More than S.K.I.N. Deep: Decreasing Pressure Ulcer Development in the Pediatric Intensive Care Unit

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MORE THAN S.K.I.N. DEEP: DECREASING PRESSURE ULCER DEVELOPMENT IN THE PEDIATRIC INTENSIVE CARE UNIT

by

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ABSTRACT
MORE THAN S.K.I.N. DEEP: DECREASING PRESSURE ULCER DEVELOPMENT IN THE PEDIATRIC INTENSIVE CARE UNIT

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Pressure ulcers are defined as localized areas of tissue destruction that develop when soft tissue is compressed between a bony prominence and an external surface for a prolonged period of time. Although any hospitalized child is at risk for the development of a pressure ulcer, the critically ill child is at increased risk. The critical care environment poses special challenges to preventing the development of pressure ulcers secondary to the high acuity of patients and the highly invasive nature of interventions and therapies those patients receive. The incidence of pediatric pressure ulcer development in the critical care population has been reported to be as high as 10.2 to 27%.

This prospective, quasi-experimental study was conducted in order to determine whether a specific pressure ulcer prevention bundle was associated with a significant reduction in pressure ulcer development in infants 0 to 3 months old in the pediatric intensive care unit. The four main components of the pressure ulcer prevention bundle were (S) support surfaces, (K) keep turning every 2 hours, (I) incontinence management, and (N) nutrition consultation. The second element of the study was a survey of the nursing staff of the pediatric intensive care unit to gain a better understanding of the barriers and facilitators to implementing the S.K.I.N. care pressure ulcer prevention bundle.

The implementation of the S.K.I.N. care bundle is associated with a significant drop in pressure ulcer incidence from 18.8% to 6.8%. The infants who developed pressure ulcers in the experimental group received significantly more mechanical support and had significantly longer lengths of stay than the infants who did not develop a pressure ulcer. The survey demonstrated that competing demands on nurses' time as the biggest barrier to implementation of the pressure ulcer prevention bundle. Having appropriate supplies and easy access to the support surfaces were the biggest facilitators of implementing the bundle.

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CHAPTER ONE

Introduction

Significance

Skin is the largest organ of the body and provides a protective barrier against bacteria, chemicals, and physical action while maintaining homeostasis in the internal environment (Hagelgans, 1993). Skin receives one third of the body's circulating blood and serves in many functions including protection, immunity, thermoregulation, metabolism, communication, identification, and sensation (Hagelgans, 1993). Normal skin is composed of three distinct layers including the epidermis, dermis, and subcutaneous layers. The outermost layer, the epidermis, is area in which dead skin cells continually are shed and replaced. The innermost layer, the dermis, is woven in with sweat glands, blood vessels, nerve endings, and capillaries (Pallija, Mondozzi, & Webb, 1999). Subcutaneous tissue is composed primarily of connective fatty tissue and is responsible for heat insulation, shock absorption, and caloric storage (Blackburn, 2003). Destruction to either the epidermis or dermis can lead to systemic infection, increased morbidity, increased cost of care, and has negative psychosocial implications from secondary scarring or alopecia (Curley, Quigley, & Lin, 2003; Gershan & Esterly, 1993; Groenveld et al., 2003; Hagelgans, 1993; McLane, Bookout, McCord, McCain, & Jefferson, 2004).

Physiological change to the skin in relation to vascular supply is the most important factor for attaining and maintaining skin integrity (Boynton & Paustian, 1996). When this vascular supply is compromised, a pressure ulcer may develop. According to the National Pressure Ulcer Advisory Panel, a pressure ulcer is defined as a localized

injury to the skin and/or underlying tissue, usually over a bony prominence as a result of pressure or pressure in combination with shear and/or friction (National Pressure Ulcer Advisory Panel, 2007). Pressure ulcers are categorized into four stages. Stage I pressure ulcers are characterized by intact skin, while stage IV pressure ulcers are characterized by full thickness injury and damage to the muscle, bone, or supporting structures (National Pressure Ulcer Advisory Panel, 1998).

Pressure ulcers in children result in ulcer-related pain, altered body image, and negative psychosocial implications from secondary scarring or alopecia (Baharestani & Ratliff, 2007; McCord, McElvain, Sachdeva, Schwartz, & Jefferson, 2004). Pressure ulcer development in the pediatric population has been associated with increased health care costs, increased length of stay, and increased morbidity (McCord et al., 2004). The estimated cost of managing a single full-thickness pressure ulcer is as high as $70,000, and the total cost for treatment of pressure ulcers in the United States is estimated at $11 billion per year (M. Reddy, Gill, & Rochon, 2006).

Exemplary skin care is a nurse sensitive outcome measure established by the American Nurses Association and reported in the National Database of Nursing Quality Indicators. National efforts are under way to reduce pressure ulcer development (American Nurses Association, 2005). Regulating bodies recognize the need for exemplary skin care. The Joint Commission has identified reduction of health care-associated pressure ulcer development as one of its 2007 national patient safety goals and the Institute for Healthcare Improvement (IHI) has instituted the “5 Million Lives” campaign, in an effort to reduce unintended iatrogenic injury (McCannon, Hackbarth, & Griffin, 2007; National Pressure Ulcer Advisory Panel, 2007; The Joint Commission).

One key indicator in the “5 Million Lives” campaign is the prevention of pressure ulcer development in the pediatric population. Additionally, the federal centers for Medicaid and Medicare services announced in August 2008 that beginning on October 1, 2008, it will no longer reimburse for eight “reasonable preventable” conditions. One of these conditions is hospital acquired pressure ulcers (Department of Health and Human Services, 2008). Recently, the National Pressure Ulcer Advisory Panel identified research regarding guidelines for pressure ulcer prevention and treatment in the pediatric population as a key priority (Baharestani & Ratliff, 2007). The U.S. Department of Health and Human Services document, *Healthy People 2010: Understanding and Improving Health*, listed reducing pressure ulcer incidence as an objective for all health care providers (US Department of Health and Human Services, 2000).

Pressure ulcer development in children has been studied far less than in the adult population and has typically been considered a phenomenon of the adult population (Curley et al., 2003). Although potential risk factors for pediatric pressure ulcer development have been postulated, there have been few studies to separate factors associated with pressure ulcer development from those factors that are true risk factors in the pediatric population. There also have been far fewer studies of pressure ulcer incidence and prevalence in the pediatric population than in the adult population (Gray, 2004). Information gained from adult studies has been adjusted to fit characteristics of the neonatal and pediatric populations, in an effort to decrease pressure ulcer development in these populations (Razmus, Lewis, & Wilson, 2008). Support surfaces designed for adults are often used in the pediatric setting, although the ramifications are unknown. Infants and children often sink into low-air loss beds designed for adults, and adult

specialty beds in turning mode increase occipital friction and shearing (McCord et al., 2004; McLane, Krouskop, McCord, & Fraley, 2002). Body proportions of children are significantly different from adult body proportions, with the child's head carrying a greater proportion of body weight than observed in adults (Solis, Krouskop, Trainer, & Marburger, 1988). The use of 2 to 4 inch convoluted foam overlays was identified as a way to decrease the highest interface pressures in the occiput in younger children and in the sacrum in older children (McLane et al., 2002; Solis et al., 1988).

Statement of the Problem

Pressure ulcers are defined as localized areas of tissue destruction that develop when soft tissue is compressed between a bony prominence and an external surface for a prolonged period of time (National Pressure Ulcer Advisory Panel, 2007). Pressure ulcers are staged in order to classify the degree of tissue damage observed (National Pressure Ulcer Advisory Panel, 1998). Although any hospitalized child is at risk for the development of a pressure ulcer, the critically ill child is at increased risk (McLane et al., 2004). The critical care environment poses special challenges to preventing the development of pressure ulcers secondary to the high acuity of patients and the highly invasive nature of interventions and therapies those patients receive (Gray, 2004). The incidence of pediatric pressure ulcer development in the critical care population has been reported to be as high as 10.2-27% (Curley et al., 2003; Schindler et al., 2007; Schindler, Mikahilov, & Christensen, 2010).

Risk of pressure ulcer development in the pediatric intensive care unit can be stratified into several categories including age, risk of mortality, and increased length of stay (Curley et al., 2003; McCord et al., 2004; Schindler et al., 2007; Schmidt, Berens,

Zollo, Weisner, & Weigle, 1998; Zollo, Gostisha, Berens, Schmidt, & Weigle, 1996). Children who are younger are at higher risk for development of pressure ulcers (McCord et al., 2004; Schindler et al., 2007; Schindler et al., 2010). Although children less than two years of age tend to be higher risk than children older then two years of age, the population at highest overall risk are neonates, ages 0 to 3 months (Gershan & Esterly, 1993; McLane et al., 2002; Willock & Maylor, 2004). This group faces special challenges in the critical care environment, as they have inherent difference in their skin. The epidermal layer in infants is thinner and functionally immature, placing them at high risk for excess water loss and higher permeability to chemicals (Curley & Maloney-Harmon, 2001; Lund, 1999; Lund et al., 2001). The thin epidermis is more likely to blister and become damaged from mechanical trauma and use of adhesives (Lund et al., 2001). The dermal layer is thinner and produces less sebum, thereby providing less protection against drying and evaporation (Curley & Maloney-Harmon, 2001; Lund, 1999; Lund et al., 2001). Newborns have less subcutaneous fat, placing them at higher risk for compression of soft tissue between bone and a hard surface (Jones, Tweed, & Marron, 2001; Lund et al., 2001; Marcellus, 2004).

As overall acuity increases, children are at higher risk for developing pressure ulcers (Curley et al., 2003; McCord et al., 2004; Schindler et al., 2007). The Pediatric Index of Mortality (PIM) 2 is a score calculated using several physiologic indicators and diagnoses collected at admission, and it is predictive for risk of mortality (Slater, Shann, & Pearson, 2003). Increased PIM 2 scores have been associated with overall increases in risk of pressure ulcer development as well (Schindler et al., 2007). Other discrete indicators associated with increased pressure ulcer development include inotropic

utilization for hemodynamic support, conventional mechanical ventilation or high frequency oscillatory ventilation to maintain adequate oxygenation and ventilation, use of extracorporeal membrane oxygenation (ECMO) to maintain adequate tissue perfusion, and cardiac arrest after cardiovascular surgery (Gershan & Esterly, 1993; McCord et al., 2004; Neidig, Kleiber, & Oppliger, 1989; J. E. Schmidt et al., 1998). As the child's length of stay increases, so does the risk of developing a pressure ulcer. Children with a length of stay greater to or equal to 4 days have a marked increase in risk (McCord et al., 2004; Schindler et al., 2007). Additional risk factors for developing pressure ulcers include nutritional deficits, marked edema, prolonged exposure to prolonged pressure from hospital apparatus or tubes, and not turning the patient (Curley et al., 2003; McCord et al., 2004). A need exists for nurse researchers to identify effective interventions to reduce the incidence of pressure ulcer development in this vulnerable population.

Purpose of the Study

The purpose of this study was two-fold. Its primary focus was to determine whether specific targeted nursing interventions can significantly decrease incidence of pressure ulcers in infants ages 0 to 3 months in the pediatric intensive care unit (PICU). Researchers at Children's Hospital of Wisconsin reported a baseline pressure ulcer incidence in this population of 18.8%. The secondary focus of the study was to evaluate supports and resources provided to nurses as changes in practice were implemented. In order to effect change in practice, it is important to design a comprehensive, supported, and sustained approach to implementation of the intervention (Clarke et al., 2005). When implementing an innovation such as evidence based nursing interventions, supportive environments are imperative, as is identification of potential barriers to success. A

systematic approach in planning may ameliorate some the inherent challenges of practice change, including introduction of new technology, new knowledge, and additional demands on nursing time (Clarke et al., 2005). A survey of the PICU staff was utilized to identify both facilitators and barriers to change.

Specific Aims

The primary aim of this study was to evaluate the effectiveness of implementing a skin care bundle on the incidence of pressure ulcer development in a high risk subset of patients (infants 0 to 3 months of age) in the PICU at a large tertiary care children's medical center. The secondary aim of the study was to identify potential barriers and facilitators to successful implementation of the intervention, in order to provide insight on the best approach to implementing this clinical nursing intervention.

Research Questions/Hypotheses

Investigators from Children's Hospital of Wisconsin (CHW) conducted a large multi-site study exploring nursing interventions associated with lower pressure ulcer incidence in the PICU population (Schindler, Mikhailov, & Conway, 2009). Results from this study were used for the design of the skin care bundle implemented in the PICU. Strategies associated with less frequent pressure ulcer development included use of specialty beds, egg crates, foam overlays, gel pads, dry weave diapers, foley catheters, chux, body lotion, nutrition consults, turning every 2 hours, blanket rolls, foam wedges, pillows, and draw sheets (Schindler et al., 2009). These results were used to design a specific skin care bundle that was hypothesized to decrease the overall incidence of pressure ulcer development**.** Components of this bundle include "S" (support surface),

"K" (keep turning every two hours), "I" (improve moisture management/incontinence management), and "N" (nutrition consultation).

The specific hypotheses tested were:

1. There will be a significant reduction in pressure ulcer incidence in the group receiving the complete S.K.I.N. care bundle when compared with the standard care group.
2. There will be an inverse relationship between length of stay and pressure ulcer incidence, regardless of intervention (i.e., kids with increased length of stay will have higher overall incidence of pressure ulcer development).
3. There will be an inverse relationship between risk of mortality and pressure ulcer incidence (i.e., children with increased PIM 2 scores will have a higher overall incidence of pressure ulcer development).

Conceptual Framework

Braden and Bergstom (1987) described a conceptual framework that organizes the physiologic knowledge about the etiology of pressure ulcers. The conceptual framework identified intensity and duration of pressure and tissue tolerance as primary determinants of pressure ulcer development. The conceptual framework identified intensity and duration of pressure and tissue tolerance as two primary determinants of pressure ulcer development (Braden & Bergstrom, 1987). Factors that contribute to pressure include decreased mobility, decreased activity, and impaired sensory perception. Factors that contribute to tissue tolerance can be divided into extrinsic factors that include moisture, friction, and shear, as well as intrinsic factors that include nutrition, age, and arteriolar pressure (Braden & Bergstrom, 1987). In order to facilitate further inquiry into pressure

ulcer development in the pediatric critical care population, Braden and Bergstrom's (1987) conceptual framework was utilized as a guiding framework for this study. It was modified in order to describe the hypothesized mechanism for a targeted nursing intervention to decrease incidence of pressure ulcer development in children, aged 0 to 3 months, in the PICU (see Appendix A).

Braden and Bergstrom's (1987) conceptual framework serves as the template for the Braden Scale for Predicting Pressure Ulcer Risk, as well as the Braden Q Scale for Predicting Pediatric Pressure Ulcer Risk (Bergstrom, Braden, Laguzza, & Holman, 1987; Curley, Razmus, Roberts, & Wypij, 2003). The Braden Scale for Predicting Pressure Ulcer Risk has been validated in several diverse adult patient populations and is a commonly utilized pressure ulcer risk prediction tool in adult clinical settings (Bergstrom, Demuth, & Braden, 1987; Bergstrom, Braden, Kemp, Champagne, & Ruby, 1998; Braden & Bergstrom, 1994). Quigley and Curley (1996) adapted the Braden Scale for use in the pediatric population to incorporate the unique developmental needs of this population. This adapted scale, the Braden Q Scale, included a "tissue perfusion and oxygenation" subscale, in order to account for changes in skin perfusion in children with low arteriolar pressure (Quigley & Curley, 1996). Performance of the Braden Q Scale in a pediatric population is similar to that consistently reported for the Braden Scale in adult patients (Curley, Razmus et al., 2003).

The conceptual model builds on Braden and Bergstom's two primary determinants of pressure ulcer development, namely impaired tissue tolerance and intensity and duration of pressure. Critically ill children in the PICU have extrinsic risk factors for decreased tissue tolerance including increased moisture from incontinence and

dry skin from frequent bathing. Wet skin has been associated with development of rashes, is softer, and tends to break down more easily (Butler, 2006; Lund et al., 2001; Samaniego, 2003). In addition, fecal incontinence is a risk factor for pressure ulcer development, as stool contains bacteria and enzymes that are caustic to the skin (Wound Ostomy and Continence Nurses Society, 2003). In order to ameliorate the risk of incontinence contributing to pressure ulcer development, zinc-based barrier cream was used with each diaper change (Wound Ostomy and Continence Nurses Society, 2003). Although the goal is to keep the patient dry, it is important to keep the skin moisturized. Bathing was minimized, and when the infants were bathed, gentle use of mild, non-alkaline cleansing agents were used to minimize dryness of the skin (Wound Ostomy and Continence Nurses Society, 2003). Children in the PICU also have instrinsic risk factors for decreased tissue tolerance including poor nutrition (Garvin, 1997; Langemo & Brown, 2006). Therefore, any child who scored a “1” or “2” in the nutrition subcategory of the Braden Q received a nutrition consultation by a registered dietician. By attempting to ameliorate instrinsic and extrinsic risks to tissue tolerance, it was hypothesized that the child would have improved tissue tolerance, contributing to decreased pressure ulcer development.

The conceptual model developed for this study also addressed intensity and duration of pressure experienced by children in the PICU. Immobilization often occurs during a critical or extended illness, secondary to intubation, sedation, restraints, and consequences of the disease process (Langemo & Brown, 2006). This immobilization results in both decreased movement and decreased activity, thereby increasing risk for soft tissue compression. Tissue destruction develops when soft tissue is compressed

between a bony prominence and an external surface for a prolonged period of time, and the arterioles and capillaries collapse under this external pressure (Bryant, 2000; Quigley & Curley, 1996). Compression of the vessels cuts off blood supply that nourishes cells, resulting in limited oxygen supply and decreased supply of vital nutrients, resulting in hypoxia, cellular death, injury in the surrounding area, and ultimately a pressure ulcer (Butler, 2006; Pallija et al., 1999). Two factors contributing to the increase in compressive forces are intensity and duration of pressure. Increased pressure over short periods of time, and slight pressure over long periods of time, have resulted in equal damage to local tissue (Neidig et al., 1989).

Capillary closing pressure is the amount of pressure required to impede flow of oxygen and blood to the tissues. Baseline pressure in arterial skin capillaries needs to keep the capillary open for tissue perfusion ranges from 25 to 30 mm Hg at the arterial end and 5 to 10 mm Hg at the venous end (Koziak, 1959; Lindan, Greenway, & Piazza, 1965). When pressure on the tissue and underlying capillaries exceeds these pressures for two or more hours, or if it excessively exceeds these parameters for shorter durations, tissue damage and ultimately tissue necrosis can occur (Seiler & Stahelin, 1979).

Interface pressure is the amount of pressure the resting surface places on skin over a bony prominence. Interface pressures acting on the body are not uniform (Lindan et al., 1965; Seiler & Stahelin, 1979). Highest pressure areas overlie bony prominences, although circulatory responses to externally applied pressure in areas adjacent to bone are variable (Lindan et al., 1965; Sangeorzan, Harrington, & Wyss, 1989). In adults, sacral pressures can reach 70 mmHg after short periods of immobilization, and pressure under an unsupported heel can reach 45 mmHg (Crediror, 1993).

In order to relieve pressure, particularly over bony prominences, it is essential to place infants on a pressure relieving surface. Children in this study were placed on a Delta-202 Warmer Overlay (29” x 23.75” x 2.25”). This particular overlay was found to reduce occipital interface pressure in children less than 2 years of age, as well as having the lowest tissue interface pressure in neonates (McLane et al., 2002; Turnage-Carrier, McLane, & Gregurich, 2008a). Another strategy for limiting pressure over bony prominences is frequent turning. The aim of repositioning is to reduce or eliminate pressure, in order to maintain circulation to areas of the body at risk for pressure ulcer development (Hardy et al., 2007; Lund et al., 2001; Marcellus, 2004; Willock & Maylor, 2004). Gel-filled pillows were used by nurses to assist with positioning and padding bony prominences (McLane et al., 2004; Reddy et al., 2006). By attempting to ameliorate risks related to intensity and duration of pressure, it was hypothesized that the child would have decreased tissue interface pressures, contributing to decreased pressure ulcer development.

Summary

In this chapter, an overview of the significance of pediatric pressure ulcers, as well as a rationale for exploring potential interventions for decreasing pressure ulcer incidence in a select group of patients in the pediatric intensive care unit, was presented. Specific aims of the study were described, and supporting hypotheses were identified. The conceptual framework based on Braden and Bergstrom’s classic work was described as the underpinning of the conceptual model that was developed to guide this study. The aim of this study was to address gaps in the literature that exist related to identification

and testing of interventions to reduce the development of pressure ulcers in this vulnerable population.

CHAPTER TWO

Review of the Literature

Critical Review of the Literature

Chapter Two will include a review of the literature relevant to pressure ulcer development in general and specifically in the pediatric population. In Chapter One, the role of pressure in the face of immobility as the key determinant of pressure ulcer development was described. The Delta foam overlay was identified as way of reducing the tissue interface pressure, therefore ameliorating some of the risk associated with immobility and decreased activity. In this chapter, the literature as it relates to the other risk factors and proposed nursing interventions aimed at ameliorating the risk of developing a pressure ulcer while in the pediatric intensive care unit (PICU) will be reviewed. This review of the literature will include a summary of relevant research concepts specific to risk factors for pressure ulcer development in critically ill infants, including increased moisture and impaired nutrition. The preventive factors not previously described in Chapter One will be explored through a comprehensive review of the literature, including the use of barrier creams, non alkaline cleansing agents, and optimizing nutritional support. This review will identify gaps in the literature and the way in which this study addressed some of the current gaps in scientific knowledge related to pressure ulcer prevention in this vulnerable population. Chapter Two also contains a description of the philosophical underpinnings of the research and the theoretical stance that informs the research design will be described.

Critical Illness and Pressure Ulcer Development

Prevention of pressure ulcers is a two step process. The first step is to identify patients at risk and the second step is to reliably implement effective prevention strategies for those patients identified as being at risk (Brandeis, Berlowita, & Katz, 2001). We know that adults in the critical care environment are at high risk for development of pressure ulcers, secondary to a host of risk factors including disease states that necessitate admission to the critical care environment, therapies used to manage these disease states, as well as decreased sensory perception and mobility related to sedation. These states can lead to prolonged periods of unrelieved pressure resulting in soft tissue ischemia and ultimately development of a pressure ulcer (Boyle & Green, 2001; Braden & Bergstrom, 1987; Carlson, Kemp, & Shott, 1999; Clark, 2003; Pender & Frazier, 2005). Many patients in the critical care unit experience severe dysfunction or failure of organ systems and may also experience skin failure as part of multi-system organ failure. Langemo and Brown (2006) described skin failure as an event in which the skin and underlying tissue die due to hypoperfusion that occurs concurrently with severe dysfunction or failure of other organ systems. Development of skin failure, whether acute or chronic, can make pressure ulcer prevention an even more difficult task in those patients with a heavy disease burden, as those seen in the pediatric intensive care unit.

Although there are many similarities in risk profiles for children in the intensive care unit including marked edema, limited positioning options, nutritional deficits, poor tissue perfusion and oxygenation, and exposure to prolonged pressure from hospital apparatus or tubes, additional pediatric specific risk factors have been identified in the literature (Gray, 2004; McCord et al., 2004; Quigley & Curley, 1996; Schindler et al.,

2007). Children and infants have a greater head-to-body proportion compared to adults which predisposes them to occipital pressure ulcers (Garvin, 1997; McCord et al., 2004; Solis et al., 1988). Additionally, children may have specific neurologic impairments, including myelomeningocele, that place them at higher risk for recurrent pressure ulcers (Willock & Maylor, 2004).

Moisture and Pressure Ulcer Development

Wet skin plays a significant role in pressure ulcer development. Wet skin is more amenable to the development of several types of skin pathology including rashes, diaper dermatitis, and most importantly the development of pressure ulcers (Fader, Clarke-O'Neill, & Cook, 2003; Schnelle et al., 1997). Both urinary and fecal incontinence play a role in the development of pressure ulcers (Brown & Sears, 1993; Lund, 1999; Lund et al., 2001). Perineal dermatitis can be produced by the ammonia and uric acid from urine, when there is prolonged contact with the skin (Schnelle et al., 1997). Perineal dermatitis results in irritation and decreased structural integrity, making the skin more friable and placing the patient at high risk for pressure ulcer development (Schnelle et al., 1997). Although urinary incontinence plays an important role in pressure ulcer development, fecal incontinence is particularly damaging because of the bacteria and enzymes present in the feces that can be caustic to the skin and may disrupt the skin's natural balance of flora (Shannon & Skorga, 1989). Skin has a mean pH of 5.5, which is slightly acidic and acts as a natural barrier to discourage bacterial growth (Fiers, 1996; Whitely, 2007). Both urine and feces are alkaline in nature; therefore when incontinence occurs, the skin pH becomes more alkaline, making it susceptible to irritation (Berg, 1986; Le Lievre, 2000). Children in the intensive care unit face developmental, cognitive, and physical

impairments that may limit their ability to maintain continence of their bowel and bladder (Lund, 1999; Lund et al., 2001; M. Reddy et al., 2006). The role of moisture management is essential, and prompt cleansing of the skin is essential for decreasing the damaging effects of incontinence (Lund, 1999; Lund et al., 2001).

Barrier Creams/ Non alkaline cleansing agents

As a part of a holistic skin care regimen, it is essential to keep the skin protected from the impact of urinary and fecal incontinence. Two main approaches are supported in the literature. These approaches include protecting the skin from incontinence with a protective barrier cream, and the second approach is to utilize a non-alkaline cleaning agent to minimize irritation to the skin, prevent dryness, and restore normal pH of the skin (Bale, Tebble, Jones, & Price, 2004; Hunter et al., 1995; Lund, 1999; Lund et al., 2001; Thompson, Langemo, Anderson, Hanson, & Hunter, 2005; Wound Ostomy and Continence Nurses Society, 2003). In order to maximize effectiveness, barrier creams should be applied with each incontinent episode (Lund, 1999; Nield & Kamat, 2007; Wound Ostomy and Continence Nurses Society, 2003). Ideally, the barrier cream should remain in contact with the skin despite cleansing and should have an active ingredient of zinc oxide, dimethicone, or other high quality silicone (Dealey, 1995; Wound Ostomy and Continence Nurses Society, 2003). Petroleum based skin protectants should be avoided in the diaper area as they only protect for a short time, do not remain in contact with the skin, and can actually interfere with absorption of urine into the diaper (Montoya, 2008; Wound Ostomy and Continence Nurses Society, 2003).

Nutrition and Pressure Ulcer Development

Good nutrition is essential for optimal functioning of the body and can help to optimize proper immune function (T. Schmidt, 2002). On the other hand, poor nutrition can cause multiple deleterious effects on overall function by altering the body's metabolism, inhibiting tissue regeneration, and affecting the body's inflammatory response (Thomas, 2001). There is a strong relationship between nutritional status including adequate hydration and pressure ulcer development (J. Maklebust & Magnan, 1994; Shannon & Skorga, 1989). Adequate nutrition and hydration play an important role in the prevention of pressure ulcers, as well as in the maintenance of tissue integrity (Allman, 1986; Breslow, 1991; Ek, Unosson, Larrson, von Schneck, & Bjurulf, 1991; Ferguson, Rimmasch, Voss, Cook, & Bender, 2000; Fuoco, Scivoletto, Pace, Vona, & Catellanno, 1997; Gilmore, Robinson, Posthauer, & Raymond, 1995; Himes, 1999; Strauss & Margolis, 1996; Thomas, 1997). Adult patients who are malnourished are twice as likely to develop pressure ulcers as those patients who receive adequate nutrition (Thomas, 1997). A combination of lean body mass and immobility increases the risk of pressure ulcer development by 74% (Horn, Bender, & Feguson, 2004). Severity of pressure ulcers is also highly associated with nutritional status. The majority of adult patients with Stages III and IV pressure ulcers were noted to be below their usual body weight, had a low prealbumin, and were not receiving enough nutrition to meet their needs (Guenter et al., 2000). Although it is important to assess the patient while in the hospital, there is some evidence to suggest that there is a strong link to pre-hospital nutritional status and the development of pressure ulcers, indicating that early assessment is essential for optimizing nutritional status (Lewis, 1998). There is a paucity of literature

related to the role of nutritional status and the development of pressure ulcer development in children, but existing evidence suggests that there is a relationship between inadequate nutrition and pressure ulcer development (Curley et al., 2003; Gordon, 2008; Rodriguez-Key & Alonzi, 2007). Additionally, children with a history of prematurity, chromosomal abnormalities, or neurologic abnormalities appear to be at increased risk for nutritional deficits (Rodriguez-Key & Alonzi, 2007).

Nutrition Consultation

The importance of dietary assessments as a tool for identifying patients at high risk for inadequate nutrition is supported in the literature (Bergstrom et al., 1987; Curley, Razmus et al., 2003; J. Maklebust & Magnan, 1994; Ripley, 2006; Schols & de Jager-v.d.Ende, 2004). There is an association between inadequate dietary intake of calories and protein and pressure ulcer risk and development (Bergstrom & Braden, 1992; Berlowitz & Wilking, 1989; Breslow, 1991; Maklebust & Sieggreen, 1996; Piloian, 1992). A complete nutrition history should include questions related to the patient's recent dietary intake, food preferences, food intolerances, dietary modifications, use of medical nutritional supplements, use of vitamin and herbal supplements, and any recent weight gain or loss (Ferguson et al., 2000; Hengstermann, Fischer, Steinhagen-Thiessen, & Schulz, 2007). Use of nutritional guidelines in daily practice with patients at risk for pressure ulcer development is helpful in ensuring nutritional screening in daily practice, as well as the content and extent of the nutritional assessments (Meijers et al., 2008). The Braden Q Scale provides a sub-category that assists nurses in assessing nutritional status of patient by providing four well-defined subcategories that stratify a child's nutrition status (Curley, Razmus et al., 2003; Quigley & Curley, 1996). Nutritional assessment of

children is a multidisciplinary endeavor that should include registered dieticians, nurses, and physicians (Ripley, 2006). A research based approach to increase the use of nutritional screening is to have nurses screen all patients and identify individuals at high risk for inadequate nutrition. Those individuals found to be at high risk should be referred to a specialist, such as a registered dietician (Williams, 2005). An 80% risk reduction for the development of pressure ulcers in children was found when a registered dietician consulted during the admission process (Schindler et al., 2010).

Gaps in the Literature

The intensive care unit (ICU) and critically ill patients in the ICU pose unique challenges to staff caring for them. They have a high degree of physiologic instability requiring a coordinated approach to care, including a comprehensive approach to pressure ulcer pressure ulcer prevention. Much of the pressure ulcer prevention care that nurses provide is steeped in tradition rather than evidence. Pediatric intensive care unit (PICU) nurses are faced with caring for the skin of some of the most vulnerable patients, and evidence based interventions are needed to provide the most effective care.

There are significant gaps in the literature as it relates to pediatric pressure ulcer development and interventions targeted at reducing risk. Although there has been some research about the use of foam overlays in pediatrics, none of the studies have been conducted in acutely or critically ill children (McLane et al., 2002; Turnage-Carrier et al., 2008). It was an important first step to determine that tissue interface pressure is lower in healthy controls; however, it is unclear how this finding will translate to critically ill infants. The principal investigator was unable to locate any published studies in which turning protocols and their role in pressure ulcer prevention in critically ill infants were

evaluated. Many of the recommended guidelines promote turning patients every two hours (Butler, 2006; Quigley & Curley, 1996). Although this routine is the recommendation, there has been some evidence in the adult literature to suggest that an two hour turning schedule may not be necessary (Bates-Jensen et al., 2003; Bates-Jensen, Cadogan, Jorge, & Schnelle, 2003; Schnelle, Ouslander, Simmons, Alessi, & Gravel, 1993). It is critical to identify the impact of turning frequency in the pediatric population before applying empirical evidence from adult clinical trials, as there are key physiologic and structural differences in the two populations. It is evident that adequate nutrition is a key determinant of improved tissue tolerance and investigators have provided evidence that optimizing nutrition in the hospital setting is an effective way to help prevent pressure ulcer development (Allman, 1986; Breslow, 1991; Ek et al., 1991; Ferguson et al., 2000; Fuoco et al., 1997; Gilmore et al., 1995; Himes, 1999; Strauss & Margolis, 1996; Thomas, 1997). What is less clear is the role of risk assessment tools as prompts for involving a registered dietician in care, methods for achieving optimal nutrition status in critically ill children, and the best interventions for maintaining skin integrity after a child is determined to be at risk.

There has been a fair amount of research conducted to investigate the role of barrier creams in prevention of diaper dermatitis, but there is no convincing evidence that supports the role barrier creams have in improving overall intrinsic tissue tolerance. It remains unclear whether these creams reduce the risk for pressure ulcer development (Dealey, 1995; Lund, 1999; Lund et al., 2001; Montoya, 2008; Wound Ostomy and Continence Nurses Society, 2003).

The Institute for Healthcare Improvement (IHI) defines a bundle as a grouping of several scientifically grounded elements, essential for improving clinical outcomes. Ideally, the bundle should be a set of three to five evidence-based practices or precautionary steps, that when used together, may result in significant improvement (IHI, 2006). There is a paucity of research that evaluates a comprehensive approach to pressure ulcer prevention. This research study makes an original contribution to nursing as the proposed intervention bundles four evidence based strategies together, in an attempt to synergistically lower pressure ulcer development in this vulnerable population. The results may not be directly generalizable to other age groups, but may provide a framework for care in this population.

Philosophical Underpinnings

In order for the profession of nursing to move forward, it is important to understand where the history of the origin of nursing and how the discipline was conceptualized from the beginning. Nursing often has been characterized as both an art and a science. Florence Nightingale described the art of nursing as a reparative process in which nursing was to help and support nature's own healing process (Nightingale, 1992). Nightingale likely used "art" in a metaphorical mode when trying to articulate the nature of nursing, whereby the term "art" broadens the perception of nursing as something of excellent quality (Austgard, 2006). Another conceptualization of nursing as art is related to aesthetics which is a concept with several meanings including feelings, senses, perceptions, and impressions, all of which are used by nurses in professional practice (Austgard, 2006).

Although nursing has roots in aesthetics, it is commonly asserted that nursing is a science that is guided by aims of empirical sciences to describe, explain, and predict occurrences of the world in which we live (Edwards, 1999; Kirkevold, 1997; Parse, 1987; Rogers, 1970). This assertion of nursing as a science has arisen from an attempt to provide an account of what nursing knowledge is and how it is acquired (Allmark, 2003). Nursing science strives to generate knowledge that explains human responses in all of their appearances (Giuliano, 2003).

Scientific and artistic explorations are distinctive modes of inquiry that are both valid, despite their essentially different natures (Brownowski, 1956). This dichotomous view of nursing has given way to an assertion that there needs to be a paradigm shift within nursing that acknowledges nursing as an art and science, with a blending of humanism and positivism (Playle, 1995). While nursing knowledge is underpinned by the philosophies of art and science, they are integrated in such a way that nursing is greater than their sum and therefore a unique discipline (Rose, 1994).

Scientific inquiry in nursing is underpinned by various philosophies which serve many functions when advancing the science through research. A researcher's guiding philosophy helps the researcher to refine and specify the research methods, assists the researcher in evaluating different methodologies, and helps the researcher be creative and innovative (Easterby-Smith, 1997). Shih (1998) expanded this idea and identified four areas for consideration when determining a research method: the philosophical paradigm and the goal of the research, the nature of the phenomenon of interest, the level and nature of the research questions, practical consideration related to the research environment, and the efficient use of resources. Scientific inquiry in nursing has

philosophical roots that are diverse and support multiple ways of knowing, including empirics, personal, ethics, and aesthetics (Carper, 1978). These diverse ways of knowing also require diverse methods for scientific inquiry, in order to expand the scientific knowledge base within the discipline of nursing (Fawcett, 1999).

The legacy of positivism which promotes objectivity and reductionism excludes subjective meaning from the research process (Playle, 1995). Positivism and its conceptions of truth and inquiry have philosophically been widely dismissed as incompatible with nursing research (Clark, 1998; Guba & Lincoln, 1994). One criticism has been the positivist adherence to atheoretical, abiased views of researchers' involvement in the research process (Clark, 1998; Holton, 1993). The positivists tried to build a cumulative, universal, and law-centered view of science that was challenged by Popper, Kuhn, and Brownowski, who were known as the inductive skeptics and are noted to be the main influences in promoting post-positivist philosophies (Brownowski, 1956; Holton, 1993; Kuhn, 1970; K. Popper, 1959). Popper and Brownowski claimed that post positivism provided an alternative to the traditions and foundations of positivism for conducting disciplined inquiry (Brownowski, 1956; K. Popper, 1959). Post positivists had the less ambitious aim of gaining a greater approximation of the truth, rather than universal truths that the positivists sought (Clark, 1998). Under post positivist philosophy, the researcher and his or her perceptions were not seen as being wholly detached from inquiry (Clark, 1998).

Karl Popper provided a new framework for research. He argued that the correct method in science is to postulate hypotheses or conjectures about world. Then, predictions could be made by use of deductive reasoning, followed by attempts to falsify

them by criticism and empirical tests (Popper, 1974). Popper proposed that scientific knowledge consisted of theories or conjectures that had not yet been falsified, rather than theories or conjectures that were shown to be true (Allmark, 2003). Popper challenged the positivist belief that researchers were a neutral observers. He asserted that observations are not passive, but rather, they are a function of ideas limited by senses. He claimed that observation is theory dependent, and that the starting point of science is never pure observation (Popper, 1972).

Post positivism assumes that reality is multiple, subjective, and mentally constructed by individuals. Researchers interact with those being researched and findings are an iterative process with a focus on meaning and understanding of the situation or phenomenon under examination (Crossan, 2003). This philosophy has given way to interpretive methods that recognize that reality has multiple meanings and reality is context dependent. The interpretive philosophy can address some of the pitfalls in empiricism when trying to understand the human experience, but there are some variables that remain only accessible through empirical measures (Monti & Tingen, 1999). Contemporary empiricism is a paradigm that has the ability to facilitate the application of the scientific facts learned from empirical methods within the appropriate context by taking interpretive knowledge into account (Giuliano, 2003).

Prior to Kuhn's "The Structure of Scientific Revolution," logical positivism predominated in scientific circles. In 1970, Kuhn introduced the concept of paradigmatic revolutionary science (Kuhn, 1970). A paradigm is a set of laws, heuristic models, metaphysical commitments, values, and methodological prescriptions that a researcher accepts or rejects as a cohesive whole (Hussey, 2002). This world view is a metaphorical

lens of some theory that the researcher may use to understand his or her reality (Edwards, 1999). Kuhn argued that science is not a steady progress towards the truth. He believed that when science emerges, there are two broad phases of activity. In what he coined as "normal science," scientists work within a paradigm, and they apply their theories to various problems or puzzles (Antognoli-Toland, 1999). For Kuhn, normal science was a dynamic process, interrupted by explosive intermittent revolutions that changed the direction or growth within and across the discipline. He stressed that values, beliefs, and societal events play an integral part in these changes arising from discovery, understanding, and explaining new and existing phenomena (Kuhn, 1970).

Kuhn defined a paradigm as a unique combination of ontology, epistemology, and methodology, shared by a scientific community to define legitimate problems and solutions (Kuhn, 1970). Meleis (1999) stated that nursing maintains a world view of truth that includes an integration of norms emanating from different theories of truth. Meleis (1999) divided nursing into three epistemological categories: correspondence, coherence, and pragmatism. The correspondence view requires sensory data, variables, and operational definitions with careful rules that represent our empiricist heritage. Coherence is characterized by the logical way in which relationships and judgments are related, and truth is viewed in a transitory fashion that represents a qualitative heritage. The pragmatic view that is not solely based on evidence confirms a heritage of practice wisdom (Meleis, 1999). Nursing has a philosophical stance that embraces holism and cannot deny biological phenomena or preclude research on these phenomena, despite a subtle but persistent reluctance to include basic science questions or techniques as a mean of generating nursing knowledge (Perry, 1994). Although there has been a paradigm shift

that emphasizes interpretive methods, nursing should not dismiss the empirical approach based solely on the weaknesses of the positivist philosophy (A. Clark, 1998). Nursing should move towards a philosophical pluralism that emphasizes dialogue between empiricist and interpretive knowledge (Giuliano, 2003; Im & Chee, 2003).

The philosophers of the post positivist paradigm have provided the philosophical underpinning for this dissertation research. The goal of this study is to add knowledge to the understanding of the prevention of pressure ulcers in critically ill infants. In order to study the phenomenon of pressure ulcers, and more specifically pressure ulcer prevention, Popper's four phase approach to scientific theory development was utilized (Allmark, 2003). In the first phase Braden and Bergstom's theoretical model of pressure ulcer development provided a base for the study (Bergstrom et al., 1987). In the second phase, theories and hypotheses were developed to address gaps in knowledge that specifically related to risk factors of pressure ulcer development in critically ill infants, as well as specific nursing strategies that addressed identified risk factors. In phase three, hypotheses were subjected to rigorous testing. Finally, in phase four, evidence was provided to support a new theoretical position. The goals of this study were based on the philosophical stance of gaining a greater approximation of the truth, rather than universal truths. It was recognized that the study was conducted with a theoretical stance, and the researcher was not simply a neutral observer. The overriding goal was to utilize empirical evidence to contribute to the body of nursing knowledge.

Knowledge Development

Theories address relatively specific and concrete phenomena that vary in scope (Fawcett, 1993; Fawcett, 1999). The desire to develop nursing's theoretical base has led

to four levels of theory development literature. Meta-theories focus on philosophical and methodological questions related to the development of theory as a base for nursing (Walker & Avant, 1988). Nursing grand theories are substantively nonspecific being made up of relatively abstract concepts that lack operational definitions and relatively abstract propositions that are not amenable to direct empirical testing (Fawcett, 1993). Nursing grand theories consist of global conceptual frameworks defining broad perspectives for practice and ways of looking at nursing phenomena (Walker & Avant, 1988). Middle-range theories are more circumscribed and are substantively specific, encompassing a limited number of concepts. Middle range theories are made up of relatively concrete concepts that are operationally defined with relatively concrete propositions that can be empirically tested in a direct manner (Fawcett, 1993). Middle range theory is the link between grand nursing theories and nursing practice (Walker & Avant, 1988). Practice theory is the most specific of nursing theories (Fawcett, 1993). At this level of theory, prescriptions or modalities for practice are delineated (Walker & Avant, 1988). Walker and Avant (1988) proposed a model linking the four levels of nursing theory together. They asserted that meta-theory clarifies methodology and roles of each level of theory development in a practice discipline. Subsequently, grand theories serve as a guide for the phenomena of special concern at the middle-range level, which in turn directs the prescriptions of practice theories that are aimed at concrete goal attainment (Walker & Avant, 1988).

Theory synthesis for this study is a middle range theory. The theoretical framework displayed in Appendix A attempts to link the larger theories of pressure ulcer development with nursing practice. It was hypothesized that nursing interventions could

prevent pressure ulcer development in critically ill infants through identification and empirical testing of concrete propositions. Middle range theory is testable and intermediate in scope, adequate in empirical foundations, and it is neither too broad nor too narrow (Liehr & Smith, 1999). Middle range theories are logical and useful for the development of nursing science (Fawcett & Alligood, 2005; Fawcett, 2005). Theories are avenues for learning, critical thinking, and expanding possibilities beyond that which can be predicted and into realms that can be created (Fawcett, 1993). Utilization of nursing theory, when applied in nursing practice, provides a framework for guiding critical thinking processes of reasoning and decision making for nurses to practice in an organized manner (Alligood & Marriner-Tomey, 1997). Crafting these research-practice links can be accomplished through the development of strong middle-range theory. Fawcett (2005) suggested that many middle range theories do not identify the more abstract conceptual models or intellectual paradigms from which the theories were derived. Liehr and Smith (1999) recommended a four step process for middle range theory development. The first step was to clearly articulate the name and approach for generating the identified theory. Next, conceptual and research-practice links should be clarified, and lastly an association between the proposed theory and a disciplinary perspective in nursing should be proposed (Liehr & Smith, 1999).

Theories not only vary in scope, but they also vary in purpose. Descriptive theories describe or name specific characteristics of individuals, groups, or events by summarizing the commonalities found in discrete observations into one or more concepts that are tested by descriptive research (Fawcett, 1993). Explanatory theories specify relationships between two or more concepts developed by correlational research

(Fawcett, 1993). Predictive theories move beyond explanation to the prediction of precise relationships between two or more concepts, or the prediction of differences between groups. Predictive theories are tested utilizing experimental research (Fawcett, 1993). The proposed middle range theory is both descriptive and explanatory and should lay the foundation for the development of a predictive study.

Theory and Conceptual Models

Theory generally is constructed in order to express a new idea or insight into the nature of a phenomenon of interest (Walker & Avant, 1988). Nursing must continue to develop distinctive knowledge base, if it is to assume its place as a legitimate professional discipline (Villaruel, Bishop, Simpson, Jemmott, & Fawcett, 2001). Newman (1983) asserted that theory development in nursing proceeds by means of continuous revolution, rather than by accumulation. She emphasized that revolutionary development of theory is useful in that it locates the development of nursing theory within a matrix of psychological, social, and political factors (Adams, 1991). There are several commonly accepted approaches to theory building including analysis, synthesis, and derivation (Walker & Avant, 1988). A researcher utilizes analysis to clarify, refine, or sharpen concepts, statements, or theories. Theory development through analysis is especially useful in areas in which there is an existing body of theoretical literature, and the theorist dissects a whole into its component parts in order to gain a better understanding (Alligood & Marriner-Tomey, 1997). Theory development through synthesis combines isolated pieces of information that are as yet theoretically unconnected. The theorist utilizes information based on observation to construct a new concept, a new statement, or a new theory (Walker & Avant, 1988). Finally, theory

development through derivation employs analogy or metaphor in transposing and redefining a concept, statement, or theory from one context to another (Walker & Avant, 1988).

Models of a discipline are frameworks or paradigms that address central concepts in that discipline. The science of nursing is recognized as a fundamental pattern of knowing for nurses (Carper, 1978). Conceptual models of nursing and nursing theories help nurse researchers to identify the phenomena of central interest to nursing and to design studies that reflect nursing's distinctive perspective of people interacting with the environment in matters of health (Fawcett, 2000). A structure for that science has been proposed by Fawcett (1993, 1995), according to Kuhn's philosophy of science and scientific development (Kuhn, 1970). It is impossible to conduct research in a conceptual vacuum, keeping with Popper's assertion that it is absurd to assume that theory development proceeds outside the context of a conceptual frame of reference (Fawcett & Gigliotti, 2001; K. R. Popper, 1965). Popper asserted that each conceptual model provides a distinctive frame of reference, more specifically a horizon of expectations and a coherent, internally unified way of thinking about events and processes (Popper, 1965). It is important to explicitly identify the conceptual context for every study in keeping with Hempel's statement that the specification of the model determines in part what consequences may be derived from the theory, and hence, what the theory can describe, explain, or predict (Fawcett & Alligood, 2005). The explicit identification of the model places the research within its intended intellectual and socio-historical context (Fawcett & Gigliotti, 2001). Each conceptual model provides a focus that directs the questions one asks and the theories one proposes and subsequently tests (Alligood & Marriner-Tomey,

1997). The conceptual model provides a network within which questions, theories, and data fit together and makes possible the identification of needed areas of theory development (Alligood & Marriner-Tomey, 1997).

Summary

This chapter provided a review of the literature for each concept in the dissertation research on interventions to decrease pressure ulcer development in the PICU. There are many gaps in the literature related to the specific interventions to prevent pressure ulcer development, as well as gaps in the literature for bundles of care as promoted by the IHI. The philosophers of the post positivist paradigm provided the philosophical underpinning for this dissertation research. The theory synthesis for this dissertation is considered a middle range theory that seeks to add both descriptive and explanatory knowledge to the body of science as it relates to pediatric pressure ulcer development.

CHAPTER THREE

Research Design and Methods

This chapter provides a detailed review of the research design and methods to address the research questions for the dissertation. The research sample, data collection methods, and the statistical analyses are outlined in this chapter. Additionally, the threats to validity are identified and the strategies to limit these threats are addressed. Rationale for the research design and methods are reviewed, in order to justify decisions made.

Research Design

The aim of nursing research is to answer questions or solve problems that are relevant to the nursing profession through systematic inquiry (Polit & Beck, 2004). More specifically, the purposes of nursing research include identification, description, exploration, explanation, prediction, and control of nursing phenomena in order to advance the science of nursing (Polit & Beck, 2004). In general, there are two approaches to nursing research methods. The qualitative approach places a heavy emphasis on understanding the human experience as it is lived. Qualitative research has its philosophical underpinnings in the interpretive paradigm and tends to emphasize the dynamic, holistic, and individual aspects of the human experience (Polit & Beck, 2004; Waltz, Strickland, & Lenz, 2005). The quantitative approach is rooted in objective reality and places a great deal of importance on empirical evidence as the basis for knowledge. Quantitative research has its philosophical underpinnings in the positivist tradition and attempts to isolate relationships between phenomena while controlling for factors that are not under direct observation (Polit & Beck, 2004; Waltz et al., 2005).

The research question should drive the method when conducting research (Waltz et al., 2005). Both qualitative and quantitative research methods add to the body of nursing science and represent different perspectives from which to understand nursing phenomena (Polit & Beck, 2004). This dissertation is most closely aligned with quantitative methods as an approach to test this middle range theory. This dissertation is designed to evaluate the effectiveness of implementation of the S.K.I.N. care bundle in reducing the incidence of pressure ulcers in critically ill infants. In order to address the secondary aim of the research, additional data were collected from the participating nurses via an online survey to determine what barriers the nurses encountered when trying to implement the intervention and what strategies helped them to remain faithful to the intervention. These data were used as an adjunct to the quantitative data in order to gain a broader perspective on the challenges of clinical research and potentially provide insight as to what the best implementation approach might be for clinical nursing interventions.

Research Questions

Q1. Is there a significant reduction in pressure ulcer incidence in the group receiving the complete S.K.I.N. care bundle when compared with the standard care group?

Q2. What is the relationship between length of PICU stay and pressure ulcer incidence regardless of intervention?

Q3. What is the relationship between risk of mortality and pressure ulcer incidence?

Q4. What are the barriers to implementing the S.K.I.N. care bundle?

Q5. What are the facilitators to implementing the S.K.I.N. care bundle?

Setting

The pediatric intensive care unit (PICU) at Children's Hospital of Wisconsin in Milwaukee (CHW) was selected as the site for data collection. CHW is a 294 bed free-standing children's hospital with a 72 bed PICU. In 2009, CHW had 2,751 admissions to the PICU, and of those admissions, 372 were infants between the ages of 0 and 3 months. The principal investigator has access to PICU at CHW, based on employment as a pediatric nurse practitioner with the division of critical care.

Selection of Sample Participants

Investigators from CHW conducted a large multi-site study exploring nursing interventions associated with lower pressure ulcer incidence in the PICU population (Schindler, Mikhailov, & Conway, 2008). Results from this study were used for the design and power analysis of the proposed study. The overall incidence of pressure ulcer development in infants 0-3 months of age at CHW was 18.8%. This prospective, quasi-experimental study was conducted in order to determine whether the S.K.I.N. care bundle was associated with a significant reduction in pressure ulcer development. The primary investigator utilized the previously cited pressure ulcer incidence of 18.8% with infants 0-3 months cared for in the PICU as the control group. Infants from 0-3 months of age admitted to the PICU at CHW between August 1, 2009 and December 31, 2009 were enrolled in the experimental arm of this study. No children were excluded from enrolling in this study because the intention was to gain an understanding of the problem, regardless of diagnosis, gender, risk of mortality, or length of PICU stay.

The goal of this study was to test the null hypothesis that the proportion of pressure ulcer development was identical in the two populations. The criterion for

significance (alpha) was established at 0.05. A 1-tailed test was used, indicating that only an effect in the expected direction was interpreted. With the proposed sample size of 147 enrolled in the current study, and 149 subjects from the previously completed study, the study had power of 80.1% to yield a statistically significant result for an independent t-test. This computation assumed that the difference in proportions is 0.1 (specifically .188 versus .088). This effect size was selected as the smallest effect that would be important to detect, in the sense that any smaller effect would not be of clinical or substantive significance. It was also assumed that this effect size was reasonable, in the sense that an effect of this magnitude could be anticipated in this field of research.

A letter describing the study and inviting nurses to participate in a confidential online survey was drafted by the principal investigator and given to the director of the PICU to distribute to the 242 PICU nurses employed in the 72-bed PICU at CHW. (Appendix B). The survey was designed to identify facilitators and barriers to implementing the S.K.I.N. care bundle. (Appendix C). The principal investigator then sent the link to the anonymous Survey Monkey survey to all 242 PICU nurses. A reminder was sent to all nurses two weeks and four weeks after the survey was made available. The survey was closed shortly after the four-week reminder. All subjects were adult professional nurses. All PICU nurses were eligible to participate in the study as it was designed to determine barriers and facilitators of targeted nursing interventions for all PICU nurses, rather than just a select subset.

Data Collection Methods

The principal investigator utilized two methods of data collection for the study. The VPS (Virtual PICU Systems) is a clinical database dedicated to standardized data

sharing and benchmarking among PICUs and is used to facilitate research at CHW. Each patient in the PICU is assigned a VPS identification number and has data entered into a research database that is available to all researchers with permission, in order to reduce multiple investigators gathering redundant information on the same participants. Data abstracted from the VPS for this study included age, race, length of stay, primary and secondary diagnoses, use of extracorporeal membrane oxygenation (ECMO), PIM2 score, use of non-invasive positive pressure ventilation (NIPPV), use of conventional ventilation, oscillatory ventilation, and previous cardiac or respiratory arrest. The principal investigator also developed an instrument to collect additional study data from participants (Appendix D). Information collected on the data collection instrument included use of vasoactive infusions, Braden Q subcategory scores, location and grade of pressure ulcer, whether or not lotion was applied, use of a specialty mattress was in use, frequency of turning, and documentation of the skin care initiative. The study data were entered into an Access database and linked with the VPS database by VPS ID number to compile the complete data set. This process was completed with assistance from the National Outcomes Center (NOC). CHW participates as a member of the NOC.

The measures that were included in the data collection tool were selected to provide empirical data to support the theoretical and conceptual framework of the study. Demographic data were collected on each patient in order to fully describe the sample. These data included age, race, length of stay, primary and secondary diagnoses, and the pediatric index of mortality 2 score (PIM 2). In order to control for acuity between the study populations as well as evaluate pressure ulcer development and its relationship with patient acuity, PIM 2 was used as the standard measure of acuity. Other discrete

indicators of patient acuity that have been shown to be associated with increased pressure ulcer development in the pediatric population include ECMO, high frequency oscillatory ventilation, mechanical ventilation, non-invasive positive pressure ventilation, vasoactive drips, and cardiac or respiratory arrest (Curley, Quigley, et al., 2003; Gershan & Easterly, 1993; McCord et al., 2004; Schindler et al., 2007; Schmidt et al., 1998). These data were also collected to describe the patient population and provide additional data about acuity. The conceptual framework describes alterations in moisture, nutrition, mobility, and activity as the four main risk factors addressed by the preventative strategies in order to decrease pressure ulcer development. The Braden Q risk assessment is divided into subcategories that assess each of these risk factors. In order to assess each risk factor, the Braden Q subcategory scores were collected rather than just the total score. Although it is the aggregate score that is most sensitive and specific for identifying a patient's risk for pressure ulcer development, the sub-categories allow the investigator to discriminate where patients are most at risk (Curley, Razmus et al., 2003). Additionally, data were collected on specific measures implemented as attempts to reduce pressure ulcer development. These strategies fell into four categories that include pressure reduction surfaces, moisture control, nutrition, turning frequency. The corresponding data that were collected about these preventative measures include whether or not lotion was used on the skin, whether a specialty mattress other than the study surface was used, the frequency at which the children were turned, and whether or not a nutrition consultation was obtained. The theoretical framework supports that these preventative strategies should ultimately decrease pressure ulcer development in the study population and in

order to measure the incidence, the researcher collected data about the location and stage of all identified pressure ulcers.

The data collectors for the study consisted of three registered nurses, one research coordinator, and three research assistants. All of the data collectors completed the Collaborative Institutional Training Initiative (CITI) education prior to starting data collection. The CITI training provided baseline knowledge about research ethics and principals guiding research involving human subjects. In order to facilitate interrater reliability between the data collectors, they participated in training with the principal investigator. The training included an overview of expectations of the data collectors, use of the data collection instrument, methods for extracting patient data, data management, as well as when and how they should contact the principal investigator with concerns or questions about data collection. Each data collector completed eight practice charts to compare data extraction technique with the principal investigator. The charts were then reviewed with each data collector to ensure that proper procedures were being followed. The principal investigator was available for consultation throughout the study, and four additional inter-rater reliability checks were completed on randomly selected charts during the data collection period.

Instruments

Risk of pressure ulcer development was quantified using the Braden Q risk assessment tool. The Braden Q scale is a modification of the adult Braden Scale that was developed and tested in the pediatric population, and its subscales reflect the developmental needs of the pediatric population (Quigley & Curley, 1996). There are seven discrete categories, and each category includes a title and concept descriptor. The

minimum score for each item is “1” (more risk) and a maximum score is “4” (less risk), with potential scores ranging from 7 to 28. The subcategories include mobility, activity, sensory perception, moisture, friction and shear, nutrition, and tissue oxygenation and perfusion. Each subcategory is mutually exclusive (see Table I). The Braden Q risk assessment tool was validated and found to perform similarly to consistent reports for the Braden Scale in adult patients (Curley, Razmus et al., 2003; Bergstrom et al., 1998). Curley (2003) demonstrated the area under the curve for the Braden Q was 0.83, and when using a cutoff score of 16, sensitivity for predicting pressure ulcer development was 0.88 and specificity was 0.58.

PIM 2 scores were used to describe patient acuity. The PIM 2 is a risk of mortality tool that utilizes 10 physiologic indicators and diagnoses collected at admission, in order to calculate risk of death of groups of patients admitted to the PICU (see Table II) (Slater, A., Shann, F., Pearson, G., 2003). By adjusting for differences in severity of illness and diagnosis, the model can be used to compare the standard of care between units and within units over time (Slater, A., Shann, F., Pearson, G., 2003). The model fit the test data well (deciles of risk of goodness-of-fit $\chi 2$ 8.14, p = .42) and discriminated between death and survival well, i.e., area under the receiver operating characteristic (ROC) plot 0.90 (0.89-0.92). The final PIM2 model also fit and discriminated well ($\chi 2$ 11.56, p = 0.17, area 0.90 [0.89 - 0.91]) (Slater, A., Shann, F., Pearson, G., 2003). It has been validated in the pediatric intensive care population, and it has been the most accurate mortality prediction model for the PICU study population (Slater, A. & Shann, F., 2004).

Table I
Braden Q subcategories

Braden Q Subcategories

Mobility: The ability to change and control body position

1. Completely Immobile: Does not make even slight changes in body or extremity position without assistance
2. Very Limited: Makes occasional slight changes in body or extremity position but unable to completely turn self independently
3. Slightly limited: Makes frequent though slight changes in body or extremity position
4. No Limitations: Makes major and frequent changes in position without assistance

Activity: The degree of physical activity

1. Bedfast: Confined to bed
2. Chairfast: Ability to walk severely limited or nonexistent. Cannot bear own weight and/or must be assisted in to chair or wheelchair
3. Walks occasionally: Walks occasionally during day, but for very short distances, with or without assistance. Spends majority of each shift in bed or chair
4. All patients too young to ambulate or walks frequently: Walks outside the room at least twice a day and inside the room at least once every 2 hours during waking hours

Sensory Perception: Ability to respond in a developmentally appropriate way to pressure related discomfort

1. Completely limited: Unresponsive (does not moan, flinch, or grasp) to painful stimuli, due to diminished level of consciousness or sedation or limited ability to feel pain over most of body surface
2. Very limited: Responds only to painful stimuli. Cannot communicate discomfort except by moaning or restlessness or has sensory impairment which limits the ability to feel pain or discomfort over ½ of body
3. Slightly limited: Responds to verbal commands, but cannot always communicate discomfort or need to be turned or has some sensory impairment which limits ability to feel pain or discomfort in 1 or 2 extremities
4. No impairment: Responds to verbal commands. Has no sensory deficit, which limits the ability to feel or communicate pain or discomfort

Moisture: Degree to which skin is exposed to moisture

1. Constantly moist: Skin is kept moist almost constantly by perspiration, urine, drainage, etc. Dampness is detected every time the patient is moved or turned
2. Very moist: Skin is often, but not always moist. Linen must be changed at least every 8 hours.
3. Occasionally moist: Skin is occasionally moist, requiring linen change every 12 hours
4. Rarely moist: Skin is usually dry, routine diaper changes, linen only requires changing every 24 hours

Friction and Shear: Friction occurs when skin moved against support surfaces. Shear occurs when skin and adjacent bony surface slide across one another.

1. Significant problem: Spasticity, contracture, itching, or agitation leads to almost constant thrashing and friction
2. Problem: Requires moderate to maximum assistance in moving. Complete lifting without sliding against sheets is impossible. Frequently slides down in bed or chair, requiring frequent repositioning with maximum assistance
3. Potential problem: Moves feebly or requires minimum assistance. During a move, skin probably slides to some extent against sheets, chair, restraints, or other devices. Maintains relative good position in chair or bed most of the time but occasionally slides down
4. No apparent problem: Able to completely lift patient during a position change. Moves in bed and chair independently and has sufficient muscle strength to lift up completely during move. Maintains good position in bed or chair at all times

Nutrition: Usual food intake pattern

1. Very poor: NPO and/or maintained on clear liquids, or IVs for more than 5 days or albumin <2.5 mg/dl or never eats a complete meal. Rarely eats more than ½ of any food offered. Protein intake includes only 2 servings of meat or dairy products per day. Takes fluids poorly. Does not take a liquid dietary supplement
2. Inadequate: Is on a liquid diet or tube feedings/TPN which provide inadequate calories and minerals for age or albumin <3 mg/dl or rarely eats a complete meal and generally eats only about ½ of any food offered. Protein intake includes only 3 servings of meat or dairy products per day. Occasionally will take a dietary supplement.
3. Adequate: Is on tube feedings or TPN, which provide adequate calories and minerals for age or eats half of most meals. Eats a total of 4 servings of protein (meat, dairy products) each day. Occasionally will refuse a meal, but will usually take a supplement if offered
4. Excellent: Is on a normal diet providing adequate calories for age. For example: eats/drinks most of every meal/feeding. Never refuses a meal. Usually eats a total of 4 or more servings of meat and dairy products. Occasionally eats between meals. Does not require supplementation

Tissue Oxygenation and Perfusion:

1. Extremely compromised: Hypotensive (MAP<50mmHg or 40mmHg in a newborn) or the patient does not physiologically tolerate position changes
2. Compromised: Normotensive; oxygen saturation may be <95% or hemoglobin may be <10 mg/dl or capillary refill may be > 2 seconds; serum pH is <7.40
3. Adequate: Compromised: Normotensive; oxygen saturation may be <95% or hemoglobin may be <10 mg/dl or capillary refill may be > 2 seconds; serum pH is normal
4. Excellent: Normotensive, oxygen saturation >95%; normal hemoglobin; capillary refill< 2 seconds

Table II
Pediatric Index of Mortality 2

PIM 2 physiologic and diagnostic categories

1. Systolic blood pressure, mmHg (unknown=120)
2. Pupillary reaction to bright light (>3 mm and both fixed=1, other or unknown=0)
3. PaO2, mmHg (unknown=0), FiO2 at time of PaO2, if oxygen via ETT or headbox (unknown=0)
4. Base excess in arterial or capillary blood, mmol/l (unknown=0)
5. Mechanical ventilation at any time during the first hour in the ICU (no=0, yes=1)
6. Elective admission to the ICU (no=0, yes=1)
7. Recovery from surgery or a procedure is the main reason for ICU admission (no=0, yes=1)
8. Admitted following cardiac bypass (no=0, yes=1)
9. High risk diagnosis. Record the number in brackets. If in doubt record 0.
   [0] None
   [1] Cardiac arrest preceding ICU admission
   [2] Severe combined immune deficiency
   [3] Leukemia or lymphoma after first induction
   [4] Spontaneous cerebral hemorrhage
   [5] Cardiomyopathy or myocarditis
   [6] Hypoplastic left heart syndrome
   [7] HIV infection
   [8] Liver failure is the main reason for ICU admission
   [9] Neuro-degenerative disorder
10. Low risk diagnosis. Record the number in brackets. If in doubt record 0.
   [0] None
   [1] Asthma is the main reason for ICU admission
   [2] Bronchiolitis is the main reason for ICU admission
   [3] Croup is the main reason for ICU admission
   [4] Obstructive sleep apnea is the main reason for ICU admission
   [5] Diabetic ketoacidosis is the main reason for ICU admission.

Research Procedures

In the intervention group, the nursing staff participated in an online educational module about the Braden Q pressure ulcer risk assessment, pressure ulcer identification and grading, as well as education on the components of the S.K.I.N. care bundle intervention. The education module was an interactive online tutorial developed by the principal investigator and placed on the Children's University educational platform. Compliance with the education was tracked, and the principal investigator partnered with the nursing supervisors to ensure compliance with the education. Education about the Braden Q was essential, as prompt identification of at-risk patients is essential for providing timely implementation of prevention strategies (Wound Ostomy and Continence Nurses Society, 2003). Pediatric risk assessments were completed every 24 hours, as assessing risk provides caregivers the opportunity to re-evaluate the child's risk as their condition can rapidly change in the intensive care setting (Ayello & Braden, 2001). The education provided information about how to best conduct a full skin assessment and emphasized that infants are at highest risk for the development of occipital pressure ulcers, as the head makes up a disproportionately higher percentage of their total body weight (Huffiness & Lodgson, 1997; Neidig et al., 1989). When supine, the occiput becomes the primary pressure point, with the greatest tissue interface pressure (Solis et al., 1988). The current nursing flowsheets used during the study had a section related to skin assessment that included identification, location, and grade of pressure ulcers. The education emphasized the importance of documentation as a method of ensuring the skin was assessed, as well its utility as a communication tool. The tutorial

provided examples of how to complete documentation in order to facilitate tracking and communication about any identified pressure ulcers.

The IHI defined a bundle as a grouping of several scientifically grounded elements, essential for improving clinical outcomes. Ideally, the bundle should be a set of three to five evidence-based practices, or precautionary steps, that when used together, may result in significant improvement (Institute for Healthcare Improvement, 2006). The intervention in the study was a skin care bundle that included four components: “S” (support surfaces), “K” (keep turning every two hours), “I” (improve moisture management/incontinence management), and “N” (nutrition consultation). In order to relieve pressure, particularly over bony prominences, it was essential to place infants on a pressure relieving surface. The children in this study were placed on a Delta-202 Warmer Overlay (29” x 23.75” x 2.25”). This particular overlay was found to reduce the occipital interface pressure in children less than 2 years of age (McLane et al., 2002; Turnage-Carrier, McLane, & Gregurich, 2008). Another strategy to limit pressure over bony prominences was frequent turning. The aim of repositioning was to reduce or eliminate pressure, in order to maintain circulation to areas of the body at risk for pressure ulcer development (Lund et al., 2001). Gel-filled pillows were used by nurses to assist with positioning and padding bony prominences (McLane et al., 2002; Reddy, Gill, & Rochon, 2006). The third component of the intervention was to improve moisture and incontinence management. Wet skin has been associated with development of rashes, is softer, and tends to break down more easily. In addition, fecal incontinence is a risk factor for pressure ulcer development, as stool contains bacteria and enzymes that are caustic to the skin (Wound Ostomy and Continence Nurses Society, 2003). In order to

ameliorate the risk of incontinence contributing to pressure ulcer development, zinc-based barrier cream was used with each diaper change. Although the goal was to keep the patient dry, it is important to keep the skin moisturized. Bathing was minimized, and when the infants were bathed, gentle use of mild, non-alkaline cleansing agents were used to minimize dryness of the skin. Finally, any child who scored a "1" or "2" in the nutrition subcategory of the Braden Q received a nutrition consultation by a registered dietician.

A pressure ulcer prevention order set (Appendix E) was placed in the computer order entry system to facilitate compliance with the bundle. Additionally, skin care champions were identified in each of the three PICUs, in order to facilitate compliance with the bundle and provide additional supports on the unit. Skin care champions received additional education regarding the S.K.I.N. bundle, participated in monthly skin champions' meetings, and maintained e-mail contact with the principal investigator throughout the length of the study. They served as resources for pressure ulcer grading, they completed chart audits to ensure proper documentation, and they provided bedside education about the S.K.I.N. bundle. Resources on the Braden Q and pressure ulcer grading were placed in each bedside chart. Another important partnership during the study was the collaboration between the principal investigator and the unit based Advanced Practice Nurses (APNs). The APNs were given a weekly list of patients who developed pressure ulcers, and then they went back to do a root cause analysis to ensure that the protocol had been followed and to determine if there were any identifiable factors that could have contributed to the development of pressure ulcers.

Methodological Rigor

The aim of this study was to determine if the implementation of a complete S.K.I.N. care bundle could significantly decrease the pressure ulcer incidence in a select population of PICU patients. Additionally, this study served to explore relationships between pressure ulcer development, length of stay, and risk of mortality.

In order to achieve this goal, attempts were been made to minimize threats to validity. Statistical conclusion validity refers to the validity of inferences about the correlation between treatment and outcome (Shadish, Cook, & Campbell, 2008). It allows the researcher to make the correct decision regarding the approximate truth of the null hypothesis and therefore determine if the variables in question are related to one another. The specific threat to statistical conclusion validity in this dissertation is the possibility that the study is underpowered. In order to address this threat to validity, a power analysis was conducted to estimate the necessary sample size, a fairly homogenous population was studied, and a directional hypothesis was used in the power analysis. In addition, all statistical assumptions of the proposed statistical tests were met.

Internal validity refers to the validity of inferences about whether observed covariation between A and B reflects a causal relationship from A to B in the form in which the variables were manipulated or measured (Shadish et al., 2008). The internal validity in research is the extent to which the researcher can accurately state that the independent variable produced the observed effect, or in the case of this study, the S.K.I.N. care intervention produced lower pressure ulcer incidence in the study population. The specific threats in this study include selection bias and history. In order to address selection bias, a fairly homogenous group (infants ages 0- to 3-month-old

infants cared for in the PICU) was selected for the intervention. No infants were excluded as the intent was to gain an understanding of the entire study population and not a specific subset. Although fidelity to the intervention was supported by online education, electronic nursing order sets, availability of skin care champions on the unit, and follow up by the unit based APNs, there may have been other skin care practices utilized by the nurses to prevent pressure ulcers that may have influenced study findings. The principal investigator, research assistants, and skin care champions focused on ensuring that the nurses were remaining faithful to the intervention through continued reinforcement in both informal bedside education and communication during daily data collection. The ability to ensure that all nurses were faithful to the intervention was the single greatest threat to the study's integrity.

External validity issues are concerned with inferences about the extent to which a causal relationship may hold over variations in persons, settings, treatments, and outcomes (Shadish et al., 2008). The external validity of a study refers to the ability of the researcher to generalize the findings across populations. The homogeneity of the sample population may improve the internal validity, but the limited patient population may not generalize to the larger pediatric population, making the results applicable to a very narrow population. Random sampling simplifies external validity inferences; however, this sample population was not randomized which may be a threat to the external validity. The overall sample size is somewhat small, which also may be a threat to the external validity. The construct validity of the research was enhanced through the utilization of several operations to measure the theoretical constructs of the study (Shadish et al., 2008). This research served to evaluate several interventions that were

bundled together, making it challenging to tease out which part of the intervention was the most effective, which may have contributed to mono-operation bias.

The study was physiologically based, most closely aligned with an empiricist philosophy, and best conducted through quantitative inquiry. All efforts were made to address the threats to validity as the potential threats may limit the ability of the researcher to gain a close approximation of the truth. Through careful study design, findings from this study may contribute to the understanding of pressure ulcer development in this vulnerable population.

Statistical Procedures and Rationale

Descriptive statistics were used to analyze demographic data and describe the sample. Data were analyzed using PAWS Statistics for Windows® 18.0 (PAWS Statistics *18.0,* 2010). In order to meet the necessary assumptions for subsequent testing, range, mean, variance, and standard deviation were determined for all data sets. In order to compare differences in participants between groups, an independent t-test was used (Hypothesis 1). Independent t-tests were used to assess the relationship between length of stay, PIM 2 score, and pressure ulcer development (Hypotheses 2 and 3).

Hypothesis	**Test**	**Variables**
1	Independent t-test	Pressure ulcer incidence in Groups 1 & 2
2	Independent t-test	Length of stay & pressure ulcer incidence
3	Independent t-test	PIM 2 score & pressure ulcer incidence

Descriptive statistics were used to analyze results of the survey data that included demographic data about participants and data from the Likert-type scales. Data were

analyzed using PAWS Statistics for Windows © 18.0 (PAWS Statistics *18.0*, 2010). Survey data also provided the participants the opportunity to provide additional responses in text boxes. The narrative responses were reviewed for themes and linked with the quantitative data.

Human Subjects Protection

Protection of human subjects was addressed by the Institutional Review Boards of Marquette University and Children's Hospital of WI. Institutional Review Board approval, as well as waiver of parental consent, was obtained from both institutions (Appendix F). This study was in risk category 1, as the research did not involve greater than minimal risk to the children involved in the study. The only identifiable risk factor was a breach in confidentiality. Strict confidentiality was maintained throughout the duration of the study. The data collectors extracted the data from the patient flow sheet onto a paper data collection tool. The participants were identified by name for the initial paper data collection and then were assigned a VPS© case identification number. The data were entered into the Access database utilizing the VPS© case ID, and the paper data collection instruments were locked in the principal investigator's locked office in a locked drawer. The Access database was password protected.

The survey portion of the research was approved by the Institutional Review Boards of Marquette University and Children's Hospital of WI (Appendix G). Additionally, the survey went through the Marquette University Survey Committee and was approved (Appendix H). The survey data were collected via confidential survey, no link between surveys participants was provided. There were no points at which the

participants' data could be directly linked to their name, and data were only presented in aggregate form.

Summary

This chapter provided a detailed description of the research design and methods to address each of the five research questions for this study. The research methods were outlined and the study sample was described. The study instruments were described and the statistical procedures and rationale were described, according to each of the six research questions. The provision of human subject protection also was described in detail.

CHAPTER FOUR

Results

In this chapter, results of the research study are reported. There were two distinct goals of this research. In the first part of the study, effectiveness of a pressure ulcer prevention program in decreasing pressure ulcer incidence in the 0 to 3 month old population in the PICU was evaluated. The relationship between patient acuity and length of stay also were explored. The second element of the study was a survey of the PICU nursing staff, in order to gain a better understanding of barriers and facilitators to implementing the S.K.I.N. care pressure ulcer prevention bundle.

Descriptive and Comparative Statistics

This prospective, quasi-experimental study was conducted in order to determine whether the S.K.I.N. care bundle was associated with a significant reduction in pressure ulcer development. The control group included infants 0 to 3 months of age admitted to the PICU at CHW from April 1, 2006 through December 31, 2006. The experimental group included infants 0 to 3 months of age, admitted to the PICU at CHW between August 1, 2009 and December 31, 2009. No children were excluded from enrolling in this study because the intention was to gain an understanding of the problem, regardless of diagnosis, gender, risk of mortality, or length of PICU stay.

There were 149 patients enrolled in the control arm of the study (see Table III) and 250 patients enrolled in the experimental arm of the study (see Table IV). Demographic characteristics were compared using one sample t-tests utilizing population means for the control group. The PIM 2 risk of mortality scores were not significantly different for the control group versus the experimental group (M = 7.2 vs. M = 6,

Table III
Control group demographics (n=149)

Characteristic	Value
Number of patients	149
Gender	
Male	89 (59.7%)
Female	60 (40.2%)
Age in days at admission (Mean ± SD)	41.5 (± 30.07)
Race/Ethnicity	
African American	12 (8.1%)
Caucasian	92 (61.7%)
Hispanic	16 (10.7%)
Other/Mixed Race	29 (19.5%)
PRISM 2 Risk of Mortality (Mean ± SD)	7.2 (± 14.97)
Length of Stay (Mean ± SD)	6.2 days (± 10.06)
Primary Reason for Admission	
Cardiovascular	90 (60.4%)
Injury/Poisoning	6 (4.03%)
Neurologic	8 (5.37%)
Respiratory	20 (13.4%)
Other	25 (16.8%)
Use of Non-Invasive Positive Pressure Ventilation (NIPPV)	10 (6.7%)
Use of Mechanical Ventilation (MV)	81 (54.4%)
Use of Extracorporeal Membrane Oxygenation (ECMO)	2 (1.3%)

Table IV
Experimental group demographics (n=250)

Characteristic	Value
Number of patients	250
Gender	
Male	138 (55.2%)
Female	112 (44.8%)
Age in days at admission (Mean ± SD)	37.2 (± 27.88)
Race/Ethnicity	
African American	31 (12.4%)
American Indian	6 (2.4%)
Asian/Indian/Pacific Islander	8 (3.2%)
Hispanic	33 (13.2%)
Caucasian	152 (60.8%)
Other/Mixed Race	7 (2.8%)
Unspecified	13 (5.2%)
PRISM 2 Risk of Mortality (Mean ± SD)	6.0 (± 11.47)
Length of Stay (Mean ± SD)	18.6 days (± 36.00)
Primary Reason for Admission	
Cardiovascular	156 (62.4%)
Gastrointestinal	10 (4.0%)
Genetic	5 (2.0%)
Infectious	11 (4.4%)
Injury/Poisoning	7 (2.8%)
Metabolic	1 (0.4%)
Neurologic	7 (2.8%)
Newborn/Perinatal	8 (3.2%)
Renal/Genitourinary	2 (0.8%)
Respiratory	40 (16%)
Rheumatologic	1 (0.4%)
Other	2 (0.8%)
Use of Non-Invasive Positive Pressure Ventilation (NIPPV)	30 (12.0%)
Use of Mechanical Ventilation (MV)	111 (44.4%)
Use of Extracorporeal Membrane Oxygenation (ECMO)	11 (4.4%)

t(249) = -1.64, *p* = .10). Although the overall risk of mortality was not significantly different between the groups, there were some significant differences in the types of mechanical support provided for the children. The control group had a higher percentage of patients requiring mechanical ventilation (*M* = 54.4 vs. *M* = 44.4, *t*(249) = - 1713.60, *p* < .001) while the experimental group had a higher percentage of patients requiring NIPPV (*M* = 12 vs. *M* = 6.7, t(249) = -319.52, *p* < .001) and ECMO (*M* = 4.4 vs. *M* = 1.3, t(249) = -96.64, *p* < .001). The two groups differed in other significant ways. The experimental group was younger at admission compared with the control group (*M* = 37.2 vs. *M* = 41.5, *t*(249) = -2.43, *p* = 0.02), and the experimental group had a longer length of stay in the PICU compared with the control group (*M*=18.6 vs. *M*=6.2, *t*(249) = 5.42, *p* < .001).

There were 28 patients (18.8%) who developed a pressure ulcer in the control group (see Table V) and 17 patients (6.8%) who developed a pressure ulcer in the experimental group (see Table VI). The incidence of pressure ulcer development in the control group and the experimental group was compared using an independent t-test. Pressure ulcer development in the experimental group was significantly lower than in the control group (*M* = 6.8 vs. *M* = 18.8, t(397) = 3.72, *p* < .001). Demographic characteristics for the children who developed pressure ulcers were compared using one sample t-tests utilizing population means for the control group. There was not a significant difference in PIM2 risk of mortality scores between the two groups (*M* = 8.3 vs. *M* = 12.2, *t*(16) = 1.32, *p* = .21). Although the overall risk of mortality was not significantly different between the groups, there were some significant differences in the types of mechanical support provided for the children. The experimental arm had a significantly higher

Table V

Control group with pressure ulcer development demographics (n=28)

Characteristic	Value
Number of patients	28 (18.8 %)
Gender	
Male	16 (57.1%)
Female	12 (42.9%)
Age in days at admission (Mean ± SD)	38.3 (± 32.81)
Race/Ethnicity	
African American	2 (7.1%)
Caucasian	19 (67.9%)
Hispanic	3 (10.7%)
Other/Mixed Race	4 (14.3%)
PRISM 2 Risk of Mortality (Mean ± SD)	8.3 (± 10.57)
Length of Stay (Mean ± SD)	12.9 days (± 19.90)
Primary Reason for Admission	
Cardiovascular	19 (67.9%)
Injury/Poisoning	0 (0%)
Neurologic	2 (7.1%)
Respiratory	4 (14.3%)
Other	3 (10.7%)
Use of Non-Invasive Positive Pressure Ventilation (NIPPV)	2 (7.1%)
Use of Mechanical Ventilation (MV)	20 (71.4%)
Use of Extracorporeal Membrane Oxygenation (ECMO)	0 (0%)

Table VI
Experimental group with pressure ulcer development demographics (n=17)

Characteristic	Value
Number of patients	17 (6.8%)
Gender	
Male	11 (64.7%)
Female	6 (35.3%)
Age in days at admission (Mean ± SD)	18.8 (± 23.34)
Race/Ethnicity	
African American	1 (5.9%)
American Indian	0 (0%)
Asian/Indian/Pacific Islander	0 (0%)
Hispanic	2 (11.8%)
Caucasian	14 (82.3%)
Other/Mixed Race	0 (0%)
Unspecified	0 (0%)
PRISM 2 Risk of Mortality (Mean ± SD)	12.2 (± 12.18)
Length of Stay (Mean ± SD)	82.5 days (± 68.38)
Primary Reason for Admission	
Cardiovascular	15 (88.2%)
Gastrointestinal	0 (0%)
Genetic	1 (5.9%)
Infectious	0 (0%)
Injury/Poisoning	1 (5.9%)
Metabolic	0 (0%)
Neurologic	0 (0%)
Newborn/Perinatal	0 (0%)
Renal/Genitourinary	0 (0%)
Respiratory	0 (0%)
Rheumatologic	0 (0%)
Other	0 (0%)
Use of Non-Invasive Positive Pressure Ventilation (NIPPV)	7 (41.2%)
Use of Mechanical Ventilation (MV)	17 (100%)
Use of Extracorporeal Membrane Oxygenation (ECMO)	5 (29.4%)

percentage of patients requiring NIPPV (*M* = 41.2 vs. *M* = 7.1, *t*(16) = -54.36, *p* < .001*)*, as well as a significantly higher percentage of patients requiring ECMO (*M* = 29.4 vs. *M* = 0, *t*(16) = 2.58, *p* = .02). In addition, participants in the experimental arm of the study were significantly younger at admission (*M* = 18.8 vs. *M* = 38.3, *t*(16) = -3.44, *p* = .001) and had a significantly longer length of stay (*M* = 82.5 vs. *M* = 12.9, t(16) = 4.20, *p*=.001). A difference in mechanical ventilation impact could not be examined, as all experimental participants who developed pressure ulcers received mechanical ventilation (*SD* = 0).

Of the 17 experimental participants that developed pressure ulcers, 13 (76.4%) developed 1 pressure ulcer, 2 (11.8%) participants developed 2 pressure ulcers, and 2 (11.8%) participants developed 3 pressure ulcers in a range of locations (see Table VII). There were 4 (17.4%) stage 1 pressure ulcers, 14 (60.9%) stage 2 pressure ulcers, 1 (4.3%) stage 3 pressure ulcer, and 4 (17.4%) pressure ulcers that were not staged. PIM2 risk of mortality and length of stay were evaluated using independent-tests to determine any relationship with pressure ulcer development. Participants who developed a pressure ulcer had significantly higher risk of mortality when compared with participants who did not develop a pressure ulcer (*M* = 12.2, *SD* = 12.19 vs. *M* = 5.6, *SD* = 11.31, *t*(248) = -2.32, *p* = .02). In addition, participants who developed a pressure ulcer had a significantly longer length of stay when compared with children who did not develop a pressure ulcer (*M* = 82.5, *SD* = 68.38 vs. *M* = 13.9, *SD* = 27.34, t(248) = -8.63, *p* < .001). Correlations were also analyzed for length of stay, PIM 2 risk of mortality scores, the Braden Q mean score, and the frequency of turning to determine if there was a relationship between any of the variables. The only significant finding was that length of stay and Braden Q mean

Table VII
Experimental group pressure ulcer location and stage (n=17)

Location	Stage
Abdomen	Stage 1
Ankle	Stage 2
Foot	Stage 2 Not staged
Head	Stage 3 Not staged
Hip	Stage 1
Nare	Stage 1 Stage 2 Stage 2 Stage 2 Stage 2
Neck	Stage 2 Stage 2 Not staged Not staged
Occiput	Stage 1 Stage 2 Stage 2
Sacrum	Stage 2 Stage 2
Other	Stage 2 Stage 2

score were negatively correlated, $r(15) = -.63$, $p = .007$).

Nutrition consultation for children deemed high risk was a part of the S.K.I.N. care bundle. Children who developed a pressure ulcer received a nutrition consultation significantly more often than those children who did not develop a pressure ulcer (M = 64.7, SD = 49.60 vs. M = 27.5, SD = 44.73, $t(248) = -3.29$, $p = .001$). Turning every two hours was also part of the S.K.I.N. care pressure ulcer prevention bundle. Prior to analyzing whether more frequent turning was associated with less pressure ulcer development, one outlier was removed from the group of participants that did not develop a pressure ulcer. The outlier stated that the participants was turned every 27 hours even though the length of stay in the PICU was less than one day. An independent t-test was used to compare mean turning time, and there was no difference in frequency of turning between the two groups (M = 5.8, SD = 3.12 vs. M = 5.8, SD = 2.00, $t(243) = -.03$, p=.97).

The mean Braden Q score was calculated for each child in the experimental group, and an independent t-test was used to compare groups to determine any differences between participants that developed pressure ulcer and participants who did not develop a pressure ulcer. Participants who developed pressure ulcers had significantly lower mean Braden Q scores than participants who did not develop pressure ulcers (M = 18.7, SD = 3.38 vs. M = 21.9, SD = 3.03, $t(227) = 4.10$, $p<.001$). The Braden Q subcategories that were relevant in the conceptual model, including nutrition, moisture, activity, and mobility also were compared using independent t-tests There were not significant differences between groups in the nutrition (M = 2.4, SD = .83 *vs.* M= 2.4, SD =.44, $t(227) = .33$, $p = .74$) and moisture subcategories (M = 3.5, SD = .45 *vs.* M= 3.4, SD

=.37, $t(227) = .95$, $p = .34$). Participants in the experimental arm who developed pressure ulcers had significantly lower scores in the activity ($M = 3.2$, $SD = .88$ *vs.* $M = 2.6$, $SD = .99$, $t(227) = 2.638$, $p = .008$) and mobility ($M = 2.8$, $SD = .74$ *vs.* $M = 2.1$, $SD = .60$, $t(227) = 4.29$, $p < .001$) subcategories.

Survey Results

Of the 242 eligible nurses, 110 nurses (45.5%) completed the online survey. One-hundred-five (95.5%) participants were female and 5 (4.5%) were male. Seventy-four (67.2%) participants worked full time, and 35 (31.8%) participants worked part time, and 1 participant did not respond (0.9%). The mean number of years employed as a registered nurse was 9.5 years (*SD* 10.77, range = 0-42, *Mdn* = 4, mode = 1). The mean number of years employed as a registered nurse in the PICU was 6.5 (*SD* 8.74, range = 0-33, *Mdn* = 2, mode = 1). The mean number of years employed at CHW was 8.1 (*SD* = 8.58, range = 1-33, *Mdn* = 5, mode = 2). The survey questions were answered with an 11-point Likert-type scale and the participants were able to type in free text comments to the questions, as well.

Barriers

The responses were coded in the "barriers" portion of the survey on a scale of 0 to 10, with "0" representing "Not a barrier" and "10" representing "A major barrier". Nurses indicated that competing demands on their time was the greatest barrier, with a mean score of 5.2 (*SD = 2.90,* range = 0-10, *Mdn* = 6, mode = 6). When comments were examined, a theme emerged that there was not enough staff to pull for help when larger immobile children needed to be repositioned. Time also played a role in preventing nurses from getting necessary products in a timely manner, making it challenging to

provide optimal care in a timely fashion. Participants shared that they believed the medical team placed a lower priority on pressure ulcer prevention (*M* = 3.9, *SD* = 2.87, range = 0-10, *Mdn* = 4, mode = 0) than the nursing staff as a whole (*M* = 2.4, *SD = 2.41* range = 0-10, *Mdn* = 2, mode = 0) and lower than themselves as individuals (*M* = 1.2, *SD* = 1.69, range = 0-9, *Mdn* = 1, mode = 0). Not only did they indicate that the medical team placed a lower priority on pressure ulcer prevention, some comments indicated that physicians prevented turning because of patient acuity. Physicians were noted to give verbal and written orders not to turn patients that were deemed "too sick" to move.

Participants described the current documentation format of pressure ulcer risk assessment and nursing interventions a modest barrier to optimal pressure ulcer prevention (*M* = 3.4, *SD = 3.03*, range = 0-10, *Mdn* = 3, mode = 0). One comment related to documentation indicated that more room was needed to be able to effectively describe the risk assessment, the skin assessment, and nursing interventions. Participants indicated that having insufficient supplies presented a modest barrier to providing optimal care (*M* = 3.2, *SD = 2.92*, range = 0-10, *Mdn* = 3, mode = 0). Although participants indicated that having insufficient resources to provide guidance and expertise in pressure ulcer prevention was only a modest barrier (*M* = 3.2, *SD = 3.04*, range = 0-10, *Mdn* = 2, mode = 0), many reported feeling very unprepared to provide optimal wound care after a pressure ulcer developed. There were several responses that indicated it would be helpful to have either a wound care team or a full time Advanced Practice Nurse (APN) dedicated to wound care available for consultation and bedside education once the pressure ulcer developed. The survey data indicated that most nurses did feel that neither their skill in assessing a pressure ulcer (*M* = 2, *SD* = 2.28, range = 0-8, *Mdn*

= 1, mode = 0), nor their knowledge about pressure ulcer prevention (*M* = 1.4, *SD* = *1.64*, range = 0-8, *Mdn* = 1, mode = 0), posed a barrier to effective care.

The comments in the "barrier" section also identified other barriers not specifically included in the survey as important obstacles to providing effective care. Despite education about the need for repositioning and slight movement changes in even the most unstable infants, participants indicated nursing and medical staff members experienced some reluctance to move critically ill infants. Specific examples of these situations provided in the survey data included infants on ECMO support, central venous catheters that don't work well in certain positions, and infants who were deemed unsafe to move because of ineffective levels of sedation. Infants who had particularly long operative courses also were identified as challenging from a pressure ulcer prevention standpoint, as it was conveyed that participants believed that pressure ulcer development started while the infant was in the operating room. Devices in general, and endotracheal tubes in particular, were viewed as a source of frustration for participants, as a belief was conveyed that there are not effective strategies for device related pressure available. Finally, inclusion of multiple caregivers, as opposed to one primary caregiver, was reported to pose a unique challenge because of multiple deviations in the plan of care when more caregivers are involved. Despite the barriers described by the nursing staff, they indicated that they believed they were very capable of overcoming barriers, and that ultimately, optimal skin care is provided (*M* = 7.4, *SD = 1.97*, range = 1-10, *Mdn* = 8, mode = 9).

Facilitators

The responses were coded in the "facilitators" portion of the survey on a scale of 0 to 10, with 0 being "Not at all helpful" and 10 being "Very helpful". The nurses identified having appropriate skin care products readily available (*M* = 6.9, *SD* = 2.39, range = 0-10, *Mdn* = 7, mode = 7) and the ease of obtaining pressure reduction surfaces (*M* = 6.9, *SD* = 2.39, range = 1-10, *Mdn* = 7, mode = 9) as the most helpful aspects in providing optimal pressure ulcer prevention. Although having readily available skin care products and support surfaces was viewed favorably, the nurses still felt that they could benefit from additional education on the specific skin care products and when to use them as well as additional education about the support surface. Overall, the education component of the pressure reduction intervention was viewed fairly favorable; however, the nurses identified education about pressure ulcer staging (*M* = 6.5, *SD* = 2.49, range = 0-10, *Mdn* = 7, mode = 8) more helpful that the education about the Braden Q risk assessment tool (*M* = 5.4, *SD* = 3.17, range = 0-10, *Mdn* = 6, mode = 2). Collaboration with the interdisciplinary team was generally viewed as a facilitator to optimal pressure ulcer prevention (*M* = 6.4, *SD* = 2.45, range = 0-10, *Mdn* = 7, mode = 7). There was a somewhat neutral response to the usefulness of the current documentation system (*M* = 5, *SD* = 2.63, range = 0-10, *Mdn* = 5, mode = 2), the unit based skin care champions (*M* = 5.1, *SD* = 2.94, range = 0-10, *Mdn* = 5, mode = 5) and the Sunrise pressure ulcer prevention nursing order set (*M* = 5.7, *SD* = 2.72, range = 0-10, *Mdn* = 6, mode = 7). The skin care champions were seen as helpful, but some nurses felt that they were not visible enough on the unit and that they could provide additional support by making sure the staff knew when they were working and by providing research to the nursing staff to

help them really understand the rationale behind what they are doing. The nurses did not report any additional facilitators to providing optimal pressure ulcer prevention outside of the ones specifically asked about in the survey. In general the nurses viewed the efforts being made to facilitate their ability to prevent pressure ulcer development in the PICU favorably (M = 7.1, SD = 1.98, range = 0-10, Mdn = 7, mode = 7).

CHAPTER FIVE

Discussion

In this chapter, an interpretation of the findings will be presented. Findings from this study will be presented in the contexts of relevance to practice, education, and research. The strengths and limitations of the study will be described, and future areas of research that can build upon these findings will be presented.

Interpretation of the Findings

Despite a significant reduction in pressure ulcer development in the 0 to 3 month old population in the PICU, pressure ulcer development remains a significant clinical problem in critically ill infants, with an incidence in the experimental group of 6.8%. In this study, effective nursing care with targeted interventions reduced the incidence of pressure ulcers in critically ill infants, yet it remains unclear why the incidence was unable to reach 0%. Possible explanations include deviations in prescribed nursing care, sub-optimal effectiveness of the intervention itself, or presence of a heavy disease burden with secondary skin failure making total eradication of pressure ulcers extremely difficult. It also may be a combination of any or all of the above proposed explanations. It is clear that study participants that developed pressure ulcers were extremely young, stayed in the PICU for extended periods of time, and had heavy disease burdens with the need for invasive mechanical support. The S.K.I.N. care pressure ulcer prevention bundle appears to be associated with improved outcomes.

Results of the PICU staff nurse survey revealed many perceived barriers associated with implementation of the S.K.I.N. care bundle. The PICU is a fast paced, high stress environment, which likely impacted the response that competing demands was

the most significant barrier to implementing the pressure ulcer prevention bundle. Nurses described the need for more hands on education about the skin care products available to them in order to provide optimal care. They also expressed that physician and other nurse colleagues may have placed a lower importance on pressure ulcer prevention than they did. Despite describing several barriers to implementing the pressure ulcer prevention bundle, nurse participants felt empowered to overcome barriers and provide optimal skin care for their patients.

Survey results indicated that the most helpful change in providing optimal skin care was allowing nurses to make decisions about use of skin care products and support surfaces. By eliminating the need for a physician order for barrier creams and a call to facilities management to obtain a pressure reduction surface, nurses were able to implement two key components of the pressure prevention bundle in a more efficient manner. They identified collaboration with the interdisciplinary team as an important facilitator to providing optimal skin care. Nurse participants indicated that they would have liked having the skin care champions more visible in the unit, as they were viewed as facilitators to high quality care. Overall, the nurses believed that efforts had been made to facilitate their ability to provide optimal skin care.

Statistical Importance of the Findings

Statistical significance is an important tool for interpreting results from this study, but statistical significance provides an incomplete picture of the results. A statistically significant difference in age between the children who developed a pressure ulcer in the control group and the experimental group was identified. Although this difference was statistically significant, the infants in both groups are very young, and the difference in

mean age was only 20 days. It may be more accurate to recognize that there are key features about neonates including the inherent difference in their skin and their greater head-to-body proportion that places them at higher risk for pressure ulcer development (Curley & Maloney-Harmon, 2001; Garvin, 1997; McCord et al., 2004; Solis et al., 1988).

Although the PIM2 risk of mortality was not statistically different between infants who developed pressure ulcers in the control and experimental groups, infants in the experimental arm required more mechanical support during their PICU stays. The PIM2 risk of mortality score was calculated on the first day of admission, but it was not reflective of the actual PICU course. It is possible that infants in the experimental arm went on the have much more unstable PICU courses as they uniformly needed more ECMO support, more NIPPV support, and every one of them required mechanical ventilation during their PICU admission.

Overall, findings from this study were statistically significant, indicating that the S.K.I.N. care pressure ulcer prevention bundle was associated with a decrease in pressure ulcer incidence. Although this finding is important, this sample was small. Replication is indicated in order for the findings to be generalizable.

Relationship between Findings and the Conceptual Framework

The conceptual framework was built upon the belief that critical illness in infants places them at disproportionately high risk for pressure ulcer development, secondary to impaired tissue tolerance and increased intensity and duration of pressure. Study participants who went on to develop pressure ulcers were very young, required a high degree of mechanical support, and were in the PICU for prolonged periods, adding

further support to previously described risk factors (McCord et al., 2004; Curley et al., 2003; Schindler et al., 2007; Schmidt et al., 1998). Use of mechanical ventilation, ECMO, and NIPPV all have been implicated as risk factors for developing pressure ulcers and serve as proxy determinants of severity of illness (Gershan & Esterly, 1993; McCord et al., 2004; Neidig, Kleiber, & Oppliger, 1989; Schmidt et al., 1998). Results from this study provide further validation for the premise that critical illness is a key determinant for development of pressure ulcers.

Improved Tissue Tolerance

The conceptual framework proposed that the two major determinants in pressure ulcer development were impaired tissue tolerance and increased tissue interface pressure, and that these risk factors were to be ameliorated, incidence of pressure ulcer development could be decreased. In order to identify key interventions for improving tissue tolerance, it was important to drill down and explore specific risk factors related to critical illness that place infants at risk for decreased tissue tolerance. The conceptual framework proposed that critically ill infants in the PICU have an extrinsic risk factor for decreased tissue tolerance, secondary to increased moisture from incontinence and dry skin from frequent bathing. Moist skin has been associated with development of rashes, is softer, and it tends to break down more easily (Butler, 2006, Lund et al., 2001, Samaniego, 2003). The comparison of the Braden Q subcategories did not reveal significant differences in moisture between infants who developed pressure ulcers and those infants who did not develop pressure ulcers. Despite the limited variability in scores, this population is universally incontinent, and this phenomenon has been identified as a significant risk factor in development of several types of skin pathology

including rashes, diaper dermatitis, and most importantly, the development of pressure ulcers (Fader, Clarke-O'Neill, & Cook, 2003; Schnelle et al., 1997). Both urinary and fecal incontinence play a role in development of pressure ulcers (Brown & Sears, 1993; Lund, 1999; Lund et al., 2001). In order to address this risk factor, preventative strategies including use of a zinc-based barrier cream with each diaper change, minimal bathing with a mild, non-alkaline cleansing agent, and lotion application after each bath were implemented (Wound Ostomy and Continence Nurses Society, 2003).

The second identified risk factor for decreased tissue tolerance was poor nutrition (Garvin, 1997; Langemo & Brown, 2006). Adequate nutrition and hydration play an important role in prevention of pressure ulcers, as well as maintenance of tissue integrity (Allman, 1986; Breslow, 1991; Ek, Unosson, Larrson, von Schneck, & Bjurulf, 1991; Ferguson, Rimmasch, Voss, Cook, & Bender, 2000; Fuoco, Scivoletto, Pace, Vona, & Catellanno, 1997; Gilmore, Robinson, Posthauer, & Raymond, 1995; Himes, 1999; Strauss & Margolis, 1996; Thomas, 1997). The conceptual framework proposed that critically ill infants in the PICU may have an intrinsic risk factor for decreased tissue tolerance secondary to poor nutrition. The analysis of the Braden Q subcategory supported the premise that in this sample, critically ill infants had poor nutrition, placing them at risk for pressure ulcer development. Although there were not significant differences in nutrition scores between those infants that did or did not develop pressure ulcers, nutrition scores for the entire group reflected that infants in this study who were admitted to the PICU had compromised nutrition.

Any infant who scored “1” or “2” in the nutrition subcategory of the Braden Q was supposed to receive a nutrition consultation by a registered dietician. There were

significantly more nutrition consultations in the group of children who developed pressure ulcers, indicating that this group of infants may have had worse nutritional status. What is less clear from these data is whether the nutrition consultation was protective for infants in the group that did not develop pressure ulcers. Additionally, a further review of the infants who developed pressure ulcers revealed that all of these infants had Braden Q nutrition scores of "1" or "2" at some point during their stay in the PICU, yet only 64.7% of them actually received a nutrition consultation. It is unclear why all eligible infants did not receive nutrition consultations. This omission may have been related to the low priority placed on nutrition support in the face of the profound disease burden the children were facing or the newness of the S.K.I.N. care bundle itself. The data that were available on the infants who developed pressure ulcers supports nutritional deficits as a risk factor for pressure ulcer development within the conceptual framework.

Decreased Tissue Interface Pressure

The conceptual model developed for this study also addressed intensity and duration of pressure experienced by the infants in the PICU. Increased pressure over short periods of time, and slight pressure over long periods of time, has resulted in equal damage to tissue (Neidig et al., 1989). In critically ill children, immobilization occurs secondary to intubation, sedation, restraints, and consequences of the disease process (Langemo & Brown, 2006). Within the conceptual framework, immobilization was theorized to decrease both movement and activity and thereby increasing the risk for soft tissue compression. The comparison of the Braden Q subcategories supported this premise, as the infants who developed pressure ulcers had lower scores on the Braden Q subcategories of "Activity" and "Mobility."

The conceptual framework proposed two preventative strategies to ameliorate the risk of decreased mobility and activity. All infants in the study were placed on the Delta-202 Warmer Overlay, in order to reduce the interface pressure experienced as a result of decreased activity (McLane et al., 2002; Turnage-Carrier, McLane, & Gregurich, 2008). In order to account for the increased risks imposed for pressure ulcers, secondary to decreased mobility, turning the infants every two hours was proposed as a preventative strategy to reduce pressure and maintain circulation to areas of the body at risk for pressure ulcer development (Hardy et al., 2007; Lund et al., 2001; Marcellus, 2005; Willock & Maylor, 2004). The mean turning time in both groups was 5.8 hours which was well above what had been described in the S.K.I.N. care bundle, which calls into question this preventative strategy in the conceptual framework. Because every infant in the study was placed on the pressure reduction surface, additional study is indicated to clarify what the right turning frequency should be when using a pressure reduction surface.

Although there are some areas of the conceptual framework that need further study, the framework was supported to a large extent by study data, and it appears to adequately identify risk factors and key determinants associated with pressure ulcer development in this population. Further study is indicated to ensure that proposed preventative measures represent the most efficacious measure for ameliorating the identified risk factors for pressure ulcer development.

Implications for Nursing Practice

Although pressure ulcer incidence did not drop to 0%, implementation of the pressure ulcer prevention bundle decreased the overall incidence in a clinically

meaningful way. It is unclear which intervention may have been the most influential. Rather, it is likely that the synergistic effect of the bundle of cares led to a more significant decrease in incidence than any one of the interventions might have had on its own. The study findings demonstrated that infants who developed pressure ulcers were different than those infants who do not develop pressure ulcers. Although nurses should apply pressure ulcer prevention strategies to all patients in the PICU, they should be more vigilant about skin care in infants who are most at risk. The analyses revealed that even with an intensive promotion of the S.K.I.N. care pressure ulcer prevention bundle, nurses did not consistently apply the interventions as outlined in the bundle. Specifically, barriers still exist to re-positioning infants, as described more completely in the survey results, as well as barriers to obtaining nutrition consultations. The reasons for not obtaining nutrition consultations were not identified in the survey data. There is still work to be done to overcome barriers to implementing the complete bundle consistently for all infants in the PICU.

The survey results unveiled that there a number of nurses believe that there is a belief among physicians and nurses alike that some infants are too sick to move. This long held belief may be putting these infants at risk for developing pressure ulcers as the evidence suggests that even small position changes and pressure redistribution may ameliorate the risks of sustained pressure (Butler, 2006; Quigley & Curley, 1996). Although staff in the PICU primarily care for the critically ill children in the hospital, the children also leave the unit for extended periods of time to go to the operating room, radiology, and other locations for various procedures. It is important to assess risk for pressure ulcer development when the infants are out of the unit and do a thorough

assessment when they return to the unit. As staff in the PICU improve care that they provide, it will be important to partner and share knowledge with other departments, in order for improvements in care to be communicated throughout the institution and ultimately improve pressure ulcer prevention initiatives throughout the hospital.

Significant improvements were made in pressure ulcer incidence with the implementation of the pressure ulcer prevention program. Since this program was introduced, several other initiatives have been introduced to the nursing staff including educational opportunities, and new clinical priorities. In addition, new staff nurses have been hired to work in the PICU. With changes occurring within the unit, it becomes challenging to sustain meaningful change. Although education plays a role in change, survey results indicated that education is not enough. If nurses can link their practice with improved patient outcomes, essential key learning elements may be more sustainable. It clearly was demonstrated that despite having access to the right skin care products, nurses needed “hands on” education about how and when to use them.

Skin care champions played an important role in educating the staff, ensuring that skin assessments were being completed, and that the staff understood and maintained fidelity to the pressure ulcer prevention bundle. Despite this level of involvement, there was still a sense that the skin care champions were not visible enough. It is recommended that the way in which the availability of skin care champions is communicated be formalized. In the PICU, there is a main communication board that documents patient flow, the charge nurse, and various resource staff members. It would be helpful to add the skin care champion to that list so that it is clearly communicated in a central place. The root cause analysis process provided valuable information about the pressure ulcer itself

and also which risk factors appeared to contribute to pressure ulcer development. Utilizing APNs to assist with contining this process, as well as helping staff nurses critically analyze these problems, helping them take accountability for practice decisions, as well as making the link between practice and outcomes is indicated.

The survey data raised questions about the best approaches for implementing change in the PICU. There are multiple committees including clinical practice, quality improvement, journal club, and various sub-committees that evaluate specific practices, including pressure ulcer prevention. All of the committees do important work, yet they seem to be working in silos, addressing multiple needs and patient care concerns in parallel. Nurses may be better served to have committees approach one single clinical problem at a time, so that link between practice and outcomes can be better evaluated. An example of this approach might be for the clinical practice committee to identify a clinical problem and work with the journal club to find evidence related to the problem. The subcommittees could join together to work on one project and work in conjunction with the quality improvement committee to measure the outcomes. These outcomes then could be communicated to staff, providing greater impetus for practice changes

Implications for Education

The survey data indicated that traditional nursing education may not be adequate to create or sustain changes in nursing practice. A need exists for new and innovative strategies to bring education to nurses, including interactive technology, “hands on” learning opportunities, and training at the bedside. Too often changes are implemented, yet nurses do not receive any feedback on whether this change resulted in improvement

of patient outcomes. Without this connection between change in practice and improved outcomes, it is difficult to sustain any change in practice.

Survey participants generally were experienced nurses, with many respondents spending a large portion of their career at CHW. Although there are countless benefits to a stable staff, it may also contribute to a practice based on culture rather than evidence. Nurses may stagnate in the belief that "this is how we have always done it," which can make implementing and sustaining change much more challenging.

Although the survey results illustrated many ways in which nursing education may be improved, it also was very hopeful. Nurses want to see experts at the bedside to provide real time "hands on" education related to patient care. They are eager for knowledge related to pressure ulcer prevention, wound care, and the products available to them. They want more access to the research behind what they are doing so that they can make the connection between research and practice.

Implications for Research

The pressure ulcer prevention bundle was associated with a significant decrease in pressure ulcer development in a very narrow patient population. In order to validate that this bundle of cares actually is associated with improved patient outcomes, it is important to replicate the research in other age groups and other PICUs. By replicating the study, the relationship between the incidence of pressure ulcer development the skin care bundle can be evaluated more fully.

There is some evidence in the adult literature that suggests that it is not necessary to turn patients every two hours when they are on a support surface. However, this finding has not been supported in the pediatric literature (Butler, 2006; Quigley &

Curley, 1996). Although this study was neither designed nor powered to evaluate the effectiveness of turning as it relates to pressure ulcer development, it does not appear that more frequent turning was protective with respect to pressure ulcer development. This finding may be related to the use of a pressure redistribution surface, but that premise cannot be determined in this study. This area has not been studied adequately in the pediatric population. Further investigation with respect to turning protocols as they relate to support surfaces is indicated.

Increased length of stay has been associated with an increased risk of pressure ulcer development in the literature and in this study (McCord et al., 2004; Curley et al., 2003; Schindler et al., 2007). This pattern raises questions about whether patients can be indentified early as potentially having a long PICU stay, as well as whether early targeted interventions could help decrease pressure ulcer development in infants who have extended PICU stays.

A nutrition consultation for infants at risk for inadequate nutritional was included as a part of the skin care bundle, but good baseline data about the nutritional status of the infants was not collected. Future studies should include evaluation of baseline nutritional status of critically ill infants and examine relationships between this status and pressure ulcer development. This type of information might assist nurses in discerning whether there are additional risk factors or lab values that clinicians should be evaluating when assessing pressure ulcer risk. There is some evidence supporting implementation of early enteral nutrition in even the most critically ill children, and it would be interesting to determine whether early enteral nutrition provides any protection from development of pressure ulcers (Chellis, Sanders, Webster, Dean & Jackson, 1996).

Limitations of the Study

An important limitation of the study is the use of a historical control group. Even though the control group also was cared for in the PICU at CHW, many changes had occurred in the environment of care, as well as the addition of new nursing staff members, and many new education and practice initiatives in preparation for the move to the new ICU tower. These additional changes may have influenced results of the study. All attempts were made to compare group participant characteristics. However, it was difficult to quantify and classify changes in the nursing staff. These changes may have had a profound impact on the study itself. The sample included in the study did not exhibit a great deal of variability, which compromised external validity and makes it difficult to apply the findings to other age groups and settings. Nursing documentation of pressure ulcer risk assessment, pressure ulcer identification, pressure ulcer staging, and documentation of nursing interventions was relied upon heavily. Despite efforts to maintain good documentation by the part of the investigator, the skin care champions, the unit based APNs, and nursing supervisors, missing data elements occurred, impacting internal validity of study. Another limitation to this study was the possibility of misclassification of pressure ulcers due to differences in experience and competency between individuals in the identification and staging of pressure ulcers. This potential misclassification should have been minimized by the intense educational focus on identification and staging of pressure ulcers, that was an integral component to this study.

The investigator used the Braden Q subcategory of “Nutrition” as an assessment of the participating infant’s nutritional status in the study. Although this is one piece of a nutrition assessment, the classification remains somewhat subjective and nurse

dependent. The inclusion of more quantifiable measures of nutritional status, including pre-albumin, body mass index, and weight for length percentages may have provided a stronger assessment of nutrition status. Additionally, involvement of a registered dietician (RD) may have improved the nutritional status of participants who were assessed, but there are no quantifiable measures to determine if the involvement of the RD actually improved the nutritional status of the participants. In addition, it is possible that important interventions or factors that could have had a positive or negative impact on pressure ulcer development were not included. Specific characteristics or therapies, such as depth of sedation, modes of ventilation, and use of restraints were not collected. No data were collected about care provided off the unit, such as complex operative or diagnostic procedures, during which time the patient may have been immobilized for extended periods of time.

Although the nurse participant survey provided some important information, only 45.5% of the eligible respondents provided feedback on barriers and facilitators to implementing the pressure ulcer prevention bundle. There may have been key differences between the nurses that chose to complete the online survey and those nurses who chose not to complete the survey. These differences may have influenced the overall results of the study and the internal validity. The survey included very pointed questions about barriers and facilitators, yet it was not helpful in determining why all the infants eligible for a nutrition consultation did not receive one. This gap indicates that there still may be key pieces of information that were not provided in the survey.

Strengths of the Study

This study was strengthened by its homogenous groups by increasing the internal validity. Infants in the study were similar in age and had equivalent severity of illnesses, which helped to support the hypothesis that the pressure ulcer prevention bundle was associated with lower pressure ulcer incidence rather than some intrinsic difference in the infants. The study was grounded in a conceptual framework that provides the necessary structure for study replication in other age groups, as well in other PICUs. Incorporation of a nursing care framework into the study design also demonstrated the importance of work that staff nurses do each day. This study was augmented by the VPS © database, which provided the investigator access to a large amount of demographic data that otherwise would have been very burdensome to collect.

One of the study strengths was involvement of the interdisciplinary team, which included physicians, nurses, advanced practice nurses, pharmacists, registered dieticians, a research coordinator, data collectors, information technology (IT), and facilities management. The partnership between hospital administrators and clinicians was essential to implementation of the pressure ulcer prevention bundle. The partnership allowed the investigator to navigate traditional roadblocks by providing high level support on the administrative side. Traditionally, the support surfaces were kept in a central location housed by facilities management. Although this system may have made sense in terms of storage space, it often meant a delay in getting infants on appropriate support surfaces in a timely manner. The investigator was able to move the support surfaces to the PICU, enabling them to be placed as soon as the child arrived in the PICU, thereby decreasing the amount of time infants spent on a non-support mattress.

Traditionally, nurses needed a physician order for barrier creams, which often delayed children from having barrier creams used in a timely fashion or occasionally prevented them from receiving them at all. The investigator worked closely with the pharmacy and therapeutics committee to change barrier creams to a nursing order as it makes sense for nurses to have the necessary tools for pressure ulcer prevention readily available. The investigator worked closely with the Information Technology (IT) Department, in order to ensure that nursing order set was placed in the Sunrise© online order system to reinforce the components of the pressure ulcer prevention bundle.

The survey response rate of 45.5% was a bit higher than anticipated for an online survey. Response rates for online surveys have typically been cited to be lower than traditional mail surveys, and they generally range between 25-30% (Shih & Fan, 2008; Duffy, M, 2002; Division of Instructional Innovation and Assessment, 2007). The online survey provided the investigator with a highly efficient way of delivering the survey to the nursing staff in the PICU, as well as benefits gained from the speed of data access and decreased costs for data collection and data entry. Survey results provided valuable information about the pressure ulcer prevention bundle that can be applied to ongoing efforts to reduce pressure ulcer development in the PICU.

Suggestions for Future Research

The investigator was able to answer the questions outlined in the study; however, results from the study stimulated many more questions than the results were able to answer, thereby providing ample opportunities for future research. There are opportunities to evaluate the role of turning and re-positioning in the PICU. There are several questions arise including:

- Which steps should be taken to overcome barriers to re-positioning in the PICU?
- What is the most appropriate turning frequency for infants on a support surface when compared with those infants not on a support surface?
- What is the most effective manner to re-position unstable patients?
- What role does sedation play in pressure ulcer development?
- What is the relationship between level of sedation and pressure ulcer development?
- What role does decreased sensory perception play in pressure ulcer development in infants?

A great deal of work still needs to be accomplished. The intersection of nutrition and pressure ulcer development requires further study. Including the role of early enteral nutrition in pressure ulcer prevention, measures of nutrition status in infants, and how to best optimize nutrition in the PICU demand investigation. Little is known about device related pressure ulcers and how to best protect infants from the hazards of the invasive devices used in the PICU. Many infants enrolled in the study were profoundly ill and likely had impaired perfusion and tissue oxygenation. Much research is needed in these areas. Another important area of inquiry is examination of skin failure as a consequence of multi-organ failure. Rich descriptions of the role of skin failure secondary to multi-organ failure in pressure ulcer development are needed. Nurses clearly desire more "hands on" education, and use of innovative educational technologies to teach nurses about effective ways of reducing pressure ulcer incidence, including simulation and interactive computer software must be explored. Impact of these technologies also must be explored.

Pressure ulcers represent a serious iatrogenic injury in the acute care setting and have been identified as a nursing research priority (Harrison, Wells, Fisher, & Prince, 1996). Although there have been several published studies on skin integrity, pressure ulcer development, and pressure ulcer prevention strategies in the adult population, the science related to pediatric pressure ulcers is still a developing area of inquiry. In order to protect the vulnerable pediatric population, it is important to continue to refine the level of nurses' understanding with respect to physiologic indices of pressure ulcer development and the most effective evidence based interventions. Only if these strategies are completed will nurses be able to employ the most sophisticated evidence-based approaches when caring for their tiniest patients.

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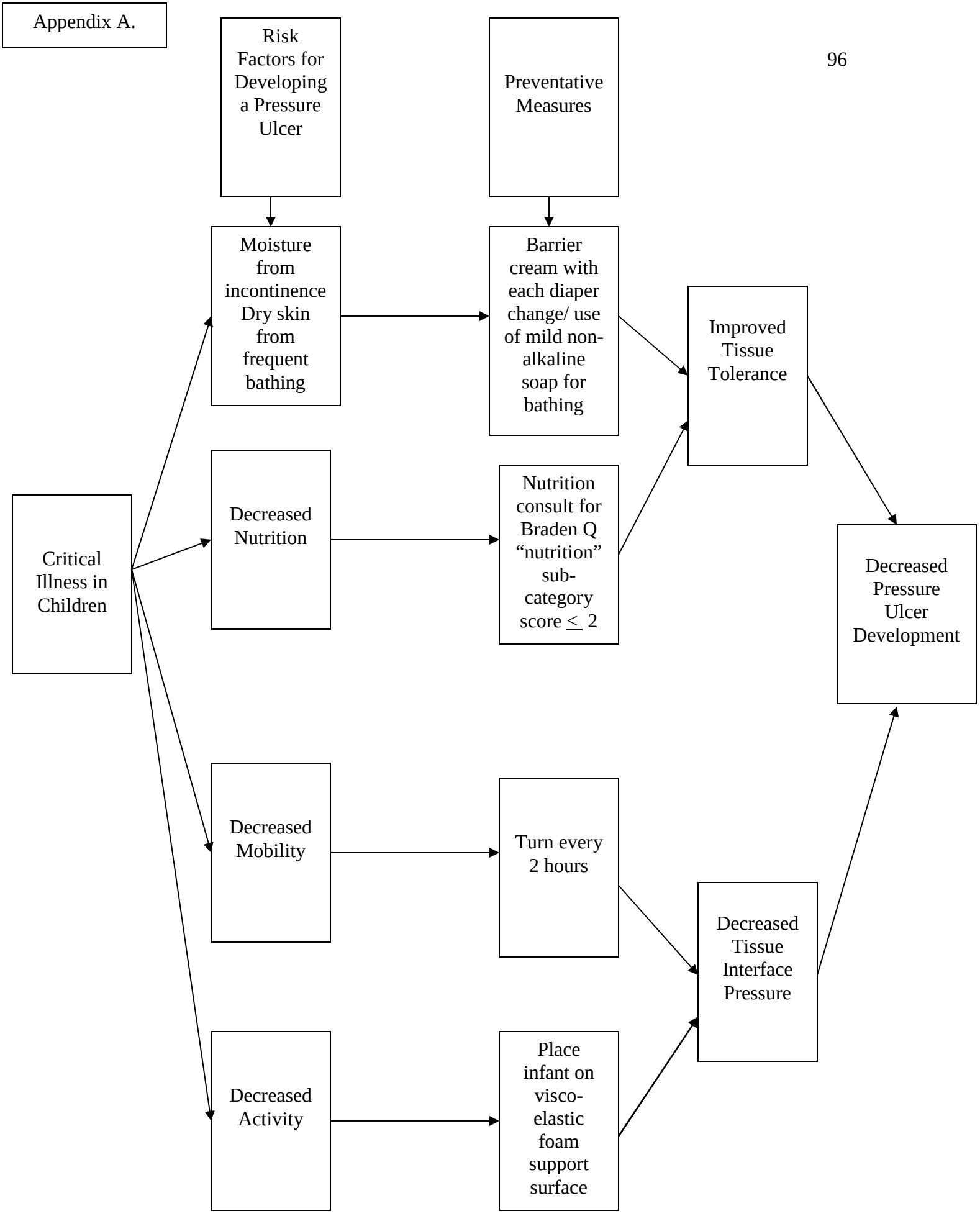
Risk Factors for Developing a Pressure Ulcer
Preventative Measures
Moisture from incontinence Dry skin from frequent bathing
Barrier cream with each diaper change/ use of mild non-alkaline soap for bathing
Improved Tissue Tolerance
Critical Illness in Children
Decreased Nutrition
Nutrition consult for Braden Q "nutrition" sub-category score ≤ 2
Decreased Pressure Ulcer Development
Decreased Mobility
Turn every 2 hours
Decreased Tissue Interface Pressure
Decreased Activity
Place infant on visco-elastic foam support surface

Appendix B- Survey Invitation Letter

Dear PICU Nurses,

Children's Hospital of Wisconsin has been looking at ways to eradicate pressure ulcers in the PICU. We are interested in hearing from you about what (if anything) gets in the way of you being able to provide optimal skin care for your patients as well as what (if anything) helps you to provide optimal skin care for your patients. In order to effect change in practice, it is important to design a comprehensive, supported, and sustained approach to the implementation of the intervention. Your feedback will assist us in identifying gaps in support and allow us to make changes as necessary to support your efforts in eradicating pressure ulcers. You are asked to complete this survey because of the important work that you do in the PICU. This is part of a research study being conducted in the PICU.

You are not obligated to participate. This survey should take about 10 minutes to complete. No information which could identify you personally will be collected, and all results will be reported in aggregate. Your email address is connected to the survey for tracking purposes only; confidentiality is guaranteed.

There are no foreseeable risks or direct benefits to you. This project and survey have been approved by the Institutional Review Board at the Children's Hospital of Wisconsin.

Please click on the link below to be directed to the automated electronic survey. This link is uniquely tied to this survey and your email address; please do not forward this message. By continuing further, you have indicated consent for participation in this survey.

http://www.surveymonkey.com/s.aspx

Thank you for your participation in this project.

Sincerely,

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Appendix C- Online Survey

Pressure Ulcer Prevention in the PICU
Barriers and Facilitators

Children's Hospital of Wisconsin has been looking at ways to eradicate pressure ulcers in the PICU. We are interested in hearing from you about what (if anything) gets in the way of you being able to provide optimal skin care for your patients as well as what (if anything) helps you to provide optimal skin care for your patients. You are asked to complete this survey because of the important work that you do in the PICU. This is part of a research study being conducted in the PICU. Your participation is voluntary and implies informed consent. The results of the survey will be used to drive improvement activities. No information identifying any one nurse will be collected or shared. We anticipate that the survey will take approximately 10 minutes to complete. Thank you in advance for your willingness to participate.

Demographic Information:

Male/ Female

Number of years as a RN?

Number of years employed by CHW?

Number of years working in the PICU?

Part time or Full time employment?

Below are some potential barriers to optimal skin care. On a scale of 0 to 10, with 0 being "Not a barrier" and 10 being "A major barrier" please **select** the number that best rates these barriers to <u>your</u> personal ability to provide optimal skin care for your patients over the past year.

1. Competing demands on my time

0 1 2 3 4 5 6 7 8 9 10
Not a barrier A major barrier

2. Limitations in my ability to assess risk of pressure ulcer development

0 1 2 3 4 5 6 7 8 9 10
Not a barrier A major barrier

3. Limitations in my knowledge about pressure ulcer prevention

0 1 2 3 4 5 6 7 8 9 10
Not a barrier A major barrier

4. Low priority given to pressure ulcer prevention by <u>medical staff</u>

0 1 2 3 4 5 6 7 8 9 10
Not a barrier A major barrier

5. Low priority given to pressure ulcer prevention by <u>nursing staff</u>

0 1 2 3 4 5 6 7 8 9 10
Not a barrier A major barrier

6. Low priority given to pressure ulcer prevention by <u>me</u>

0 1 2 3 4 5 6 7 8 9 10
Not a barrier A major barrier

7. Current documentation format for pressure ulcer risk/ nursing interventions

0 1 2 3 4 5 6 7 8 9 10
Not a barrier A major barrier

8. Insufficient resources to provide guidance/expertise in pressure ulcer prevention

0 1 2 3 4 5 6 7 8 9 10
Not a barrier A major barrier

9. Insufficient supplies/equipment to provide optimal pressure ulcer prevention care

0 1 2 3 4 5 6 7 8 9 10
Not a barrier A major barrier

10. What other barriers to pressure ulcer prevention at CHW are not included on this tool?

11. In general, to what degree do you feel you are able to overcome barriers and ultimately provide optimal skin care for your patients?

0 1 2 3 4 5 6 7 8 9 10
Not at all able Very able

Below are some potential facilitators to optimal skin care. On a scale of 0 to 10, with 0 being "Not at all helpful" and 10 being "Very helpful" please **select** the number that best rates these facilitators to <u>your</u> personal ability to provide optimal skin care for your patients over the past year.

1. Education about Braden Q risk assessment of pressure ulcer development

0 1 2 3 4 5 6 7 8 9 10
Not at all helpful Very helpful

2. Education about pressure ulcer grading

0 1 2 3 4 5 6 7 8 9 10
Not at all helpful Very helpful

3. Current documentation format for pressure ulcer risk/ nursing interventions

0 1 2 3 4 5 6 7 8 9 10
Not at all helpful Very helpful

4. Unit based skin care champions

0 1 2 3 4 5 6 7 8 9 10
Not at all helpful Very helpful

5. Sunrise pressure ulcer prevention nursing order set

0 1 2 3 4 5 6 7 8 9 10
Not at all helpful Very helpful

6. Ease of obtaining pressure reduction surfaces

0 1 2 3 4 5 6 7 8 9 10
Not at all helpful Very helpful

7. Collaboration with interdisciplinary team (nursing/medicine/pharmacy/dietary)

0 1 2 3 4 5 6 7 8 9 10
Not at all helpful Very helpful

8. Appropriate skin care products readily available

0 1 2 3 4 5 6 7 8 9 10
Not at all helpful Very helpful

9. What other facilitators to pressure ulcer prevention at CHW are not included on this tool?

10. In general, to what degree do you feel you that efforts are being made to facilitate your ability to prevent pressure ulcer development in the PICU?

0 1 2 3 4 5 6 7 8 9 10
Not at all A great deal

1. **Patient Name:**
2. **MRN:**
3. **Visit ID:**
4. **Date of PICU Admission**
5. **VPS ID:**

Appendix D
Skin Integrity Data Collection Tool

6. Sheet Date: _____6 AM Through _____6 AM

7. Vasoactive drips
- **1. Yes**
- **2. No**

8. Mobility:
- o **1. Completely Limited**
- o **2. Very Limited**
- o **3. Slightly Limited**
- o **4. No Limitations**
- o **99 No data**

9. Activity:
- o **1. Bedfast**
- o **2. Chairfast**
- o **3. Walks Occasionally**
- o **4. Walks frequently/ Too young to walk**
- o **99 No data**

10. Sensory Perception:
- o **1. Completely Limited**
- o **2. Very Limited**
- o **3. Slightly Limited**
- o **4. No impairment**
- o **99 No data**

11. Moisture:
- o **1. Constantly Moist**
- o **2. Very Moist**
- o **3. Occasionally Moist**
- o **4. Rarely Moist**
- o **99 No data**

12. Friction:
- o **1. Significant Problem**
- o **2. Problem**
- o **3. Potential Problem**
- o **4. No Apparent Problem**
- o **99 No data**

13. Nutrition:
- o **1. Very Poor**
- o **2. Inadequate**
- o **3. Adequate**
- o **4. Excellent**
- o **99 No data**

14. Tissue Oxygenation & Perfusion
- o **1. Extremely compromised**
- o **2. Compromised**
- o **3. Adequate**
- o **4. Excellent**
- o **99 No data**

16. Lotion
- **1 Yes**
- **2 No**

17. Specialty Bed (flowsheet):
- **1 Yes**
- **2 No**

18. Specialty Bed (Sunrise):
Date Ordered:

19. Nutrition Consult (Sunrise):
Date Ordered:

20. Turning:
- o **Q 1 hour**
- o **Q 2 hours**
- o **Q 3 hours**
- o **Q 4 hours**
- o **Q 5 hours**
- o **Q 6 hours**
- o **Q 7 hours**
- o **Q 8 hours**
- o **Q 9 hours**
- o **Q 10 hours**
- o **Q 11 hours**
- o **Q 12 hours**
- o **Q 13 hours**
- o **Q 14 hours**
- o **Q 15 hours**
- o **Q 16 hours**
- o **Q 17 hours**
- o **Q 18 hours**
- o **Q 19 hours**
- o **Q 20 hours**
- o **Q 21 hours**
- o **Q 22 hours**
- o **Q 23 hours**
- o **Q 24 hours**
- o **Self**
- o **Other_____**
- o **None**
- o **No documentation**

20. Skin Care Initiative:
- **1 Yes**
- **2 No**
- **99 No data**

15.	Breakdown Site/ # of PU	Grade				None
o	Abdomen /	I	II	III	IV	0
o	Back/	I	II	III	IV	0
o	Buttocks/	I	II	III	IV	0
o	Chest/	I	II	III	IV	0
o	Ears/	I	II	III	IV	0
o	Elbow/	I	II	III	IV	0
o	Eyes/Orbit/	I	II	III	IV	0
o	Forehead/	I	II	III	IV	0
o	Heels/	I	II	III	IV	0
o	Lips/Mouth/	I	II	III	IV	0
o	Neck/	I	II	III	IV	0
o	Nose/	I	II	III	IV	0
o	Occiput/	I	II	III	IV	0
o	Peri1. Patient Name:	I	II	III	IV	0

o	**Sacrum/Coccyx/**	**I**	**II**	**III**	**IV**	**0**
o	**Scrotum/**	**I**	**II**	**III**	**IV**	**0**
o	**Shoulders/**	**I**	**II**	**III**	**IV**	**0**
o	**Other/**	**I**	**II**	**III**	**IV**	**0**
o	**None**					

Skin Integrity Data Collection Key

1. **Patient Name**: There will be a list of all patients who fall within the specified time frame. Please document the name of the patient on the data collection sheet. The patient's name is located on the patient sticker on the top left hand corner of the flow sheet. The HUCs will print out a daily 6am census. Please refer to this and cross reference with the hand written census kept at the central nursing station.
2. **MRN**: Located on the patient sticker on the top left hand corner of the flow sheet.
3. **Visit ID**: Located on the patient sticker on the top left hand corner of the flow sheet
4. **Date of PICU Admission:** This can be determined from the 6 am census. If there is any question, please cross reference with the hand written log book.
5. **VPS ID:** Will be assigned by the National Outcomes Center
6. **Sheet Date:** Please document the actual date documented on the flowsheet. The flow sheet actually spans 2 dates as it is from 6am-6am rather than midnight to midnight.
7. **Vasoactive drugs:** In the section under "IV dose" please check for any of the following medications documented: Epinephrine "Epi", Norepinephrine "Norepi", Dopamine "Dopa", Phenylephrine "neosynephrine", Vasopressin, Milrinone, Dobutamine, Nicardipine, Nipride, Neseritide. If they are listed, please check "yes" in this box

For the following sections of the sheet, you can indicate by either marking the circle or circle the entire statement.

8. **Mobility:** The number 1-4 should be documented in the mobility section of the Braden Scale Box under the section titled "Integumentary" on the flow sheet. Please document "99" if there is no documentation.
9. **Activity:** The number 1-4 should be documented in the activity section of the Braden Scale Box under the section titled "Integumentary" on the flow sheet. Please document "99" if there is no documentation.
10. **Sensory:** The number 1-4 should be documented in the sensory section of the Braden Scale Box under the section titled "Integumentary" on the flow sheet. Please document "99" if there is no documentation.
11. **Moisture:** The number 1-4 should be documented in the moisture section of the Braden Scale Box under the section titled "Integumentary" on the flow sheet. Please document "99" if there is no documentation.
12. **Friction:** The number 1-4 should be documented in the friction section of the Braden Scale Box under the section titled "Integumentary" on the flow sheet. Please document "99" if there is no documentation.
13. **Nutrition:** The number 1-4 should be documented in the nutrition section of the Braden Scale Box under the section titled "Integumentary" on the flow sheet. Please document "99" if there is no documentation.
14. **Tissue Oxygenation & Perfusion:** The number 1-4 should be documented in the tissue section of the Braden Scale Box under the section titled

"Integumentary" on the flow sheet. Please document "99" if there is no documentation.

15. **Breakdown Site:** This is may be documented with a "9" on the body diagram under the integumentary section of the flow sheet. It also may be documented in the integumentary section in the box with the "incision/wound/drain" documentation in the top left of the section. Please note that there may be more than one pressure ulcer. Please document all pressure ulcers. If there is more than one pressure ulcer on the same site, please indicate this next to the pressure ulcer location. For example, if there are bilateral heel ulcers, please document 2 next to heels. If there are different grades, please document each grade. If only one has a documented grade, then document the grade and the "0" for the one that is not documented, if they are both the same grade then just circle one grade and it will be used for both. Please document "99" if there is no documentation.
    Breakdown Grade: This is documented in the "Integumentary" section in the sub-section titled "condition". After the "9" the nurse should circle the pressure ulcer grade
16. **Lotion:** This is documented in the section "Cares/Interventions" in the skin sub section. If "LO" is marked in the blank square representing the time of day adjacent to the key this should be documented as a "yes" for this section.
17. **Specialty Bed (flowsheet):** Our standard PICU beds are now the stryker go bed with isoflex mattress, cub cribs, and delta foam overlays. Look for this variable in the "Cares and Interventions" section on page 4 of the PICU flowsheet, under "specialty bed". Any indication on that line should be considered a "yes" on the datasheet. The only exception is that a radiant warmer is not a specialty bed.
18. **Specialty Bed (sunrise):** On the first data collection sheet only: please document the date the specialty bed was ordered in Sunrise. Leave the subsequent dates blank unless a new type of specialty bed is ordered, then just document the date the new bed was ordered on the first page as well with a note.
19. **Nutrition Consult:** This can be found in Sunrise. Go under the "Orders" tab and under "Status/Priority" select "all" and under "Order selection" select "consults". If there was a nutrition consult ordered, please document the date it was ordered on the first data collection page and leave all other pages blank. If there was a subsequent nutrition consult, please document that date on the first page with a note as well.
20. **Turning:** This is documented in the "Comfort Zone" section under the sub-section "position". There are blank boxes extending to the left of the word "position" where the nurse documents the position of the patient as "L" left, "S" or "Su" supine, "R" right, or "P" prone. Please determine how much time elapses between position changes (each box is an hour) and the longest time between re-positioning should be documented as the turning frequency. Arrows or symbols should not be used to determine turning frequency. If patient is self turn (i.e. "Se" or "self", H= held, HE= held, PA=parent, Stroller=up in stroller, RN= RN held) for the entire flowsheet indicate "self".

If the patient is only occasionally documented as “self” on the flowsheet, please use the longest frequency of turning other than the self turning time. Example: If a patient is documented as “Se” for three hours, then “S” for two hours, the turning frequency would be Q2.

21. **Skin Care Initiative:** Under the “Integumentary” section, please look if the patient has “Skin protocol initiative” checked yes or no. If neither is checked, please check no data.

Appendix E- Online Order Set

Nursing Order Set

Skin Integrity Assessment:
- Daily Braden Q score
- Document and stage any pressure ulcer

Pressure redistribution surface
-Stryker Go Bed (critical care only)
-Cub Crib (critical care only)
-Visco-Elastic Foam Overlay (critical care only)
-low air loss/alternating pressure mattress overlay
- In Tough bed (Kids with Braden Q <16)

Activity
-Turn q 2 hours using a pillow between the ankles and knees and behind the back as position and size permit
-HOB </= 30 degrees
-Use draw sheet for moving

Supplies at bedside
-Gel pad under the occiput (no donuts)
**Note: No gel pads under the occiput of non-intubated infants per policy
-Heels should float off pillow

Incontinence care (diaper care) for dermatitis
-hand hygiene
-change diaper as soon as possible after incontinent episode
-clean perineum with perineal wash (Aloe Vesta or Sensicare)
-if barrier product present, remove only the barrier product that has stool on it
-pat dry, try not to wipe to reduce friction forces, allow drying
-Every 24 hours remove all barrier product to assess skin & document

Barrier Cream with each diaper change (Apply a thick layer with each diaper change)
Drop down box
-Triple Paste (use for intact, dry flaky, red fissured, denuded skin)
- Desitin (use for intact, dry flaky, red skin, dermatitis)
-Calmosptine Ointment (Intact, dry flaky, red, fissured, denuded, itchy skin, antiseptic, dermatitis, analgesic)
-A & D Ointment (To protect, soothe, and moisturize skin)
-Balmex (use for diaper rash)
-No Sting Barrier (3M Cavilon Swabs, All-Kare wipes)- use for intact or damaged (dry, red, fissured, denuded) skin
-Sensicare Protective Barrier Cream (good for barrier against stool and urine)

Bathing Infants >32 weeks up to 2 months

-Bathing should be limited to 2-3 times per week

-Use non-deodorant liquid soap and water or water only (need to throw out basin after each use)

-Lotion/ Moisturizer applied daily

Drop down box

-Eucerin- for dry, cracked skin

-Aquaphor- Prevents insensible water loss and infection, protects, soothes, and moisturizes skin

Aloe Vesta- use for irritated, fragile skin

Bathing for children> 2 months

-Comfort Bath daily

-Lotion/ Moisturizer applied daily

Drop down box

-Eucerin- for dry, cracked skin

-Aquaphor- Prevents insensible water loss and infection, protects, soothes, and moisturizes skin

Aloe Vesta- use for irritated, fragile skin

Nutrition

-If nutrition score is $\leq$2 on nutrition category on Braden Q then Nutrition consult should be ordered

Appendix F-Marquette University and Children's Hospital of WI IRB Approvals

MARQUETTE
UNIVERSITY

November 23, 2009

Ms. Christine Schindler
Nursing

Dear Ms. Schindler:

Your protocol number HR-1927, titled, "*More than S.K.I.N. deep; Nursing interventions to decrease pressure ulcer development in the pediatric intensive care unit*" was expedited on November 18, 2009, by a member of the Marquette University Institutional Review Board.

The IRB granted a waiver of consent for this protocol. The IRB granted a waiver of authorization to use protected health information (HIPAA waiver) for this protocol.

Please provide copies of any IRB continuing review approval letters, amendment approval letters, consent forms if any revisions are made, and any other approval letters or revised documentation from Children's Hospital of Wisconsin to the Marquette Office of Research Compliance on a timely basis.

You are approved to examine a total of 296 charts. Any changes to your protocol must be requested in writing by submitting an IRB Protocol Amendment Form, which can be found at: http://www.marquette.edu/researchcompliance/research/irbforms.shtml. All changes must be reviewed and approved by the IRB before being initiated, except when necessary to eliminate apparent immediate hazards to the human subjects. Any public advertising of this project requires prior IRB approval. If there are any adverse events, please notify the Marquette University IRB immediately.

Your approval is valid until November 17, 2010. Prior to this date, you will be contacted regarding continuing IRB review.

If you have any questions or concerns, please do not hesitate to contact me. Thank you for your time and cooperation.

Sincerely,

Amanda J. Ahrndt, RN, MS, MSN, CIM
IRB Manager

cc: Dr. Rebecca Bardwell, IRB Chair
Dr. Christine Shaw, Nursing
Ms. Erin Fox, Graduate School

Children's Hospital and Health System™

APPROVAL

October 6, 2009

Dear Dr. Schindler:

Expedited Review approval has been granted on behalf of the Human Research Review Board for your protocol entitled **[128468-1] Evaluation of a Pressure Ulcer Reduction Quality Improvement Initiative** on **October 5, 2009**.

For purposes of identification, this research has been assigned the following numbers: **CHW 09/154, GC 959**. *CHW protocols are also assigned a Grants and Contracts Office [GC] number by the Medical College of Wisconsin.*

PLEASE NOTE:

CONTACT DATA MANAGEMENT AT 414-337-7760 TO DETERMINE WHAT INFORMATION IS NEEDED FOR YOUR STUDY. ONCE THE REQUESTED INFORMATION IS RECEIVED, CONTACT GLENDA WATKINS AT 414-266-6952 TO DEVELOP A PLAN FOR GAINING ACCESS TO MEDICAL RECORDS.

BASED ON OUR REVIEW, THE WAIVER OF HIPAA AUTHORIZATION FORM HAS BEEN ACCEPTED. THIS WAIVER HAS ONLY BEEN REVIEWED TO ENSURE ALL REQUIRED ITEMS HAVE BEEN COMPLETED. IT IS THE RESPONSIBILITY OF THE RESEARCHER TO ENSURE THE ACCURACY OF THE INFORMATION PROVIDED ON THIS FORM AND THE MINIMUM INFORMATION NECESSARY TO COMPLETE THE STUDY IS REQUESTED.

This protocol is approved for 1-year from the original approval date and a continuing review is scheduled for October 4, 2010. Failure to submit the Continuing Review Form in a timely manner may result in the termination of your research approval.

Any changes in the protocol and any severe untoward reactions must be reported immediately to the Human Research Review Board. Changes in approved research, during the period for which Board approval has already been given, may not be initiated without Board review and approval except where necessary to eliminate apparent, immediate hazards to the human subjects.

When the above work is completed or discontinued, the Board must be notified in order to maintain an accurate record of all current projects.

If you leave the community, you are expected to notify the Board to whom the protocol should be transferred; otherwise, the protocol will be terminated.

If you have any questions, please feel free to contact the IRB Office at 414-266-7454.

Sincerely,

Bruce M. Camitta, MD, Co-Chair
Human Research Review Board

cc: Melissa Christensen; Glenda Watkins

Appendix G- Marquette University and Children's Hospital of WI Survey IRB

OFFICE OF RESEARCH COMPLIANCE

MARQUETTE
UNIVERSITY

December 4, 2009

Ms. Christine Schindler
Nursing

Dear Ms Schindler:

Thank you for submitting your protocol number HR-1936 titled, "*More than S.K.I.N. deep: Nursing interventions to decrease pressure ulcer development in the pediatric intensive care unit Survey.*" On December 3, 2009, the Marquette University Institutional Review Board granted exempt status for this protocol under Exemption Category #2: Anonymous Educational Tests, Surveys, Interviews, or Observations.

You may proceed with your research. Your protocol has been granted exempt status as submitted. Any changes to your protocol affecting participant risk must be requested in writing by submitting an IRB Protocol Amendment Form which can be found here: http://www.marquette.edu/researchcompliance/research/irb/irbforms.shtml. These changes must be reviewed and approved by the IRB before being initiated; except when necessary to eliminate apparent immediate hazards to the human subjects. If there are any adverse events, please notify the Marquette University IRB immediately.

If you have any questions or concerns, please do not hesitate to contact me. Thank you for your time and cooperation.

Sincerely,

Amanda J. Ahrndt, RN, MS, MSN, CIM
IRB Manager

cc: Dr. Rebecca Bardwell, IRB Chair
Dr. Christine Shaw, Nursing
Ms. Erin Fox, Graduate School

Room 102 - 540 North 16th Street - P.O. Box 1881 - Milwaukee, WI 53201-1881 - Telephone (414) 288-7370 - Fax (414) 288-0281

Children's Hospital and Health System™

AMENDMENT APPROVAL

November 17, 2009

Dear Dr. Schindler:

Administrative Review approval has been granted on behalf of the Human Research Review Board for the following amendment to **[128468-2] Evaluation of a pressure ulcer reduction quality improvement initiative** which as requested on **November 6, 2009**. This will be known as **Amendment I.**

The following items were reviewed and approved on **November 14, 2009**:

- Addition of PICU nursing staff survey (Survey Monkey).
- These changes do not alter the risk to subjects.

The following Protocol Numbers will remain unchanged: **CHW 09/154, GC 959**.

Any changes in the protocol and any severe untoward reactions must be reported immediately to the Human Research Review Board. Changes in approved research, during the period for which Board approval has already been given, may not be initiated without Board review and approval except where necessary to eliminate apparent, immediate hazards to the human subjects.

When the above work is completed or discontinued, the Board must be notified in order to maintain an accurate record of all current projects.

If you leave the community, you are expected to notify the Board to whom the protocol should be transferred; otherwise, the protocol will be terminated.

If you have any questions, please feel free to contact the IRB Office at 414-266-7454.

Sincerely,

Mary Jo Kupst, PhD, Chair
Human Research Review Board

cc: Melissa Christensen, Glenda Watkins

Appendix H- Marquette University Online Survey Approval

RE: “2009 Pressure Ulcer Prevention in the PICU: Barriers and Facilitators Survey”

Dear Christine & Christine:

Your on-line survey project entitled, “2009 2009 Pressure Ulcer Prevention in the PICU: Barriers and Facilitators Survey” has been approved by the MU Online Survey Committee.

In addition, it is my understanding that:

1) you may need ITS to show you how to build the survey(s) and to host your survey (I am cc:ing Mykl Novak in ITS on this email),

2) you will provide your own list of emails,

and

3) you would like the survey to be live from January 4-14, 2010.

Please respond to this email letting me know if these are correct, and if not what information is erroneous.

Please keep me in the loop and feel free to contact me if you have any questions or concerns.

Thank you again for your patience and cooperation.

Gary

Gary Levy, Ph.D.
Associate Vice Provost for Institutional Research & Assessment
Professor of Psychology
Marquette University
202 O’Hara Hall
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