcers in pediatric burn patients. The primary intent of this type of design is to explain the nature of the relationships, not subscribe a cause and effect. In addition, the design is used to improve the precision of measurement and to refine explanatory knowledge for nursing practice (Burns, 2007).

Setting and Sample

The settings for this multicenter study were three pediatric burn intensive care units: Shriners-Galveston, TX, Shriners-Cincinnati, OH, and Shriners-Sacramento, CA. At the time the study was conducted, each burn center was adjacent to a large university teaching hospital. Each hospital was comparable in the number of acute burn ICU beds

and the number of pediatric burn patients admitted annually. Each hospital admitted approximately 250-350 acute pediatric burn patients annually.

Recruitment of Subjects

A power analysis for a logistic regression model with a large effect (odds ratio = 4.75), .50 standard deviation, alpha of .05, and power of .80 showed a minimum required sample N = 68 (Owen, personal communication, July 12, 2007). A power analysis for the confirmatory factor analysis was 160 patients; therefore the sample size for all analyses was 160 patients.

A convenience sample of 163 acutely injured pediatric burn patients, ages 2 months to 18 years, was recruited from the Shriners Hospitals—Galveston, Cincinnati and Sacramento. Convenience sampling technique is used when subjects are not or cannot be randomized to groups or to treatment. The convenience sample in this study consisted of acutely burned patients admitted to one of the three burn hospitals. Without randomization, convenience sampling is considered the weakest form of sampling because it has a greater risk for bias. To decrease the potential sampling bias, all acutely burned children in each hospital were approached and given the same opportunity to enroll in the study.

The principle investigator recruited acute burn patients admitted to the burn intensive care unit at Shriners Hospital-Galveston after obtaining oral consent from parents or guardians and assent from children (7 years and older). Oral assent was approved from the IRB UTMB since skin risk assessment is not a new practice; it is a daily nursing procedure and part of the standards of nursing practice at Shriners Hospitals. If children were not awake or alert, parents were informed of the procedure and asked to provide verbal consent. None of the parents or children who were asked about study participation refused to participate. Co-investigators from the other two Shriners burn units followed the IRB procedures of their respective institutions. Subjects were included in the study if they were admitted to one of 3 Shriners Hospitals (Galveston, Cincinnati, and Sacramento) for acute burn injury, had total body surface area burned that did not exceed 85%,

1. Had at least one trip to the operating room for debrieding during the acute burn admission.

2. Were in the hospital for longer than 3 days and were between 1 day to 18 years of age

3. In addition, all subjects spoke either English or were Spanish-speakers.

Subjects were excluded in the study if:

1. They did not speak English or Spanish.

2. They were 19 years of age or older.

3. The length of stay was expected to be less than 3 days.

4. The primary diagnosis was not acute burn injury.

5. Total Body Surface Area Burned >85%.

Research Approval

   Prior to data collection, approval of study procedures was obtained from each Institutional Review Board with each Shriners Hospital campus. The Galveston site was given permission to have an oral consent with the parents and oral assent from the patients who were older than 7 years of age. (See Appendix 3 for a copy of the oral consent and assent outline).

Ethical Considerations

   Confidentiality: Data collected for the study were carefully stored and protected in the investigator's locked office in a locked file cabinet. The data were not used for any other reason other than instrument development as identified in the study. Patient names, addresses and identifiable patient-sensitive data are not included in the database.

Instrumentation

   The pressure ulcer skin risk assessment scale (PrUSRAS) was developed in 2005 by a group of burn nurses' from three Shriners burn units: Galveston, Cincinnati and

Sacramento as part of a multicenter research grant funded by Shriners Hospitals. Fifteen pediatric burn nurses (The Panel of Experts) assisted in the development of the scale by participating in 3 rounds of a modified Delphi research technique. The final Burn PrUSRAS, developed by the group of nurses, has nine risk factors for pressure ulcer development (Appendix 1). The first two risk factors are interval level data (percent total body surface area injury and the number of splints in place) produced. The remaining seven factors, prior or current pressure ulcers, increased prominence of bones, activity/mobility, unburned skin exposed to wetness, number of low systolic blood pressure readings in past 24 hours, calorie intake, and urine and stool in contact with unburned skin, produced ordinal level data.

The demographic data collected for the study included the age of the child, percent burn, co-morbidities, post-op day of assessment, cumulative hours spent in the operating room, length of hospital stay and the presence or absence of pressure ulcers.

STANDARDIZATION OF RESEARCH PROCEDURES

Facilitator Training

Nurses who were employed by the three burn intensive care sites were trained in the use of the PrUSRAS and on how to stage pressure ulcers. One nurse from the Galveston unit trained the research nurses' at all three sites to use the PrUSRAS. The training was accomplished by the use of teleconference and power point presentation. Research nurses at each site also were trained to identify and stage pressure ulcers using the National Database for Nursing Quality Indicators (NDNQI) training module for staging pressure ulcers. This training module incorporates the recommendations from the National Pressure Ulcer Advisory Panel, who serve as the authoritative voice for improved patient outcomes in pressure ulcer prevention and treatment through public policy, education and research.

After reviewing the NDNQI training module, the nurses were evaluated on their ability to accurately stage pressure ulcers. The principal investigator made clinical rounds with the Wound Ostomy Continence Nurse (WOCN) at UTMB to evaluate their skills in staging a variety of existing pressure ulcers.

Data Collection Procedures

      Prior to data collection, the principal investigator and the administrations for each burn unit reviewed the standard of care for pressure relief to insure that all burn patients were provided similar care. Upon completion of the review, the administration from each unit agreed to standardize the pressure ulcer prevention care. Table 3.1 outlines the standard agreement among the burn units.

Table 3.1 Burn Units' Combined Pressure Relief Standards of Care

Service Line	Standards of Care for Pressure Ulcer Prevention

Burn	Low Risk
	   • Regular hospital bed and mattress
	   • Routine skin assessments twice daily
	   • Up ad lib
	High Risk
	   • Routine skin assessments twice daily
	   • Report pressure ulcer to appropriate personnel (wound team, CNS, MD)
	   • Maintain heel elevation off bed surface
	   • Turn immobile patients every two hours
	   • Mobilize/ambulate as ordered
	   • Obtain nutritional consult and follow recommendations
	   • Assess postoperative dressings. Change the dressing or notify MD if dressings are too tight
	   • Utilize pressure relief surfaces (Clinitron, Kin Air, Z-flow overlays on inpatients, Mega dyne gel pads in OR
	   • Social worker available to assess patient/family needs.

      Once assent was obtained from the participant and consent was obtained from the parent, the demographic data forms (Appendix 4) were completed. This assessment was

conducted after surgery on post-op day one, two or three. The research nurse then assessed the participants' risk of pressure ulcer development by observing the patient for those factors outlined on the PrUSRAS to make a baseline assessment. The research nurses completed the assessment, assigning a score to each item on the instrument then adding together the score given to each item. The total score was then entered into a computer database. The computer database was located on a Shriners intranet site and was available to each research nurse located at the three sites for data entry.

The patients were then inspected every day until discharge for evidence of a pressure ulcer. The daily inspection included all unburned skin for evidence of pressure ulcers at potential pressure ulcer sites in relation to the patient's position or location of pressure wraps—either supine or prone. Patients lying in a supine position were at risk for pressure ulcers on the occiput, shoulders, sacrum and heels. Patients lying prone were at risk for pressure ulcers on the face, chest, knees and feet. If a pressure ulcer was detected, the depth was staged according to the National Pressure Ulcer Advisory Panel staging criteria (Stage 1, 2, 3, 4, Unstageable or Deep Tissue Injury), the location of the ulcer was identified, and the information documented in the database. All databases were kept on a Shriners intranet site with limited access and password protection. Databases were reviewed weekly by the investigator for completeness. All incomplete databases were sent to the Co-PI and correction was made within a specified amount of time. Anonymity was maintained by assigning each patient a unique code number that was entered into the database.

Data Analysis Methods

Data were cleaned and analyzed using SPSS 14 for Windows. Descriptive statistics, means, and percentages were used to describe the sample. Inferential statistics were used to evaluate the reliability, validity and predictability of the scale.

Data Screening

Prior to performing descriptive and inferential statistics, data screening and data cleaning were conducted. The scores were checked for plausibility, distribution and that they met the statistical assumptions necessary for each analysis.

To test hypothesis 1.1 that interrater and internal consistency estimates of the PrUSRAS will be at least .70, two techniques were used. First, the internal consistency of the 9 risk items on the scale was assessed with Cronbach's alpha. Internal consistency is an important indicator of the scale's quality. Second, to evaluate interrater reliability of the risk assessors, intraclass correlation (ICC) was used. Specifically, the ICC is an item (fixed effect) by rater (random effect) consistency model.

For hypothesis 1.2, a confirmatory factor analysis was used to establish the unidimensional aspect of the PrUSRAS. The factor analysis explains variability among the risk factors and supports validity of the scale.

For hypothesis 2, to predict the occurrence of pressure ulcers, a logistic regression analysis was used to assess the individual and collective worth of PrUSRAS items in predicting ulcers.

Logistic regression describes the relationship and predictability of a set of independent variables (risk factors) and the bivariate dependent variable (pressure ulcer). The goal for using logistic regression was to determine how accurately the PrUSRAS predicts the risk for pressure ulcers based on the variables in the scale. A logistic regression model was built and tested, with the PrUSRAS total score hypothesized to predict pressure ulcer occurrence.

SUMMARY

This study used a predictive correlation design that examined the type and strength of relationships between nine risk factors and the occurrence of pressure ulcers in pediatric burn patients. One hundred and sixty-three patients from three Shriners Burn Hospitals participated in this study. Research design, sampling procedures, a description of PrUSRAS instrument development, standardization of research procedures and data analysis procedures were included in this chapter. Chapter Four describes the psychometric analysis of the PrUSRAS.

CHAPTER FOUR: FINDINGS

This chapter presents a description of the sample, hypotheses, and the analyses of the data using descriptive, parametric and non-parametric statistical tests. Data collection began after approval was obtained from UTMB Institutional Review Board. Parents' verbal consent and children's verbal assent (children $\geq$ 7 years) were obtained prior to enrolling the children in the study.

The study evaluated the psychometric properties of a new pressure ulcer skin risk assessment scale (PrUSRAS), which is intended to be used clinically to assess pressure ulcer risk in pediatric burn patients. The purpose of this study was to evaluate the validity, reliability and predictability of scores from the PrUSRAS. The study was guided by the following hypotheses:

- H 1.1: Interrater and internal consistency estimates of the PrUSRAS will be at least .70.
- H 1.2: In a confirmatory factor analysis, the PrUSRAS will show unidimensionality.
- H 2: In a logistic regression model, the total PrUSRAS risk index score will predict the occurrence of pressure ulcers.

The study examined the relationship of nine pressure ulcer risk factors and the total score (PrUSRAS) with the occurrence of pressure ulcers in pediatric burn patients. Patients were assessed on post-op day one, day two or day three for their risk of pressure ulcers with the PrUSRAS. Patients were assessed daily, after post-op baseline, for evidence of pressure ulcers until they were discharged from the hospital. If a pressure ulcer was found, it was staged and the location was noted. Monthly pressure ulcer point prevalence rates continued to be assessed at the three burn units in Galveston, Texas, Cincinnati, Ohio and Sacramento, California.

THE INSTRUMENT

The PrUSRAS instrument has nine risk factors, represented as individual items. The nine risk factors include: percent total body surface area burned, number of splints in place, prior or current pressure ulcers, increased prominence of bones, reduction of activity/mobility, unburned skin exposed to wetness, number of low systolic blood pressures in past 24 hours, calorie intake, and urine or stool in contact with unburned skin. The first two risk factors (% total body surface area burned and number of splints in place) were captured as interval level data for use in Hypothesis 2. The remaining seven risk factors were ordinal level data. Two of the seven ordinal level variables (activity/mobility and number of systolic blood pressures in past 24 hours) had three possible scores (0, 1, and 2). The assumption assessed was that the higher the item score or the total score, the greater the risk for pressure ulcer development.

DATA ANALYSIS

The statistical analyses were performed using SPSS 14.0. The interrater reliability of the risk assessment scale data were evaluated using the Intraclass Correlation Coefficient,; the internal consistency of the scale was assessed with the Cronbach's coefficient alpha. The validity of the scale scores was examined with exploratory factor analysis and logistic regression. Confirmatory factor analysis was not conducted as planned, due to the poor results of the internal consistency reliability analysis, so only the exploratory factor analysis was performed. The results are described below.

Sample Characteristics

A total of 163 burned children were enrolled in the study, which occurred during April 2007 - December 2008. The following table (4.1) shows the number of burn patients entered from each burn site:

Table 4.1 Burn Patients from Each Site

Sites	Patients (N= 163)
Galveston	98
Cincinnati	25
Sacramento	40

Of the 163 children enrolled in the study, 44 (24.6%) developed a pressure ulcer during their hospitalization. Table 4.2 displays *t*-test comparisons between those with pressure ulcers and those without on selected demographic variables for the group:

Table 4.2 T-test Comparisons

Pressure Ulcer		*N*	Mean	Std. Deviation	*p*
Age	None	118	6.76	5.21	.089
	Present	44	8.39	5.92	
Burn%	None	118	37.6	20.64	<.001
	Present	44	53.74	17.92	
CoMorb	None	118	.17	.38	.622
	Present	44	.20	.46	
OR Hours	None	118	5.9	6.10	.009
	Present	44	9.6	8.40	
LOS days	None	118	29.36	30.95	.011
	Present	44	46.68	39.46	

Results indicated that the children who developed pressure ulcers were slightly older than the group of children who did not develop pressure ulcers, but not significantly so. On the other hand, the average percent burn surface area was significantly larger for the children who developed pressure ulcers. Co-morbidity differences were not significant. The number of hours spent in surgery was significantly greater for the children who developed pressure ulcers, as was the total length of hospital stay.

Study Hypotheses

H 1.1: Interrater and internal consistency estimates of the PrUSRAS will be at least .70.

Two estimates of reliability of the PrUSRAS were computed: the intraclass correlation coefficient (ICC) and Cronbach's coefficient alpha. The ICC measures the interrater reliability of the observers' common interpretation of the PrUSRAS. Two nurse raters observed 20 patients at the same point in time and assessed each patient's risk for pressure ulcer development with the PrUSRAS. The ICC captures consistency of scores

among the nurses who evaluated the same patient's risk for pressure ulcers. The PrUSRAS Total Score's strength of the relationship between both raters simultaneously was 1.00 (Table 4.3). The individual items also showed high ICCs, with the exception of a single rater for item 2 (number of splints), The ICC here—.86—is acceptable, but lower than all other ICCs in this reliability study. The strong relationship between the raters' scores means that the nurse raters dependably gave similar ratings.

Table 4.3 Reliability Assessment with ICC

| | Burn (*n* = 20) | |
Score	*Average*	*Single*
TOTAL	1.00	.99
Sub1	1.00	1.00
Sub2	.92	.86
Sub3	1.00	1.00
Sub4	.96	.94
Sub5	1.00	1.00
Sub6	1.00	1.00
Sub7	1.00	1.00
Sub8	.95	.90
Sub9	1.00	1.00

The "Average" ICC refers to the interrater reliability of two raters combined. "Single" ICC refers to the reliability of one nurse.

Cronbach's coefficient alpha assumes unidimensionality of the instrument and equal variances among the items. Because the nine items had different metrics, the standardized alpha was used to compensate for the different variances. The alpha was low, 0.559. Because the alpha score was below 0.70, which is a crude minimal level for a new instrument, the PrUSRAS items were shown to be only loosely related, rather than homogeneous. The low alpha also implies that there may be more than one dimension of the instrument and reveals a large amount of variability (44%) credited to extraneous fluctuations (error variance), which cannot be explained. Therefore, this is an unacceptable estimate of reliability and does not support the hypothesis that the internal consistency of the instrument will be at least 0.70. This low alpha score also changed the plan to do a Confirmatory Factor Analysis, as it offers no hope that any sample size would improve the outcome of the PrUSRAS dimensionality.

In summary, the PrUSRAS instrument has strong interrater reliability, but weak internal consistency reliability. Therefore, hypothesis 1.1 is partially rejected.

H 1.2: In a confirmatory factor analysis, the PrUSRAS will show unidimensionality.

The following correlation matrix (Table 4.4) displays correlation coefficients between all pairs of variables in the PrUSRAS. Correlation coefficients can range between -1.00 and +1.00. The higher the coefficient, the more related is a given pair of items. As noted in the table, very few items correlate substantially with another item. For example, the highest correlation (-.953) is between prior/current pressure ulcers and activity, which is not clinically logical (the more pressure ulcers the patient has, the less likely they will have high activity scores). A negative correlation (-.636) exists between increased prominence of bones and prior or current pressure ulcer, which, again, is not clinically logical: the patient who has increased prominence of bones, was less likely to have current or prior pressure ulcers. The remainder of the variables shows minimal correlation with any other variables. These results confirm the lack of homogeneity of the PrUSRAS instrument.

Table 4.4 Inter-Item Correlation Matrix

	Constant	Burn	Splint	Priorcur	Increase	Activity	Unburned	Lowsbp	Calorici	Incontin
Constant	1.000			-.953	.520	-1.000				
Burn		1.000	-.242				.252	-.101	.210	-.235
Splint		-.242	1.000				.075	-.015	-.227	-.103
Priorcur	-.953			1.000	-.636	.953				
Increase	.520			-.636	1.000	-.520				
Activity	-1.000			.953	-.520	1.000				
Unburned		.252	.075				1.000	-.082	.019	-.104
Lowsbp		-.101	-.015				-.082	1.000	-.153	-.088
Calorici		.210	-.227				.019	-.153	1.000	-.109
Incontin		-.235	-.103				-.104	-.088	-.109	1.000

The purpose of the confirmatory factor analysis was to test the unidimensionality underlying the central construct in the PrUSRAS. Unfortunately, the evidence from preliminary analyses did not support an attempt at confirmatory analysis.

Thus an exploratory factor analysis was conducted to extract some number of dimensions from a correlation matrix. Exploratory Factor Analysis assumes no *a priori* hypotheses about dimensionality of the items on the scale (Polit & Beck, 2008). Each factor represents independent sources of variation found in the data matrix (Polit & Beck, 2008). Polit and Beck (2008) suggest that the number of factors extracted should account for 60% of the total variance and have factor extraction eigenvalues greater than 1 as their cutoff point. As illustrated in Table 4.5, there are 4 factors with eigenvalues that are greater than 1; those 4 factors have a cumulative variance of 61.191 %. Thus, it appears that there is a four-factor model underlying the nine items of the PrUSRAS; however, the four factors seem uninterpretable.

Table 4.5 Total Variance Explained

Factor	Initial Eigenvalues			Extraction Values of Squared Loadings			Rotation Sums of Squared Loadings
	Total	Variance %	Cumulative %	Total	Variance %	Cumulative	Total
1	1.950	21.665	21.665	1.404	15.596	15.596	.260
2	1.413	15.702	37.366	.770	8.558	24.153	.649
3	1.136	12.619	49.986	.495	5.502	29.655	.825
4	1.009	11.206	61.191	.331	3.674	33.329	.744
5	.913	10.150	71.341				
6	.806	8.952	80.293				
7	.683	7.592	87.885				
8	.618	6.862	94.747				
9	.473	5.253	100.000				

The second phase of factor analysis is rotating the factor matrix to simplify the factor structure. The initial factors were rotated using an Oblimin solution, which allows the extracted factors to be correlated with each other. The resulting pattern matrix of the 4- factor model displays four of the nine variables that have loadings greater than 0.40; they are % burn, splints, caloric intake and unburned skin exposed to wetness (Table 4.6). This is difficult to interpret because the items on the scale were not created to reflect multiple constructs; thus they may be poor indicators of the one construct, skin risk.

Table 4.6 Pattern Matrix

	Factor			
	1	2	3	4
# Splints	.698	-.029	.149	-.134
Burn	.623	.352	-.042	.125
Activity	.427	-.266	-.039	.168
Prior/current PU	-.008	.423	-.134	-.036
Incontinent Urine or Stool	.086	.375	.366	-.048
Caloric Intake	-.022	-.240	.664	.061
Low SBP	.022	.006	.180	.018
Unburned Wet	-.046	.097	.075	.633
Increased Bones	-.027	.065	.018	-.345

Extraction Method: Principal Axis Factorisng
Rotation Method: Oblimin with Kaiser Normalization
    a.   Rotation converged in 17 iterations

H 2: In a logistic regression model, the total PrUSRAS score will predict the occurrence of pressure ulcers.

Logistic regression was done to describe the predictability of a set of independent variables (risk factors) for the bivariate dependent variable (pressure ulcer). The goal was to determine how accurately the PrUSRAS predicts the risk for pressure ulcer based on the variables in the scale. The analysis assessed the individual and collective value of PrUSRAS items in predicting pressure ulcers in pediatric burn patients.

A power analysis for a logistic regression model with a large effect (odds ratio = 4.75) shows a minimum required sample N =160 (Owen, personal communication, July 12, 2007). However, a power analysis for the confirmatory factor analysis demanded 160 patients; therefore the sample size for all analyses is N=160.

The initial logistic regression was run with all nine predictors (variables) in the model. The results are found in Table 4.7. Two of the predictors appear to be significant: percent burn and # of splints. However, three of the predictors (prior/current pressure ulcers, increased prominence of bones and activity) have extremely large standard errors. This is caused by too much collinearity among the predictor variables. The correlation matrix (Table 4.4) identified that activity and prior/current pressure ulcer are correlated—

.953. Thus they are measuring the same thing. Therefore, activity was removed from the predictor list and the logistic regression was rerun with eight predictors.

Table 4.7 Variables in the Equation (non-stabilized)

	B	S.E.	Wald	df	Sig.	EXP(B)	95.0% C.I. for EXP(B)	
							Lower	Upper
Burn	.038	.017	5.168	1	.023	1.039	1.005	1.073
Splint	.233	.121	3.729	1	.053	1.263	.997	1.601
Priorcur	87.529	12502.691	.000	1	.994	1.0E+38	.000	
Increase	-16.797	3977.151	.000	1	.997	.000	.000	
Activity	50.361	7647.084	.000	1	.995	7.4E+21	.000	
Unburned	1.253	1.323	.897	1	.344	3.500	.262	46.768
Lowsbp	-.750	.538	1.945	1	.163	.472	.165	1.355
Calorici	-.008	.533	.000	1	.988	.992	.349	2.818
Incontin	-.318	.501	.403	1	.525	.727	.272	1.943
Constant	-105.465	15294.169	.000	1	.994	.000		

The second logistic regression was run with eight predictors, without the activity predictor. As seen in Table 4.8, the standard errors stabilized for all predictors. The significant predictors in the equation included percent burn, # of splints, and prior/current pressure ulcer. In fact, if a child had in the past or currently had a pressure ulcer, the odds of another pressure ulcer were increased by a factor of 200 (with a .95 confidence interval spanning 12.4 to 3167.1). Collinearity was not a problem in this model as shown in the reduced correlation matrix of Table 4.9.

The predictability of the model is poor. The specificity is better at predicting who will not get a pressure ulcer (95%) than the sensitivity of predicting who will get a pressure ulcer (54%), which is hardly better than a coin toss (Table 4.10).

Table 4.8 Variables in the Equation

	B	S.E.	Wald	df	Sig.	Exp (B)	95.0% C.I. for EXP (B)	
							Lower	Upper
Incontin	-.278	.498	.311	1	.577	.757	.285	2.011
Calorici	-.152	.520	.085	1	.770	.859	.310	2.381
Lowsbp	-1.127	.612	3.394	1	.065	.324	.098	1.075
Unburned	.735	1.072	.470	1	.493	2.086	.255	17.052
Increase	-1.102	1.668	.436	1	.509	.332	.013	8.738
Priorcur	5.291	1.413	14.027	1	.000	198.636	12.458	3167.114
Spint	.266	.120	4.955	1	.026	1.305	1.032	1.650
Burn	.034	.015	4.930	1	.026	1.034	1.004	1.065
Constant	-4.144	1.370	9.152	1	.002	.016		

Table 4.9 Correlation Matrix

	Constant	Incontin	Calorici	Lowsbp	Unburned	Increase	Priorcur	Splint	Burn
Constant	1.000	.030	-.152	.141	-.815	-.167	-.333	-.140	-.535
Incontin	.030	1.000	-.091	-.083	-.078	-.095	-.157	-.090	-.226
Calorici	-.152	-.091	1.000	-.153	-.025	.148	.027	-.230	.135
Lowsbp	.141	-.083	-.153	1.000	-.117	-.013	-.304	-.017	-.084
Unburned	-.815	-.078	-.025	-.117	1.000	.192	.249	.057	.139
Increase	-.167	-.095	.148	-.013	.192	1.000	-.232	-.016	.005
Priorcur	-.333	-.157	.027	-.304	.249	-.232	1.000	.210	.168
Split	-.140	-.090	-.230	-.017	.057	-.016	.210	1.000	-.297
Burn	-.535	-.226	.135	-.084	.139	.005	.168	-.297	1.000

Table 4.10 Classification Table

		Predicted		
		Pressure Ulcer(s)		
		none	Pressure Ulcer(s) Present	Percentage Correct
Observed				
Pressure Ulcer(s)	None	98	5	95.1
	Pressure Ulcer(s) Present	17	20	54.1
Overall Percentage				84.3

SUMMARY

The PrUSRAS instrument was developed to identify risk for pressure ulcer development in the pediatric burn patient. This study investigated the psychometrics of the PrUSRAS instrument. The data for the study came from skin risk assessment of 163 burned children who were treated in one of three Shriners Hospitals. Demographic data revealed significant findings: children who developed pressure ulcers had a higher percent burn injury, spent increased number of hours in the operating room and had a longer length of stay compared to those children who did not develop pressure ulcers.

Two estimates of reliability of PrUSRAS scores were computed: the intraclass correlation coefficient (ICC) and Cronbach's coefficient alpha. The ICC calculation among the nurses who evaluated patients' risk for pressure ulcers showed a strong relationship for the Total Score, at 1.0. However, Cronbach's standardized coefficient alpha was found to be low at 0.559. The low alpha score does not support homogeneity of the instrument's items, which is not supportive for reliability evidence.

An exploratory factor analysis was used to assess construct validity. The analysis identified a 4-factor model, which supports the multidimensionality of the instrument. However, the pattern matrix for the four factors was not readily interpretable.

A logistic regression was used to predict the occurrence of pressure ulcer. Three of the PrUSRAS items were significant predictors of pressure ulcers in the pediatric burn patients—percent burn, number of splints, and prior or current pressure ulcers.

Unfortunately, the data in this study did not offer much supportive psychometric evidence of the PrUSRAS for identifying risk of pressure ulcers in the pediatric burn patient. The quest for an instrument that captures the unique risks for pressure ulcer development in the pediatric patient population continues to be elusive.

CHAPTER 5: DISCUSSION, CONCLUSIONS, AND IMPLICATIONS

This chapter presents a summary of the study and important conclusions drawn from the data presented in Chapter 4. It provides a discussion of the implications for action and recommendations for further research.

STUDY SUMMARY

The purpose of this study was to evaluate the psychometric properties of a new investigator-developed pressure ulcer skin risk assessment scale (PrUSRAS), which was intended to predict pressure ulcer risk in pediatric burn patients. The specific aims and hypotheses of the study are outlined below.

Aim 1: To identify the interrater, internal consistency and internal structure estimates of the PrUSRAS.

> Hypothesis 1.1: Interrater and internal consistency estimates of the PrUSRAS will be at least .70.

> Hypothesis 1.2: In a confirmatory factor analysis, the PrUSRAS will show unidimensionality.

Aim 2: To determine the ability of the PrUSRAS to predict pressure ulcer development.

> Hypothesis 2: In a logistic regression model, the total PrUSRAS score will predict the occurrence of pressure ulcers.

The study was conducted as a quasi-experimental, predictive correlation design that examined the type and strength of relationships between nine risk factors and the occurrence of pressure ulcers in pediatric burn patients. The settings for this multicenter study were three pediatric burn intensive care units, Shriners-Galveston, Shriners-Cincinnati and Shriners-Sacramento. One hundred and sixty-three pediatric burn patients were assessed with the PrUSRAS instrument on one of the following days: post-op day 1, 2 or 3. Patients were assessed daily for evidence of pressure ulcers during their length of hospitalization.

There was no statistical significance found for hypothesis 1.1, 1.2, or 2 for the psychometrics of the PrUSRAS instrument. Nevertheless, although the instrument was neither reliable nor valid, there were three risk factors that predicted risk for pressure ulcers in the pediatric burn patient. These three risk factors will be presented and discussed. A discussion of the findings will be organized in terms of each of the three hypotheses. Additionally, conclusions and implications for future research will also be offered.

DISCUSSION

Little is written on the magnitude of the problem of pressure ulcers in children. In fact, pressure ulcers in children are presumed to be uncommon (Baldwin, 2002) and to date there is no general incidence or prevalence data available in the literature. Although data are not readily available, pressure ulcers do occur in pediatric patients, particularly in burned children. Indeed, pressure ulcer point prevalence rates and incidence rates in pediatric burn patients have been collected, but not yet published, from three burn units that will contribute valuable information to the pediatric pressure ulcer literature.

Most of the prevention interventions for pressure ulcers in children have been extrapolated from adult studies and were never intended to guide pediatric clinical practice (Baharestani & Ratliff, 2007; Zollo et al., 1996). One highly recommended intervention is the use of skin risk assessment scales for identifying patients who are at risk for pressure ulcer development (AHCPR, 1992, 2000). Risk assessment scales have provided a means of improving the identification of patients who are at risk for pressure ulcer development (Abruzzese, 1985; Gosnell, 1973; Moolten, 1972).

Sample

One hundred and sixty-three pediatric burn patients were enrolled in this study. Of the 163 children enrolled in the study, 44 (24.6%) developed a pressure ulcer during their hospitalization. Those patients who developed pressure ulcers were older (mean age 8 years) than those who did not develop pressure ulcers (mean age 6 years). It is unclear why the older children were more prone to develop pressure ulcers, but this population of 8-year-olds had a significantly larger burn size (54% Total Body Surface Area Burn)

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compared to the 6-year-olds (37% Total Body Surface Area Burn). Perhaps the significantly larger burn size in the 8 year-old group explains, in part, why that group had more pressure ulcers. As discussed in Chapter 2, the larger the burn the more prone patients are to complications from the burn injury (e.g., sepsis, fluid and electrolyte imbalances, edema) which increase their length of stay.

The number of hours spent in surgery was significantly greater for the children who developed pressure ulcers, as was the total length of hospital stay. The finding that children who developed pressure ulcers spent more time in surgery was expected because burn patients typically require increased number of hours in surgery for excision and auto grafting. Moreover, larger and deeper burn injuries require more operations. In addition, the increased length of stay is directly related to burn size.;

Hypothesis 1.1-Reliability of the PrUSRAS Instrument

The internal structure of the PrUSRAS instrument was tested with intraclass correlation (interrater) and internal consistency estimates. The interrater reliability of the scale was tested when two nurses used the PrUSRAS to examine the same patient at the same time. The PrUSRAS performed well, as evidenced by the results of the intraclass correlation coefficient. Internal consistency is concerned with the homogeneity of the items within the scale, which is demonstrated when the items are highly intercorrelated with each other. This was not the case with the PrUSRAS instrument: items on the PrUSRAS did not correlate well with each other, which suggests that the items were not measuring the same construct, skin risk for pressure ulcer development. The majority of the scores ranged from minimal (-.3) to no correlation (.00). Although the literature suggests that increased prominence of bones, activity/mobility, unburned skin exposed to wetness, low blood pressure, calorie intake and urine or stool in contact with unburned skin have been associated with pressure ulcer development in different populations (Pallija et al., 1999; Samaniego, 2004; Willock, 2005; Willock et al., 2007), when examined together as a representation of the construct, skin risk assessment no correlation was found among the items. Unfortunately, a new instrument cannot be partially reliable (intraclass correlation coefficient), thus the reliability of the PrUSRAS was not demonstrated. This finding was a surprise because these items were identified in

the pressure ulcer literature and the expert panel of pediatric burn nurses agreed these items were clinically strong as predictors of pressure ulcers in the pediatric burn patient. Because the expert panel agreed on the items that approximate the construct of skin risk, a question is raised whether skin risk is a complex construct and would best be captured using an instrument that assessed multiple dimensions.

Hypothesis 1.2-Construct Validity

The next analysis was an exploratory factor analysis, which was done to test the unidimensionality underlying the central construct in the PrUSRAS. Exploratory factor analysis assumes no *a priori* hypotheses about dimensionality of the items on the scale (Polit & Beck, 2008). Each factor represents independent sources of variation found in the data matrix (Polit & Beck, 2008). Polit and Beck (2008) suggest that the number of factors extracted should account for 60% of the total variance and have factor extraction eigenvalues greater than 1 as their cutoff point. Four factors had eigenvalues greater than 1 and had a cumulative variance of 61.191%. However, this finding is difficult to interpret because the items on the scale were not created to reflect multiple constructs; thus they are likely poor indicators of the one construct, skin risk. For example, percent burn loaded on Factor 1 and had a secondary loading on Factor 2. Incontinent urine or stool loaded on Factor 2 and Factor 3. The exploratory factor analysis did not show satisfactory interpretation. Therefore, construct validity was not shown. Considering the low inter-item correlation, it would have been suspect if one dimension had been supported.

Hypothesis 2-Predictability of the PrUSRAS Instrument

Logistic regression was conducted to describe the predictability of a set of nine independent variables (risk factors) for the bivariate dependent variable (pressure ulcer). The goal was to determine how accurately the PrUSRAS predicts the risk for pressure ulcer based on the variables in the scale. The analysis assessed the individual and collective value of PrUSRAS items in predicting pressure ulcers in pediatric burn patients.

Collinearity among two predictors (activity and prior/current pressure ulcers) was a problem when all nine predictors were entered into the analysis. Collinearity occurs when, within a set of independent variables, some of the independent variables are nearly predicted by the other independent variables. Any minor fluctuations in the sample, such as measurement errors or sampling errors, would have a major impact on the beta weights. Although there are different methods of dealing with collinearity, including use of another type of analysis or another type of regression analysis, and combing the variables or removing one of the two collinear variables, the method that was most appropriate for this study was to remove one of the variables. Therefore, activity was removed from the second analysis and the standard errors stabilized for all predictors. Although there were three significant predictors in the equation (percent burn, number of splints and prior/current pressure ulcer), the predictability of the model is poor. It is logical that the percent burn and number of splints are good predictors because the larger the percent burn, the more splints will be in place. A prior/current pressure ulcer is supported in the literature as a predictor of additional pressure ulcers. The content validity and intraclass correlation coefficient of the PrUSRAS was high, so it is puzzling why all the risk factors did not predict.

Since this study did not include the design of the PrUSRAS instrument, perhaps the results seen in this research may be due, in part, to the design of the PrUSRAS instrument, and not so much on the failure of the risk factors to predict risk of pressure ulcers. The instrument was designed to be very simple and easy to use. To accomplish that goal, binary or ordinal response options were used for each risk factor. The advantage of using binary responses is that the items are extremely easy to answer, but the major disadvantage of using binary response options is the minimal variability. Each item contributes very little to the sum of the scale (DeVellis, 2003).

The specificity of the instrument was stronger for predicting which child would not develop a pressure ulcer (95%) than the sensitivity for predicting who would develop a pressure ulcer (54%). This percentage of 54% for sensitivity predictability is hardly better than a coin toss. Since the evidence shows that the PrUSRAS is not measuring skin risk for pressure ulcer, it is not surprising that the PrUSRAS is better at identifying which child would not develop a pressure ulcer. One reason for this lack of surprise is because,

in general, the higher the specificity the lower the sensitivity. Although the sensitivity of the PrUSRAS was slightly over 54%, it is not much different from the sensitivity of the widely-used Braden Scale, which is reported to be 61% (Bergquist & Frantz, 2001.

CONCLUSIONS AND IMPLICATIONS FOR PRACTICE

The PrUSRAS instrument was designed to capture the unique risk factors for pressure ulcers of the pediatric burn patient. The psychometric properties of the instrument did not support the internal consistency, construct validity, or predictability of the instrument for pressure ulcer risk. Three factors: percent burn, number of splints, and prior/current pressure ulcers, were strong predictors of pressure ulcers. Based on these findings, pressure ulcer prevention strategies could be used for patients who have any of the following risk factors: *>53% total body surface area burn, multiple splints in place and/or has had or currently has a pressure ulcer.*

There is still a significant amount yet to be accomplished in the goal of developing a skin risk assessment scale for pediatric burn populations. There are unique risk factors that make burned children a higher risk for pressure ulcers, yet there are expectations by The Joint Commission and recommendations by The National Pressure Ulcer Advisory Panel, The Wound Ostomy Continence Nurses Association, and Agency for Research Quality for nurses to use a skin assessment scale in clinical practice. Although the Braden and the Braden Q are widely used, they do not predict burn ulcer risk in the pediatric burn population (Gordon et al., 2002; Gordon et al., 2004b). The rationale for using the Braden scales in a pediatric burn population is perplexing since neither was developed for pediatric burn patients. Perhaps a question that needs to be asked is, "does the risk assessment scale in use predict risk in the targeted population of patients?"

Some investigators suggest that more randomized control clinical trials are needed to support the use of any risk scale. Furthermore, some contend that no scale is better than clinical judgment (Cullum et al., 1996; Papanikolaou et al., 2007). Other researchers suggest that pressure ulcer risk assessment is an abstract and complex concept, and that it cannot be captured by direct measurement techniques and therefore measurement should not be done (Balzer et al., 2007).

Some clinicians support a simpler approach to risk assessment by using a valid screening tool to identify risk for pressure ulcers. The screening tool contains risk factors that are linked to the pathophysiology of pressure ulcers: restricted mobility, shear and friction (Dijkstra et al., 1996). Once risk has been identified, a holistic individualized prevention plan could be put in place to meet the needs of a particular patient. Although use of a screening tool is not popular, it does have some support in the literature.

SUMMARY

One standard of care for prevention of pressure ulcers is to use a risk-assessment scale to target patients who are at risk for pressure ulcers and implement evidence-based prevention strategies. Because no valid and reliable instrument exists for the pediatric burn patient, a new skin risk assessment scale (PrUSRAS) was developed. The goal of this research study was to provide clinicians with a psychometrically defensible instrument to use in skin risk assessment with burn patients that could be incorporated into daily practices of skin risk assessment and pressure ulcer prevention. Additionally the intent was to use the instrument in clinical studies for the prediction of pressure ulcers in pediatric burn patients. Another goal was to use the instrument to assess the outcomes of targeted intervention studies to prevent the development of pressure ulcers. The psychometrics of the new scale were assessed and the analyses showed no statistically significant reliability, validity, or predictability, although three of the risk factors had significant pressure ulcer predictability. The ultimate clinical impact of this research was to decrease the incidence and prevalence rates of pressure ulcers in pediatric burn patients. The three risk factors can immediately be incorporated into practice as a screening technique to identify patients who are high risk and then implement pressure ulcer prevention interventions. This study provides a beginning step and certainly more research needs to be done in this very important s area of clinical practice.

RECOMMENDATIONS FOR FUTURE RESEARCH

One major recommendation for future research is to redesign the instrument using the same risk factors but with more than two response options for each factor. The advantage of using binary responses is that the items are extremely easy to answer but,

the major disadvantage of using binary response options is the minimal variability. Each item contributes very little to the sum of the scale (DeVellis, 2003). In addition to providing an opportunity for more options, it would be helpful to perhaps design the instrument to have more factors to capture what appears to be the complexity of the construct skin risks.

Further research in needed to understand the importance of the three risk factors (percent burn, number of splints and current/past pressure ulcers) that were significant predictors. It would also be interesting to expand the study to adult patients to see if the same three risk factors are predictive in the adult burn population.

Basic science research in burn patients has identified other variables that may impact burn patients' risk for pressure ulcers: carbon monoxide poisoning, albumin levels and vitamin E deficiency. Further research may be indicated.

Appendix 1: Burn PrUSRAS

Burn Pressure Ulcer Skin Risk Assessment Scale		
Risk Factor	**Definition**	**Possible Score**
% Total Body Surface Area Burned	% Burn as recorded on Lund and Browder chart at time of admission.	Enter % as a number
Number of splints in place	The total number of individual splints (count them) held in place with ace wraps during the past 24 hours.	Enter number of splints
Prior/current pressure ulcer	During current hospitalization, if the patient has no pressure ulcer, enter 0 for no pressure ulcer, or 1 if the patient was admitted with a pressure or has developed a pressure ulcer since admission.	Enter 0 or 1
Increased prominence of bones	Having prominent bones. Enter 0 for none or 1 for bony prominences present (extremely thin stature).	Enter 0 or 1
Immobility	Current assessment of the patient's level of immobility. Enter 0 for no immobility problems, 1 for partial immobility, and 2 for total immobility.	Enter 0, 1 or 2
Unburned skin exposed to wetness	Unburned skin described as wet or moist from perspiration, drainage, wet dressings, or dry. Enter 0 for no wetness or 1 for wet or moist unburned skin.	Enter 0 or 1
Mean blood pressure past 24 hours	Identify the number of hypotensive episodes (mean B/P less than 60 mm Hg.) No hypotensive episodes (0), one hypotensive episode (1), more than one episode of hypotension (2).	Enter 0, 1, or 2
Calorie intake	Based on the past 24 hours of nutritional intake (tube feeds, TPN, po foods), what level of calorie intake was accomplished? Goal met (0), some intake, but fails to meet goal (1), or no caloric intake (2).	Enter 0, 1, or 2

Bowel and bladder incontinence	Identify the number of incontinent bowel and/or bladder episodes during past 24-hours. Enter <u>none (0)</u>, sometimes (1), or always incontinent (this includes all children who are not potty trained) (2).	Enter 0, 1 or 2
	TOTAL	

Appendix 2: Revised PrUSRAS

Burn Pressure Ulcer Skin Risk Assessment Scale		
Risk Factor	**Definition**	**Possible Score**
% Total Body Surface Area Burned	% Burn as recorded on Lund and Browder chart at time of admission.	Enter % as a number
Number of splints in place	The total number of individual splints (count them) held in place with ace wraps during the past 24 hours.	Enter number of splints
Prior/current pressure ulcer	During current hospitalization, if the patient has no pressure ulcer, enter 0 for no pressure ulcer, or 1 if the patient was admitted with a pressure or has developed a pressure ulcer since admission.	Enter 0 or 1
Increased prominence of bones	Having prominent bones. Enter 0 for none or 1 for bony prominences present (extremely thin stature).	Enter 0 or 1
Activity/Mobility	Current assessment of the patient's level of mobility. Enter 0 for fully mobile, 1 for partially mobile, and 2 for bed rest.	Enter 0, 1 or 2
Unburned skin exposed to wetness	Unburned skin described as wet or moist from perspiration, drainage, wet dressings. Enter 0 for dry or 1 for wet or moist.	Enter 0 or 1
Number of low systolic blood pressures in past 24 hours from right now	Count the number of low systolic blood pressures in past 24 hours. Birth-<1 mo. (< 60 mmHg); 1-12 mo.(<70 mmHg), 13mo-10 yrs.(70mmHg + age in yrs x 2); >10 yrs.(<90mmHg) Identify the number of hypotensive episodes. Enter 0 for no hypotensive episodes, 1 for one hypotensive episode, and 2 for two or more hypotensive episodes.	Enter 0, 1, or 2
Calorie intake	Based on the past **48** hours of nutritional intake (tube feeds, TPN, po foods), what level of calorie intake was accomplished? Patient meets $\geq$ 90% of estimated nutrition needs (0); or patient meets $\leq$ 89% of	Enter 0, 1

	estimated nutrition needs (1). If you are unsure, contact the dietitian or check the chart.	
Urine or stool in contact with unburned skin	Identify the number of incontinent bowel and/or bladder episodes during past 24-hours. Enter <u>0 for none,</u> or 1 for sometimes/often incontinent (this includes children who are not potty trained).	Enter 0, 1

TOTAL

Appendix 3: Oral Consent and Assent Outline

Oral Assent Outline for Child

Greeting
Introduction of nurse
Request permission to talk about a research project
Explain the purpose of the project: To see if we can identify who will get pressure ulcers during their stay in the hospital so that we stop pressure ulcers from happening to burned children
Describe the study: I would like to see if you are at risk for developing pressure ulcers by transferring your information to the categories listed on this paper.
There are no risks to you for agreeing to let me do this.
The benefits may be to other burn children who come to our hospital.
Do you have any questions?
Thank you for your help with this project.

IRB Oral Outline of Parental Assent

Greeting
Introduction of nurse
Request permission to discuss research project
Explain the project and the reason for the project:
Purpose of project is to evaluate a new pressure ulcer skin risk assessment scale that was developed for the pediatric burn patient
Explain how the risk assessment would be done:
There are 9 risk assessment categories on the scale and I would like to use it to assess (name of patient)'s risk for developing pressure ulcers.
Request permission to do a risk assessment
Opportunity to ask questions
Let them know name and phone number of nurse if they have any further questions.
Thank you very much for the opportunity

Appendix 4: Demographic Data Form

Site	Patient #	Age	Burn	Co Morb	Postop N	Min OR	LOS days

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VITA

Mary Patricia Dempsey Gordon was born to Joseph and Hildred Dempsey in Houston, Texas on October 22, 1947. Mrs. Gordon, after graduating from Jesse H. Jones High School, attended Texas Woman's University in Denton as a nursing major. She was awarded a Bachelor of Science degree in nursing from Texas Woman's University. After nursing school, she joined the Army Nurse Corps, where she met and married Jeffrey J. Gordon. They had four children: Byron Patrick Gordon, a musician, Andrew Huntley Gordon, Michael Stuart Gordon, and Patricia Lee Gordon.

Mrs. Gordon worked as a Registered Nurse at Parkland Memorial Hospital in Dallas, Texas for two years while furthering her education and earning a Master of Science degree from Texas Woman's University. Her nursing career has included Burn Clinical Nurse Specialist positions in three burn centers in Texas: Parkland Memorial Hospital in Dallas, Texas; Institute of Surgical Research at Brooke Army Hospital in San Antonio, Texas; and Shriners Hospital in Galveston, Texas. She also holds an Adjunct Faculty position in the School of Nursing at UTMB in Galveston, Texas.

Mrs. Gordon is an active member in the American Burn Association and has worked on many committees, including the Board of Trustees. Other professional organizations include: The American Association of Critical Care Nurses, and the National Association of Clinical Nurse Specialists. She was the Program Director of a multimillion dollar National Institute for Health grant awarded to the University of Texas Health Science Center in Dallas to establish a regional system for burn care in the state of Texas. Since 1981, she has continued to work with the Journal of Burn Care and Research, currently as Forum Editor, and in years past, as Associate Editor. Mrs. Gordon (Principal Investigator) and Co-Principal Investigators received grant funding from Shriners Hospital Headquarters in Tampa, Florida to develop and evaluate a new pressure ulcer skin risk assessment scale for the pediatric burn patient, which is the topic of her dissertation.

She has received several honors during her career: Curtis P. Artz Distinguished Service Award, American Burn Association, 2006; Excellence in Nursing Practice Award, Sigma Theta Tau, 2003; Distinguished Service Award, American Burn Association, 2000; and Associate Award, American Burn Association, 1975.

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