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Prevention of Skin Breakdown In the Pediatric Intensive Care Unit

Lydia H. Palmer
University of South Carolina

Prevention of Skin Breakdown in the Pediatric Intensive Care Unit

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Lydia Helmick Palmer

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Accepted by:

Kathy Scharer, Co-chair of Committee

Laura Hein, Co-chair of Committee

Katherine Chappell, Committee Member

Lacy Ford, Vice Provost and Dean of Graduate Studies

DEDICATION

This project was inspired by my work in the Pediatric Intensive Care Units in both Columbia, SC and Charlotte, NC. During my time as a PICU nurse, I have been amazed to witness the strength of my patients and families as well as the caring, intelligence, and resolve demonstrated by my fellow nurses.

This project was completed in part as a result of the helpful understanding and accommodation of my family and friends. My parents have always supported and emphasized education and have served as motivation to move forward with my ambitions. My husband, CJ, has been a constant source of support throughout this project and deserves acknowledgment for all the long hours of help he has given.

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ABSTRACT

Skin breakdown occurs when one or more layers of the skin have been disrupted (McLane et al., 2004; National Pressure Ulcer Advisory Panel, 2007). While some literature uses the terms skin breakdown and pressure ulcer interchangeably, these are actually two distinct conditions and pressure ulcers are encompassed in the definition of skin breakdown (Kuller, 2001; Lund, 1999; Suddaby et al., 2006). The consequences of skin breakdown in the pediatric population can include increased cost of treatment, infection, increased morbidity and mortality as well as psychological consequences from resulting alopecia or scarring (Schindler, 2010; Willock & Maylor, 2004). Development of skin breakdown has also been associated with increased morbidity, increased length of stay, and higher costs of care (McCord et al., 2004).

Prevention of skin breakdown can be accomplished by the use of barriers and specialty surfaces. Barrier protection is achieved by the use of preparations, such as zinc oxide, petrolatum-containing compounds, and alcohol-free barrier films, and also by the application of transparent film and hydrogel dressings (Atherton, 2004; Atherton, 2005; Baharestani, 2007; Campbell et al., 2000; Lund et al., 2001). Surfaces can be useful in the prevention of skin breakdown by aiding in the distribution of pressure and decreasing moisture, and can also be used to aid in temperature control for some patients (Norton, Coutts, & Sibbald, 2011). The PICO format question used to guide this project is: For patients in Pediatric Intensive Care Units, is barrier protection or use of specialty surfaces more effective at preventing skin breakdown?

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LIST OF ABBREVIATIONS

Agency for Healthcare Research and Quality..... AHRQ

Cumulative Index for Nursing and Allied Health Literature ..... CINAHL

Incontinence Associated Dermatitis ..... IAD

Irritant Diaper Dermatitis..... IDD

Liquid Barrier Film ..... LBF

Low Birth weight .....LBW

Neonatal Intensive Care Unit.....NICU

No Sting Barrier Film .....NSBF

Pediatric Intensive Care Unit ..... PICU

Randomized Controlled Trials..... RCTs

Scottish Intercollegiate Guidelines Network ..... SIGN

CHAPTER I

BACKGROUND

The skin is the largest organ in the body and accounts for approximately 20% of the body's weight (Nicol, Huether, & Weber, 2006). The main functions of the skin are to serve as a barrier from the outside environment against bacteria, chemicals, and physical forces (Nicol, Huether, & Weber, 2006). It protects the body from invasion by microorganisms that can lead to infection, damage from ultraviolet rays, the stress of mechanical forces, and loss of body fluids. The skin also helps in the production of Vitamin D, which aids in the absorption of calcium and phosphate, and regulates body temperature (Nicol, Huether, & Weber, 2006). Skin integrity, or skin intactness, is an important factor is the skin's ability to perform its functions, especially protecting against infection (Lio, 2011).

Anatomy of skin

The skin has three layers: the epidermis, the dermis, and the subcutaneous tissue. The epidermis, the outermost layer of the skin, is composed of basal cells, keratinocytes, and three types of branched cells: melanocytes, responsible for synthesizing pigment, Langerhans cells, which are involved in the immune response of the skin, and Merkel cells, which do not have a clearly defined function. The outermost layer of the epidermis is the stratum corneum. The dermis is composed of connective tissue and also contains histiocytes, macrophages that digest products of inflammation, and mast cells, which

manufacture and release histamine and heparin. Nerve endings which receive signals translated into sensations of touch and pressure are contained in the dermis and the subcutaneous tissue. The innermost layer of the skin contains sebaceous and apocrine glands that produce sweat and cool as well as fat cells that help insulate the body (Habif, 2010).

While the functions of skin remain basically the same over the lifespan, there are several important structural differences in infant's and children's skin that can affect skin integrity (Lio, 2011). Skin of infants and children has a higher overall water content and is able to absorb and lose water faster than adult skin, resulting in more fragile skin surface (Lio, 2011). The increased water content also means that infants especially absorb topical preparations such as lotions and medications faster than adults, resulting in the need for more careful consideration when using chemicals that could be potentially harmful or the need to apply topical preparations at a different frequency than adults to achieve similar results (Kuller, 2001; Lio, 2011). Neonates and premature infants have a thinner stratum corneum and fewer fibrils connecting the epidermis to the dermis, resulting in an increased risk for injury from physical forces (Kuller, 2001).

Overview of Skin Breakdown

Skin breakdown has occurred when one or more layers of the skin have been disrupted (McLane, Bookout, McCord, McCain, & Jefferson, 2004; National Pressure Ulcer Advisory Panel, 2007). Skin breakdown has been defined as a "change to intact skin" and includes all indications of skin disruption including non-blanchable erythema, abrasion, and mild to extensive wounds (Suddaby, Barnett, & Facteau, 2006, p. 157). While some literature used the terms skin breakdown and pressure ulcer interchangeably,

these are actually two distinct conditions and pressure ulcers are encompassed in the definition of skin breakdown (Kuller, 2001; Lund, 1999; Suddaby et al., 2006). Disruption in skin integrity can lead to infection and injury of underlying structures (McLane, et al., 2004).

Hospitalization and severity of illness have been identified as two major risk factors for skin breakdown in children (McLane et al., 2004). Children with severe illnesses or injuries who are at risk of imminent death have been cared for in a Pediatric Intensive Care Unit (PICU; Epstein & Brill, 2005; Odetola, Clark, Freed, Bratton, & Davis, 2005). Typically, PICUs have managed complex care for patients from shortly after birth to age 18 (Odetola et al., 2005). Emerging as a subspecialty in the 1960s, PICUs were created as a result of recognition that patient care outcomes are improved when children are cared for by a specialized team in a separate area from adult patients (Epstein & Brill, 2005). Following the initiation of Pediatric Intensive Care as a subspecialty, the creation of PICUs has grown both in the United States and internationally, with approximately 350 units in the U.S. and hundreds more worldwide (Odetola et al., 2005). Because of the increased medical complexity and comorbidities, patients admitted to PICUs have been placed at an increased risk of skin breakdown with an even greater risk associated with younger age and longer length of stay (Schindler, 2010; Schindler, Mikhailov, Kuhn, Christopher, Conway, Ridling…& Simpson, 2011). In a prospective cohort study in a PICU, a higher risk of mortality was associated with the development of skin breakdown and redness (Schindler, 2010).

Types of Skin Breakdown

The literature has identified three major types of skin breakdown– moisture injury, mechanical injury, and pressure injury (Kuller, 2001; Lund, 1999; McLane et al., 2004). Because of the structural differences of the skin in infants and children, distinct differences in the manifestations of skin breakdown in pediatrics as compared to the adult population have been identified (Baharestani, 2007; McLane et al., 2004).

Moisture injury

Moisture has caused skin breakdown by increasing permeability and decreasing its barrier function (Zulkowski, 2012). Skin breakdown caused by moisture has most commonly manifested in children as diaper dermatitis, an inflammation of the skin as a result of irritation caused in diaper-wearing infants and children (Vernon, Brady, & Starr, 2009). Moisture has also led to skin breakdown in skin folds, such as the neck, especially when medical devices such as braces or splits have been in place (Baharestani, 2007).

Moisture-related skin breakdown has been classified into two distinct subtypes: irritant diaper dermatitis (IDD) and breakdown related to medical devices (Atherton, 2004; Noonan, Quigley, & Curley, 2006). Irritant Diaper Dermatitis has been classified as one of the most common dermatological conditions seen in neonates and children (Jordan, Lawson, Berg, Franxman, & Marrer, 1986; Noonan et al., 2006). It has occurred as a result of the wearing of diapers, which has led to skin wetness and an alteration in the skin pH in the perineal area (Atherton, 2004; Noonan et al., 2006). Prolonged wetness has resulted in softening, or maceration, of the stratum corneum, leading to weakening of the integrity of the skin and making it more susceptible to breakdown as a result of friction and local irritants (Atherton, 2004; Zulkowski, 2012). The initial

presentation of IDD has included erythema (redness), inflammation, and papules (Jordan et al., 1986; Vernon et al., 2009). With repeated exposure to moisture and friction and without intervention, IDD has progressed to skin breakdown and has been complicated by infection with viral, bacterial, or fungal agents (Habif, 2010; Vernon et al., 2009). Irritant Diaper Dermatitis has been a very common condition with reported rates among hospitalized neonates and children of up to 42% (Baharestani, 2007; Noonan et al., 2006). Risk factors for IDD have included oral antibiotics, an alteration in stool or urine content or pattern, and gastrointestinal surgical procedures (Jordan et al., 1986; Noonan et al., 2006; Visscher, 2009). Tactics for prevention of IDD have included increased frequency of diaper changes, gentle cleansing methods, and the use of barrier creams and preparations (Baharestani, 2007; Heimall, Storey, Stellar, & Davis, 2012; Jordan et al., 1986; Lund, 1999; Mack, 2010).

Moisture has also contributed to skin breakdown in other areas on the body other than the perineum, especially in the presence of medical devices such as cervical collars, casts, or splints (Black, Buderer, Blaylock, & Hogan, 1998; Webber-Jones, Thomas, & Bordeaux, 2002). This type of injury has often been classified as a pressure injury because of the involvement of the medical device and little research has been done on the role of moisture alone in skin breakdown other than diaper dermatitis.

Mechanical injury

Skin breakdown as a result of trauma from opposing forces has been classified as mechanical injury. In hospitalized children, this type of injury has most often resulted from medical intervention (Habif, 2010; McLane et al., 2004; National Pressure Ulcer Advisory Panel, 2007), such as stripping of the skin due to adhesive removal. Adhesives

have been used frequently to secure medical devices such as intravenous catheters, endotracheal tubes, monitors, and other types of devices (Lund, 1999). Removal of adhesives without proper precautions has been shown to damage the outermost layer of the skin and result in skin breakdown (Kuller, 2001; Lund, 1999; Lund, Kuller, Lane, Lott, Raines, & Thomas., 2001). This type of injury has been classified as epidermal stripping and has been the primary cause of skin breakdown in Neonatal Intensive Care Units (NICU; Baharestani, 2007; Gordon & Montgomery, 1996; Kuller, 2001; Lund, 1999).

Epidermal stripping has been seen more often in neonates and infants but can occur in any age patient. Stripping can lead to discomfort and scarring and has been associated with an increased risk of morbidity in immuno-compromised or low birth-weight (LBW) infants (Lund, 1999; Lund et al., 2001). In younger neonates and infants, skin tears have most often occurred on the extremities, the front and back of the trunk, and the face, particularly the nose (Lund et al., 2001; Zollo, Gotisha, Berens, Schmidt, & Weigl, 1996). The prevalence of epidermal stripping as a result of adhesion removal in hospitalized children has been estimated to be between 8 to 17% in hospitalized children, although few studies have been done to examine this issue (McLane et al., 2004; Noonan, et al., 2006).

Prevention of skin tears has been accomplished by using alcohol-free skin barrier preparations, such as 3M™ No Sting Barrier Film or other pectin-containing compounds (Campbell, Woodbury, Whittle, Labate, & Hoskin, 2000; Gordon & Montgomery, 1996). Consistent use of a barrier compound has been demonstrated to help form a protective barrier against irritation and should be applied prior to any adhesive placement (Campbell

et al., 2000; Gordon & Montgomery, 1996). In addition, use of a padded surface or splint, such as an arm board, to secure devices instead of tape has decreased the risk of epidermal stripping by reducing the use of adhesives (Baharestani, 2007).

Pressure injury

Increased pressure on an area of skin, due to body structure or medical devices, has resulted in decreased blood or oxygen supply to the skin and has resulted in skin injury that is called a pressure ulcer (National Pressure Ulcer Advisory Panel, 2007). A pressure ulcer occurs as a consequence of unrelieved pressure that has resulted in damage to underlying tissue (Nicol & Huether, 2006).

Pressure ulcers are widely researched topics in the adult population, but emerging research has shown that these are a concern in the pediatric population as well (Baldwin, 2002; Bernabe, 2012; Butler, 2006; Kottner, Wilborn, & Dassen, 2010). While rates of pressure ulcers in the pediatric population differ in the literature, some studies have shown a prevalence of up to 27% in a PICU (Agarwal, Classen, Larsen, Tofil, Hayes, Sullivan…& Sharek, 2010; Schindler et al., 2010). In children, pressure ulcers have most often been found in different anatomic areas as compared to adults (Baharestani, 2007; McLane et al., 2004; National Pressure Ulcer Advisory Panel, 2007). Pediatric patients in the supine position have been most likely to develop pressure ulcers on the occiput, sacrum, and scapula (Baharestani & Ratliff, 2007; Willock & Maylor, 2004). In the adult population, pressure ulcers have typically been considered to be a result of pressure exerted by bony prominences; however, especially in hospitalized children, pressure injuries have also occurred as a result of compression between medical device, other objects, or braided hair and the skin (Dixon & Ratliff, 2011; McLane et al., 2004).

One study has estimated that approximately 50% of all pressure ulcers in hospitalized neonates and children can be attributed to medical equipment and devices (Willock & Maylor, 2004). Medical equipment that has been associated with pressure injuries includes blood pressure cuffs, pulse oximetry probes, tracheostomy securement devices, nasal cannulas, nasal and mask CPAP devices, arm boards, casts, splints, cochlear implants, and cervical collars (James, Daniel, Richmond, & Papsin., 2004; Webber-Jones et al., 2002; Willock & Maylor, 2004; Zollo et al., 1996). Medical devices such as cervical collars, securement devices, and casts have exerted pressure on the skin and trap moisture, which has also led to development of pressure ulcers (Webber-Jones et al., 2002; Willock & Maylor, 2004).

Much research has been done on pressure ulcers in adults; however, it has consistently been recognized that risk factors for skin breakdown are different in the pediatric population (Schindler et al., 2011). In the adult population, research has identified four major factors that contribute to the development of pressure ulcers – pressure, shearing forces, friction, and moisture (Nicol & Huether, 2006). The most widely used pressure ulcer risk assessment scale for pediatrics, the Braden Q scale, was adapted from the adult pressure ulcer risk assessment scale, the Braden scale, in an attempt to standardize risk assessment in the pediatric population (Quigley & Curley, 1996). While the Braden Q scale identifies risk factors for pressure ulcers occurring as a result of pressure exerted by bony prominences, the high rate of pressure injuries from medical devices has necessitated further assessment by the pediatric nurse (Quigley & Curley, 1996; Willock & Maylor, 2004). Identified risk factors for pressure ulcers in the pediatric population have included extrinsic factors, such as pressure, friction/shear, and

moisture, and intrinsic factors, such as impaired nutrition, obesity, infection, immobility, anemia, and decreased perfusion (Baharestani & Ratliff, 2007; Gallagher, 2002).

The risk factors for pressure ulcers have also overlapped with factors that increase the risk of epidermal stripping and diaper dermatitis – moisture, friction, and pressure. When considering methods of prevention, the ability and practicality to modify these basic factors should be considered.

Prevention of Skin Breakdown

Prevention of skin breakdown has been accomplished by the use of barriers and specialty surfaces. Barrier protection has been achieved by the use of preparations, such as zinc oxide, petrolatum-containing compounds, and alcohol-free barrier films, and also by the application of transparent film and hydrogel dressings (Atherton, 2004; Atherton, 2005; Baharestani, 2007; Campbell et al., 2000; Lund et al., 2001). The goal of applying barrier preparations has been to reduce friction on the skin by providing an extra layer between the skin and the offending substance, such as adhesives or urine and feces in incontinent patients (Atherton, 2004; Atherton, 2005; Gordon & Montgomery, 1996). Barrier preparations come in several different forms. Traditionally, barrier preparations containing zinc or titanium oxide have been used to treat and prevent IDD; however, many of these preparations have been shown to not provide an effective barrier (Atherton, 2004; Atherton, 2005). Talcum powder, also a product traditionally used to prevent IDD, has been demonstrated to offer no protection to the skin and can be extremely abrasive (Atherton, 2004).

The use of alcohol-free pectin barrier preparations has been demonstrated to decrease the risk of epidermal stripping and diaper dermatitis, especially in the neonatal

and infant populations (Baharestani, 2007; Campbell et al., 2000; Gordon & Montgomery, 1996; Lund et al., 2001). Products such as 3M™ Cavilon No Sting Barrier Film (NSBF), Skin Prep® (Smith & Nephew United Inc), and Liquid Barrier Film® (LBF) 'no-sting' barrier wipes have been made in both liquid form and as a single-package wipe (Admiraal & Baatenburg de Jong, 2004; Campbell et al., 2000; Lund et al., 2001; Voegeli, 2007). In two randomized trials, both zinc oxide oil and 3M™ Barrier Film were shown to be effective in preventing and treating skin breakdown in incontinent adult patients; however, due to a decreased frequency of administration and nursing time involved, the 3M™ Film was shown to be more cost effective (Admiraal & Baatenburg de Jong, 2004; Bliss, Zehrer, Savik, Smith, & Hedblom, 2007). The effectiveness of zinc oxide has also been demonstrated in a randomized clinical trial in the adult population. In this study, zinc oxide was combined with a petrolatum-based formulation and was administered via a disposable diaper with the product being embedded in the fibers of the diaper (Baldwin, Odio, Haines, O'Connor, Englehart, & Lane, 2001).

Transparent dressings, such as tegaderm™, and hydrogel dressings have also been used to prevent skin breakdown by decreasing friction on specific areas of the body (Quigley & Curley, 1996). Transparent dressings have often been used in the management of Stage I pressure ulcers to prevent further damage, and Stage II ulcers are often managed with hydrocolloid dressings (Quigley & Curley, 1996). Overall, barrier preparations have been shown to be effective in preventing epidermal stripping, diaper dermatitis, and pressure injuries in the pediatric population (Admiraal & Baatenburg de Jong, 2004; Atherton, 2004; Atherton, 2005; Campbell et al., 2000; Lund et al, 2001).

Specialty surfaces have been an important adjunct in the prevention of skin breakdown. Surfaces have been useful in the prevention of skin breakdown by aiding in the distribution of pressure and decreasing moisture, and have also been used to aid in temperature control for some patients (Norton, Coutts, & Sibbald, 2011). The National Pressure Ulcer Advisory Panel has defined a support surface as "a specialized device for pressure redistribution designed or management of tissue loads, micro-climate, and/or other therapeutic functions" (National Pressure Ulcer Advisory Panel Support Surface Standards Initiative, 2007, p. 1). Many different types of specialty surfaces have been used, including reactive and active support surfaces that have the capability to change load distribution properties, non-powered or powered surfaces, overlays, and mattresses (National Pressure Ulcer Advisory Panel Support Surface Standards Initiative, 2007).

The goals of using a therapeutic specialty surface have been reducing moisture by increasing airflow, reducing friction and shearing, and reducing or relieving pressure on body surfaces (Butler, 2006; National Pressure Ulcer Advisory Panel Support Surface Standards Initiative, 2007). Therefore, use of specialty surfaces has been useful in preventing all types of skin breakdown – mechanical, moisture-related, and pressure injuries – because moisture and pressure have been identified as risk factors for all types of breakdown. While it has been well-documented that proper positioning has played a role in the prevention of skin breakdown as a result of pressure injury, studies have found that even with correct positioning methods, a specialty surface may still be needed to prevent injury (McCord, McElvain, Sachdeva, Schwartz, & Jefferson, 2004; Norton et al., 2011). In addition, some unstable and critically ill patients have been unable to be repositioned frequently and have benefitted from the addition of a specialty surface to

decrease pressure on bony prominences (Butler, 2006; Curley, Quigley & Lin, 2003; Curley, Thompson, & Arnold, 2000).

A task force at Children's Hospital, Boston, has evaluated pressure reduction and pressure relief mattress overlays and has determined that pressure ulcers were either prevented or improved in patients using the devices (Quigley & Curley, 1996). There are many products available, but the majority of these surfaces have been designed for adult use and are ill-suited for the pediatric population (Willock & Maylor, 2004). Limited research has been available for the pediatric population, but studies that have been completed have shown encouraging results for the use of specialty surfaces in the prevention of skin breakdown (Butler, 2006; Curley et al., 2003; Garvin, 1997; Quigley & Curley, 1996).

Significance of the Problem

As established by the American Nursing Association, skin care has been a nurse sensitive outcome measure (Montalvo, 2007). Statistics related to skin care have been reported in the National Database of Nursing Quality Indicators, and many regulating bodies have recognized the need for consistently excellent skin care, including the Joint Commission and the Institute for Healthcare Improvement (National Pressure Ulcer Advisory Panel, 2007; U.S. Department of Health and Human Services, Agency for Healthcare Research and Quality, 2010; U.S. Department of Health and Human Services, National Institutes of Health, Centers for Medicare & Medicaid Services, 2012).

The consequences of skin breakdown in the pediatric population have included increased cost of treatment, infection, increased morbidity and mortality as well as psychological consequences from resulting alopecia or scarring (Schindler, 2010;

Willock & Maylor, 2004). Development of skin breakdown has also been associated with increased morbidity, increased length of stay, and higher costs of care (McCord et al., 2004). While the cost per episode of skin breakdown has been difficult to quantify due to the paucity of research on the topic, experts have estimated that annual costs related to diaper dermatitis in the United States at approximately 10 million dollars, and the cost of a single pressure ulcer in an adult patient can exceed $70,000 (McLane et al., 2004; U.S. Department of Health and Human Services, Agency for Healthcare Research and Quality, 2010).

In 2011, pressure ulcers in the pediatric population were named a composite quality indicator by the Agency for Healthcare Research and Quality (AHRQ), and were identified as a safety indicator starting in 2006. Quality indicators composed by the AHRQ have been used to monitor healthcare quality over time in regions and nationally (U.S. Department of Health and Human Services, Agency for Healthcare Research and Quality, 2010). The AHRQ has been recognized as a leader in pediatric patient safety and is a federal authority in patient safety and quality of care (Lacey, Smith, & Cox, 2008). The Centers for Medicare & Medicaid Services have defined pressure ulcers as hospital-acquired conditions, an indication that pressure ulcers "could reasonably have been prevented through the application of evidence-based guidelines" and ulcers categorized as stage III or higher are a non-reimbursable healthcare condition because they are deemed to be a result of negligent care (U.S. Department of Health and Human Services, National Institutes of Health, Centers for Medicare & Medicaid Services, 2012).

Purpose

The purposes of this project are to (1) review the scientific literature concerning skin breakdown in pediatric patients, particularly in acutely ill, hospitalized children, (2) analyze the literature regarding the use of barrier protection and specialty surfaces as they relate to the prevention of skin breakdown, (3) determine the most effective method of preventing skin breakdown in the critically ill pediatric population, and (4) determine the best practice protocol for the prevention of skin breakdown in critically ill pediatric patients.

PICO Question and Definitions

The PICO format question used to guide this project is: For patients in PICUs, is barrier protection or use of specialty surfaces more effective at preventing skin breakdown? The definitions used for this project are as follows.

1. Patients: An individual ages 1 day to 21 years receiving medical care or treatment in a Pediatric Intensive Care Unit (Patients, 2012).
2. Pediatric Intensive Care Unit (PICU): A high-acuity unit in the hospital typically caring for patients ages 1 day to 21 years that manages care for individuals with critical injuries or illnesses who are at risk of imminent death (Agarwal et al., 2010; Epstein & Brill, 2005; Odetola, et al., 2005)
3. Skin breakdown: a change to intact skin and includes all indications of skin disruption including non-blanchable erythema, abrasion, and mild to extensive wounds (Suddaby et al., 2006). Essentially, skin breakdown is a disruption in skin integrity.

4. Skin integrity: Intactness of the integumentary system. Skin integrity allows unimpeded function of the skin to serve as a barrier from the outside environment against bacteria, chemicals, and physical forces (Nicol, Huether, & Weber, 2006).
5. Epidermal stripping: A type of skin breakdown resulting from mechanical trauma. Most often occurs as a result of removal of adhesives without proper precautions which can damage the outermost layer of the skin (Kuller, 2001; Lund, 1999; Lund et al., 2001).
6. Irritant Diaper Dermatitis (IDD): A type of skin breakdown occurring as a result of the wearing of diapers and incontinence, which lead to skin wetness and an alteration in the skin pH in the perineal area. Prolonged wetness results in softening, or maceration, of the stratum corneum, which can lead to weakening of the integrity of the skin, making it more susceptible to breakdown as a result of friction and local irritants (Atherton, 2004; Noonan et al., 2006).
7. Pressure ulcer: Skin breakdown resulting from a decrease in blood flow and tissue perfusion that occurs as a consequence of unrelieved pressure and results in damage to underlying tissue (Nicol & Huether, 2006).
8. Barrier protection: A method of preventing skin breakdown accomplished by the use of preparations, such as zinc oxide, petrolatum-containing compounds, and alcohol-free barrier films, and also by the application of transparent film and hydrogel dressings (Atherton, 2004; Atherton, 2005; Baharestani, 2007; Campbell et al., 2000; Lund et al., 2001). The goal of applying barrier

preparations is to reduce friction on the skin by providing an extra layer between the skin and the offending substance, such as adhesives or urine or feces in incontinent patients (Atherton, 2004; Atherton, 2005).

9. Specialty Support Surfaces: The National Pressure Ulcer Advisory Panel defines a support surface as "a specialized device for pressure redistribution designed for management of tissue loads, micro-climate, and/or therapeutic functions" (National Pressure Ulcer Advisory Panel Support Surface Standards Initiative, 2007, p.1). A method of preventing skin breakdown by reducing or relieving pressure on the skin. The goals of using a therapeutic specialty surface, such as a mattress, overlay pad, padded arm board, or gel pad, are to reduce moisture by increasing airflow, reduce friction and shearing, and reduce or relieve pressure on body surfaces (Butler, 2006; National Pressure Ulcer Advisory Panel Support Surface Standards Initiative, 2007).

Summary

Skin breakdown has been a prevalent condition in the acutely ill pediatric population. While the terms skin breakdown and pressure ulcers have historically been interchangeable, skin breakdown encompasses several distinct types of injury (Kuller, 2001; Lund, 1999; Suddaby et al., 2006). Little research has been done on the critically ill pediatric population to determine risk factors and effective prevention tactics, and current protocols used for assessment, prevention, and treatment rely on extrapolated data from the adult population (Baharestani & Ratliff, 2007; Gallagher, 2002). The consequences of skin breakdown have included increased morbidity, increased length of

stay, and higher costs of care as well as psychological consequences for the patient from scarring or alopecia (McCord et al., 2004). Barrier protection and specialty surfaces have been two categories of prevention that have shown promise in preventing the occurrence of skin breakdown (Atherton, 2004; Atherton, 2005; Baharestani, 2007; Baharestani & Ratliff, 2007; Butler, 2006; Campbell et al., 2000; Lund et al., 2001). The outcome of this project is to determine the best practice protocol for the prevention of skin breakdown in the Pediatric Intensive Care patient population.

CHAPTER II

LITERATURE ANALYSIS

This chapter describes the process of developing the search criteria, searching the literature, and then the development of the evidence table. The final section of the chapter presents the literature analysis.

The Search Process

The initial literature search used to formulate the PICO question for this project was completed using the search terms “pediatric skin breakdown” and “pediatric skin care” in abstracts. After completing a primary search and formulating the PICO question, additional searches were completed using numerous databases and a variety of search terms to ensure completeness of results. A full explanation of terms and databases is shown in Appendix B. All terms are presented with the total number of results first followed by the number of relevant results (results/relevant).

Limits were set on all searches to select literature published in the English language because I am unable to read other languages. Several articles were chosen that were translated from other languages. The date range selected for this project was 1995 to 2013. This range was selected to attempt to encompass all modern literature related to the topic and because few articles were identified in the primary search with a publication date before 1995.

The Cumulative Index for Nursing and Allied Health Literature (CINAHL) database, the Cochrane Library database, PubMed, the Joanna Briggs Institute, and the National Guideline Clearinghouse were searched using multiple combinations of search terms. In both the CINAHL and PubMed databases, searches were limited to terms found in the abstract of the paper in order to yield the most relevant results. No relevant results were identified from the Cochrane Library database or from the Joanna Briggs Institute.

The National Guideline Clearinghouse, which has been compiled by the US Department of Health and Human Services, was searched to identify any guidelines currently in place that are related to the study topic. Two possible resources were identified from this database, but further examination of the guidelines led to exclusion of both. One guideline dealt exclusively with the neonatal population with limited potential for extraction of results to the general pediatric population (Association of Women's Health, Obstetric, and Neonatal Nurses, 2007). The other guideline discussed pressure ulcer prevention and treatment and provided general recommendations based on a broad population. After reviewing the resource, the majority of the recommendations proposed dealt with the adult population and results were not appropriate to generalize to the pediatric population (Institute for Clinical Systems Improvement, 2010).

Literature was selected for use by evaluating its relevance to skin breakdown in hospitalized pediatric patients. Abstracts were used to evaluate whether articles were related to the study topic. Articles were excluded based on not being relevant to the target population (pediatrics) or not being related to one of the study topics (barriers or surfaces). After an initial scan of the abstract, ninety-five articles were selected for further examination. Articles dealing with surface protection for skin breakdown in the

adult population were excluded because research has shown many differences in adequacy of surfaces for pediatric patients. Because pediatric patients have different weight distributions and lower body mass, surfaces designed for adult use have been shown to be inadequate for pressure reduction in this population (Bostrom, Mechanic, Michelson, Grant, & Nomura, 1996; Brown, 2001; García-Molina, Balaguer-López, Torra i Bou, Alvarez-Ordales, Quesada-Ramos, & Verdú-Sariano, 2012; Hardin, Cronin, & Cahil, 2000). Articles on barrier protection in both the adult and pediatric population were included for analysis, although it is unclear whether all of the barrier protection methods will be useful in the younger neonatal and pediatric populations (Admiraal & Baatenburg de Jong, 2004; Campbell et al., 2000; Hoggarth, Waring, Alexander, Greenwood, & Callaghan et al., 2005). Studies that exclusively examined incontinence associated dermatitis (IAD) were excluded because this term deals exclusively with diaper dermatitis in the adult and geriatric population, and there are numerous differences between the skin structures of the pediatric population versus the geriatric population (Atherton, 2004; Baharestani, 2007; Baldwin et al., 2001; Heimall et al., 2012; Nield & Kamat, 2007). Studies pertaining to the development of atopic dermatitis (eczema) were also excluded because this condition is thought to be genetically based and, therefore, does not affect the general pediatric population (Cork & Danby, 2009). From the original articles selected for secondary examination, eighteen were considered to be strongly related to the study topic and were selected for analysis.

Analysis

This section discusses the method for analysis used in this study. Literature was rated using the hierarchy of evidence system detailed in the Scottish Intercollegiate

Guidelines Network (SIGN; Scottish Intercollegiate Guidelines Network, 2011). The SIGN criteria have been adopted for use in this study, and a summary of the SIGN guidelines are presented in Appendix A of this paper. The hierarchy ratings and general summaries, limitations, and conclusions are presented in an evidence table format. A summary of each article selected for inclusion can be found in Appendix C.

Rating of the Literature

Three studies were rated as 1+ according to the SIGN criteria -- two randomized controlled trials (RCTs) and one systematic review of RCTs (Baldwin et al., 2001; Heimall et al., 2012; Hoggarth et al., 2005). In study by Baldwin et al. (2001), three separate independent, blinded, randomized clinical trials were conducted to determine the benefits of a disposable diaper designed to continuously deliver a zinc oxide and petrolatum-based formulation to the skin. This study was considered to be high quality because of the multiple randomized trials conducted by the researchers (Baldwin et al., 2001).

In a systematic review of literature and synthesis, Heimall et al. (2012) presented recommendations for the standardization of the treatment and prevention of IDD. Heimall et al. (2012) used the rating criteria described by Melnyk and Fineout-Overholt (2011) to analyze 82 articles dealing with IDD. Following this analysis, the authors were able to determine an evidence-based practice guideline that was then implemented at their hospital (Heimall et al., 2012). After implementation of the new guidelines, prevalence rates of IDD were reassessed dropped from 24% to 11% of inpatient pediatric patients over a two year period (Heimall et al., 2012).

The final article that was rated as 1+ was a study by Hoggarth et al. (2005) in which a team of researchers examined the barrier and skin hydration properties of six skin protectants in a controlled, three-phase study conducted at a research facility. The study included both a positive (glycerin) and negative control (bare skin). While there was a small sample size (N=18), the high amount of control and objective testing done by the research team earned this study a grade of 1+ (Hoggarth et al., 2005).

Three studies were rated as 2+ according to the SIGN criteria. In a study by Admiraal & Baatenburg de Jong (2004), a prospective randomized study compared the use of either 3M™ Cavilon NSBF versus zinc oxide oil in patients with moderate skin damage from incontinence. While it was a randomized trial, the limitations of the study included small sample size (N=40), isolated clinical location, and possible sample bias since all patients selected for the study already had moderate skin damage (Admiraal & Baatenburg de Jong, 2004).

In another study also rated as 2+, an evaluation of 3M™ NSBF was completed to determine if the barrier film reduced redness, prevented or reduced maceration, assisted in dressing adhesion, and/or had any adverse effects on the patient (Campbell et al., 2000). Selection of patients to receive the 3M™ NSBF was not random and was done by using an algorithm developed by the researchers. The 3M™ NBSF was not compared to any other products in this study (Campbell et al., 2000).

The final study that was rated as 2+ was a descriptive multisite study with a large sample (N=5346). The goal of this study by Schindler et al. (2011) was to determine the incidence of pressure ulcers in PICU patients and the characteristics of patients who develop pressure ulcers (Schindler et al., 2011). Although this study did have a large

sample size, all data was collected by the bedside nurse, and there was no information given about experience level or previous education about pressure ulcers. Additionally, data on specific treatment modalities that impact other areas of care, such as use of sedation, modes of ventilation, or nutritional status, were not collected (Schindler et al., 2011).

One study was rated as 2- according to the SIGN criteria. This study, by García-Molina et al. (2012), assessed the effect of two different pediatric-specific low-pressure mattresses on the incidence of pressure ulcers in a PICU. This was a prospective longitudinal study, and patients were selected for participation because they were determined to be high risk for skin breakdown according to their Braden Q or Neonatal Skin Risk Assessment score (García-Molina et al., 2012). Both mattresses showed a significant decrease in the incidence of pressure ulcers with only one participant (3.3%) who developed a non-device related occipital pressure ulcer (García-Molina et al., 2012).

Two studies were rated as level 3 (Lund et al., 2001; Quigley & Curley, 1996). Lund et al. (2001) developed and evaluated an evidence-based practice guideline for the assessment and care of neonatal skin. The guideline was presented to NICUs, special-care, and well-baby nurseries and was implemented by 51 sites (Lund et al., 2001). While the extensive sites that implemented the guideline represented a large sample size, there was the potential for significant variation between the study sites. Both the subjective nature of the study and variation in data collection led to a high risk of bias (Lund et al., 2001).

A study by Quigley & Curley (1996) evaluated a three-pronged approach to prevent, stage, and treat pressure ulcers in a PICU. The authors helped develop the

Braden Q scale, which was modeled after the Braden Scale for pressure ulcer risk assessment. Use of the Braden Q scale was intended to standardize practice for pediatric risk assessment, and the Braden Q scale has been widely adopted since this study's publication (Quigley & Curley, 1996). The authors discussed methods of prevention for pediatric pressure ulcers and recommended that all at-risk patients should be placed on a pressure reducing surface, the heels should be suspended off the bed, lifting devices should be used to reduce friction, and assessment of nutritional intake should be done to maximize adequate nutritional support. Patients on bed rest should be turned and repositioned every two hours and transparent dressings should be used to reduce friction on susceptible body surfaces. Use of a pressure ulcer algorithm was helpful in attaining consistent staging and in selecting appropriate treatment regimens (Quigley & Curley, 1996).

The majority of the evidence was rated as level 4, and most were non-analytic literature reviews. Atherton (2004) and Nield & Kamat (2007) reviewed the pathophysiology, prevention, and treatment of IDD but mentioned that limited clinical data is available to determine the effectiveness of specific barrier preparations to prevent IDD. Baharestani (2007), Butler (2006), and Kuller (2001) summarized and reviewed neonatal and pediatric wound types, physiology, prevention, and treatment. Bernabe (2012) and Willock & Maylor (2004) summarized current practices for the prevention and treatment of pressure ulcers in children. Garvin (1997) discussed the etiology, assessment, and prevention of skin breakdown in the PICU population. All of these studies mentioned the limited research available on the pediatric population on skin breakdown and suggested that further research be done in the future to help determine the

best practice guidelines for assessment, prevention, and treatment of skin breakdown (Atherton, 2004; Baharestani, 2007; Baharestani & Ratliff, 2007; Bernabe, 2012; Butler, 2006; Garvin, 1997; Kuller, 2001; Willock & Maylor, 2004).

Application to Practice

Following rating of the literature according to the SIGN criteria, literature was organized according to the specific intervention discussed – barriers or specialty surfaces. Studies that included both interventions were discussed in both sections according to the findings presented.

Barriers

Barrier preparations and protective barrier products can be used to prevent and treat moisture-related and mechanical skin injuries and can play a role in the reduction of shearing forces that can exacerbate pressure injuries. Several different barrier preparations were mentioned in the literature. To prevent and treat IDD, it was recommended that barrier preparations be applied with every diaper change (Atherton, 2004; Kuller, 2001; Nield & Kamat, 2007). Some authors felt that there was not enough evidence to recommend a specific type of barrier preparation (Atherton, 2004) while others recommended the use of petrolatum (Kuller, 2001; Nield & Kamat, 2007).

Petrolatum, also called petroleum jelly or Vaseline™, showed some effectiveness at providing a moisture barrier and improving skin condition in several different studies. In one study, the delivery of a zinc oxide/petrolatum (ZnO/Pet) formulation administered by a disposable diaper was tested in three separate independent, randomized clinical trials. The continuous delivery of the ZnO/Pet resulted in improved skin condition with less redness and irritation as compared to untreated disposable diapers (Baldwin et al.,

2001). Petrolatum was also shown to be effective in a systematic review of literature by Heimall et al. (2012). Using petrolatum as a standard of care with all diapered pediatric patients was recommended by the authors as part of an evidence-based approach to prevention of diaper dermatitis (Heimall et al., 2012). In a laboratory trial of six skin protectants, Vaseline™ was the only product that provided an effective barrier against irritation while also hydrating skin (Hoggarth et al., 2005). Zinc oxide was effective against irritants but did not provide the same skin hydration (Hoggarth et al., 2005).

Barrier preparations are also useful in the prevention of epidermal stripping. A clinical evaluation of 3M™ NSBF was conducted to determine its effectiveness at reducing redness and maceration. While the 3M™ NSBF was not compared to a control or other products, it was shown to increase dressing adhesion as well as reduce redness and maceration (Campbell et al., 2000). A prospective, randomized study compared the 3M™ NSBF to zinc oxide oil and found that, while both preparations improved skin condition, the 3M™ NSBF was more cost effective (Admiraal & Baatenburg de Jong, 2004).

Epidermal stripping and adhesion-related injuries were also discussed with the recommendations to use alcohol-free liquid skin barriers prior to application of dressings, and limit use of tape and other adhesives (Baharestani, 2007; Kuller, 2001). Careful removal of adhesives with water or adhesive solvent and limiting the force used to remove adhesives was also discussed (Baharestani, 2007; Kuller, 2001).

Appropriate use of protective barrier products such as hydrocolloids, silicone dressings, clear adhesive dressings, or foam dressings was shown to help protect skin from pressure ulcers and shearing forces (Baharestani, 2007). Dressings should be used

on those body surfaces most likely to experience shearing forces, such as elbows, the back of the hips and/or buttocks, and heels (Baharestani, 2007). Care should be taken to apply and remove dressings carefully to limit the risk of epidermal stripping or further injury resulting from the use of the dressing (Baharestani, 2007).

Specialty Surfaces

With the selection of a specialty surface, several important factors were identified by the literature. Selection of a surface should take into account the patient's size, stability, and pressure reduction needs (Butler, 2006). Determination of risk factors for pressure ulcer development and actual incidence of pressure ulcers was felt to be an important aspect of prevention strategies by Schindler et al. (2011). Prevention strategies included pressure reducing surfaces, moisture reducing strategies, and positioning devices (Schindler et al., 2011).

Specialty surfaces such as pressure-relieving mattresses, gel pillows, foam overlays, sheepskins, or egg-crate overlays were suggested for all pediatric patients at risk for pressure injury (Baharestani, 2007; Baharestani & Ratliff, 2007; Bernabe, 2012; Butler, 2006; García-Molina et al., 2012; Kuller, 2001; Quigley & Curley, 1996). Because the weight distribution of infants and children places them at an increased risk for occipital pressure ulcers, several studies advocated for the use of a gel pillow with all high-risk patients (Baharestani & Ratliff, 2007; Butler, 2006). As with adults, frequent turning and repositioning at least every two hours for patients with reduced mobility is also suggested to aid in the prevention of pressure injuries (Quigley & Curley, 1996).

While little research has been done on most of the conventional pressure redistribution surfaces used with adults, a prospective, longitudinal study in an inpatient

pediatric facility assessed the effectiveness of two pediatric-specific low-pressure mattresses. Only one patient (N=40) developed a pressure ulcer, resulting in an overall incidence rate of 3.3% which is lower than the previous pressure rate incidence of 20% for the same facility (García-Molina et al., 2012).

The risk of pressure injury from medical devices appears to be increased in the pediatric population, possibly as a result of the need to secure devices, immobility, and smaller body surface area (Baharestani & Ratliff, 2007). Specialty surfaces designed to help secure medical devices, such as pediatric appropriate arm boards with Velcro straps, were identified as a method to help reduce the risk of pressure injury (Baharestani & Ratliff, 2007).

Conclusion

Comprehensive skin care for patients in the PICU involves early and frequent assessment, selection of proper methods for prevention of injury, appropriate treatment for existing problems, and frequent reevaluation of prevention and treatment techniques. In addition to the use of barriers and specialty surfaces, several reviews advocated for a careful and thorough assessment of all skin surfaces on admission and at frequent intervals throughout the day (Baharestani, 2007; Bernabe, 2012; Quigley & Curley, 1996). The development of a multidisciplinary skin care team in a PICU was evaluated by Bernabe (2012) and was useful in educating staff about methods to prevent pressure ulcers. At Children's Hospital, Boston, a skin care task force created to examine the use of specialty mattress surfaces for pediatric patients led to the development of a risk assessment algorithm (Quigley & Curley, 1996). The task force developed the Braden Q scale by adapting the adult Braden scale for pressure ulcer risk which has been

extensively validated (Quigley & Curley, 1996). The use of the Braden Q scale for pressure ulcer prevention was mentioned by several authors (Baharestani, 2007; Bernabe, 2012; Lund et al., 2001; Quigley & Curley, 1996). The evaluation of an interdisciplinary team to standardize prevention and treatment for diaper dermatitis was also discussed in the article by Heimall et al. (2012). Challenges to implementation of skin care teams include reliance on buy-in from staff and caregivers, (Heimall et al., 2012; Quigley & Curley, 1996). Standardization of assessment with the use of a validated algorithm was also emphasized by Butler (2006) as part of a guideline for pediatric skin care.

The dearth of research on pediatric skin care issues including pressure ulcers was mentioned numerous times in the literature and continues to be a source of frustration for healthcare providers (Atherton, 2004; Baharestani, 2007; Baharestani & Ratliff, 2007; Bernabe, 2012; Butler, 2006; Heimall et al., 2012; Kuller, 2001; Nield & Kamat, 2007). The lack of concise and specific guidelines has led to variation in treatment and prevention tactics for skin injuries (Bernabe, 2012; Lund et al., 2001; Quigley & Curley, 1996). Both barriers and specialty surfaces have been shown to be useful in the prevention of skin breakdown in pediatric patients (Atherton, 2004; Baharestani, 2007; Baharestani & Ratliff, 2007; Bernabe, 2012; Butler, 2006; Heimall et al., 2012; Kuller, 2001; Nield & Kamat, 2007; Quigley & Curley, 1996). Appropriate use of these adjunctive strategies is an important step towards prevention of skin breakdown in PICU patients. By standardizing the approach to prevention and treatment of skin breakdown, consistent and evidence-based care can be given to children in PICUs who are at higher risk of developing skin breakdown and experiencing consequences of breakdown.

CHAPTER III

GUIDELINES

Recommendations

The purpose of this chapter is to outline the recommended guidelines based on the literature analysis. The strength of each guideline has been rated according to the SIGN criteria on a scale of A through D, with A representing a high level of evidence used to create the guideline and D representing a lower level of evidence. The specific criteria for the assignment of grades can be seen in Appendix A. General recommendations for pediatric skin care and assessment are presented, and then recommendations for specific types of interventions (barriers or specialty surfaces) are given.

A concise, one-page guideline is presented at the end of the chapter (Table 3.1). Use of the guideline will provide a standardized approach to prevention of skin breakdown in the PICU.

General Recommendations

1. **A comprehensive approach to skin breakdown prevention includes the use of both barriers and specialty surfaces. Grade of recommendation – C.**

   The evidence used to formulate this recommendation includes a few studies ranked 1+, 2+, and 2-, but mostly includes studies ranked level 3 or 4. Results from the higher ranked studies were not all directly applicable to the pediatric population (Admiraal & Baatenburg de Jong, 2004; Atherton, 2004; Baharestani, 2007; Baharestani & Ratliff, 2007; Baldwin et al., 2001; Bernabe,

2012; Butler, 2006; Campbell et al., 2000; García-Molina et al., 2012; Garvin, 1997; Heimall et al, 2012; Hoggarth et al., 2005; Kuller, 2001; Lund et al., 2001; Nield & Kamat, 2007; Quigley & Curley, 1996; Schindler et al., 2011; Willock & Maylor, 2004). In order to provide the most complete care for pediatric patients, interventions aimed at the prevention of skin breakdown should be aimed at addressing the individual patient's risk factors. To adequately address these factors, consideration should be given to the use of both barriers and specialty surfaces.

2. **A comprehensive skin assessment should be conducted on admission to the PICU and at frequent intervals (at least every 8 hours)**. **Grade of recommendations – D**.

Assessment is an important step in the prevention and proper treatment of skin breakdown (Baharestani, 2007; Bernabe, 2012; Butler, 2006; Lund et al., 2001; Quigley & Curley, 1996; Schindler et al., 2011). Skin assessments should include objective, specific information and a complete visual inspection of the skin should occur daily (Baharestani, 2007; Butler, 2006; Schindler et al., 2011). With the exception of the Schindler et al. (2011) study that is rated as 2+, all of the other evidence is level 3 or 4. While use of a standardized, comprehensive skin assessment was repeatedly mentioned in the literature, none of the studies included for analysis cited any meta-analyses or randomized controlled trials as justification for this recommendation (Baharestani, 2007; Bernabe, 2012; Butler, 2006; Lund et al., 2001; Quigley & Curley, 1996; Schindler et al., 2011). The literature suggests that use of a standardized skin assessment at regular intervals

will help identify potential areas of concern and, therefore, enhance efforts at prevention (Baharestani, 2007; Bernabe, 2012; Butler, 2006; Lund et al., 2001; Schindler et al., 2011).

3. **A multidisciplinary team is useful in helping to standardize assessment, prevention, and treatment of skin breakdown. Grade of recommendation – B**.

   The body of evidence for this recommendation includes one study by Heimall et al. (2012) that is rated as a level 1+, two studies by Lund et al. (2001) and Quigley & Curley (1996) rated as level 3, and one study by Bernabe (2012) that was rated as level 4. The multidisciplinary team will work with staff to standardize charting and will reinforce the importance of skin breakdown and its relationship to the outcomes of patients in the unit (Bernabe, 2012; Heimall et al., 2012; Lund et al., 2001; Quigley & Curley, 1996). The team will not only provide a reminder to staff members to complete assessments and use prevention tactics to aid in the management of skin breakdown, but will also allow them to have an informal avenue for education (Bernabe, 2012; Heimall et al., 2012; Lund et al., 2001).

4. **The multidisciplinary team should provide staff education about the prevention of skin breakdown. Grade of recommendation – B**.

   The body of evidence for this recommendation includes one study by Heimall et al. (2012) that is rated as a level 1+, two studies by Lund et al. (2001) and Quigley & Curley (1996) rated as level 3, and one study by Bernabe (2012) that was rated as level 4. Staff education should include the methods of

prevention of skin breakdown in the pediatric population as well as interventions necessary when skin breakdown does occur. The multidisciplinary team will be responsible for disseminating findings from the literature and determining the specific guidelines for skin care in their facility.

5. **Use a validated risk assessment scale for skin breakdown tailored for the pediatric population. Risk assessment should be performed on admission (within twelve hours) and at regular intervals no less than once daily. Grade of recommendation – D**.

   The evidence used to support this guideline is rated as level 3 or 4 (Baharestani, 2007; Bernabe, 2012; Garvin, 1997; Lund et al., 2001; Quigley & Curley, 1996). While there are several risk assessment scales available, the most widely used pediatric scale in the United States is the Braden Q scale (Baharestani, 2007; Quigley & Curley, 1996). The adult version of this scale, the Braden scale, has been widely researched and validated; however, the pediatric Braden Q scale has not had as many studies to verify its usefulness (Baharestani, 2007; Bernabe, 2012). The importance of the type of scale used to categorize patients according to their level of risk for skin breakdown does not seem to be as important as using a standardized instrument across the facility and recognizing the interventions that need to be taken for a patients who is placed in the high risk category (Baharestani, 2007; Bernabe, 2012; Lund et al., 2001).

6. **Assess and maintain adequate nutritional support to help prevent skin breakdown**. P**erform nutritional assessment on admission (within twelve hours) and at least daily. Grade of recommendation – D**.

The studies included in this analysis that support this recommendation are all level 3 or 4 (Baharestani, 2007; Butler, 2006; Garvin, 1997; Quigley & Curley, 1996). As identified by the Braden Q scale, proper nutritional support is paramount in the prevention of skin breakdown and impaired nutrition is recognized as a risk factor for the development of pressure ulcers and wounds (Garvin, 1997; Quigley & Curley, 1996). Patients in the PICU are under stressed conditions and therefore require more nutritional and caloric support than those children under normal conditions (Freeman & Hampsey, 2012; Garvin, 1997). In addition, nutritional intake is affected by the use of sedatives, surgeries requiring gastric rest, pain, immobility, and many other factors related to a patient's illness that may affect the ability to feed through normal means (Butler, 2006; Freeman & Hampsey, 2012). Nutritional status not only affects a patient's risk assessment for skin breakdown, but it also has an impact on wound healing once breakdown has occurred (Baharestani, 2007; Butler, 2006; Garvin, 1997).

7. **Turn and reposition pediatric patients on bed rest at least every two hours. Grade of recommendation – D**.

With the exception of the study by García-Molina et al. (2012), all of the evidence is a level 4 (Baharestani & Ratliff, 2007; Bernabe, 2012; Butler, 2006; Quigley & Curley, 1996; Schindler et al., 2011; Willock & Maylor, 2004). Extensive research has been completed on the need for frequent repositioning in bedridden adult and geriatric patients, and repositioning every two hours has been shown to be effective in preventing pressure ulcers in that population (Baharestani & Ratliff, 2007; Krapfl & Gray, 2008). While it can be assumed that the same

principle is true for pediatric patients, no studies were identified that focused on this intervention as a tool for prevention of skin breakdown and pressure ulcers (Baharestani & Ratliff, 2007; Bernabe, 2012; Butler, 2006; Quigley & Curley, 1996; Schindler et al., 2011; Willock & Maylor, 2004). Pediatric patients are susceptible to pressure ulcers on different anatomical areas than adults, so interventions that aim to reduce pressure should take into account these different pressure points. For example, repositioning of the head every two hours is of utmost importance in infants and toddlers because of their disproportionate weight distribution and propensity for the development of occipital pressure ulcers (Baharestani & Ratliff, 2007; Bernabe, 2012; Butler, 2006; Willock & Maylor, 2004). Using foam wedges, pillows, blanket rolls, or other positioning devices is suggested to help off-load areas of high pressure (Schindler et al., 2011).

8. **Use a pressure ulcer algorithm to consistently document pressure ulcers and to help in selecting the proper treatment regimen for existing pressure injuries. Grade of recommendation – D**.

   All the relevant studies in this analysis were evidence level 4 (Butler, 2006; Garvin, 1997; Quigley & Curley, 1996). The pressure ulcer staging tool suggested in the literature was developed by the National Pressure Ulcer Advisory Panel (2007) and is included in Appendix E. Consistent use of a clear, concise guideline is helpful in standardizing both documentation and treatment of any areas of concern (Butler, 2006; Garvin, 1997; Quigley & Curley, 1996).

9. **Consult a wound ostomy nurse for the care and treatment of any areas of skin breakdown**. **Grade of recommendation – D**.

Data was extrapolated from the literature and all the relevant studies in this analysis were evidence level 4 (Baharestani, 2007; Bernabe, 2012; Lund et al., 2001). The literature discussed wound care in the neonatal and pediatric populations and advocated for standardizing treatment guidelines. By using a specialty nurse to help standardize treatment, patient outcomes can be monitored effectively.

10. **Frequently reposition all medical devices that can be moved, such as pulse oximeters and blood pressure cuffs. Grade of recommendation – D.**

    Two studies used to formulate this guideline, by Baharestani & Ratliff (2007) and Willock & Maylor (2004), were rated as level 4 and one study, by Schindler et al. (2011) was rated level 2+. Medical devices are a risk factor for skin breakdown, especially in the pediatric population. Baharestani & Ratliff (2007) discussed the need for frequent reassessment of medical devices and Schindler et al. (2011) discussed the role of medical devices in the development of skin breakdown. Willock & Maylor (2004) advocated for the importance of protection from equipment that could cause skin injury.

Recommendations for Barrier Preparations

1. **Use barrier preparations to prevent moisture-related and mechanical skin breakdown**. **Grade of recommendation – B.**

    Overall, the literature used to support this guideline includes three studies rated as 1+ (Baldwin et al., 2001; Heimall et al., 2012; Hoggarth et al., 2005). Two of these studies, Baldwin et al. (2001) and Heimall et al. (2012) were completed on hospitalized pediatric patients, which is directly applicable to the

study population. The remaining study that was rated 1+ was completed in a laboratory setting, but the results were achieved using a randomized study design (Hoggarth et al., 2005). Use of a barrier preparation to prevent IDD was mentioned repeatedly in the literature and helps to prevent skin breakdown as a result of moisture and friction in that sensitive area (Atherton, 2004; Baldwin et al., 2001; Garvin, 1997; Heimall et al., 2012; Kuller, 2001; Nield & Kamat, 2007). The prevalence of diapering, especially in the younger pediatric population, makes this an important step in the overall prevention of skin breakdown (Atherton, 2004; Heimall et al., 2012).

a. **Use barrier preparations with each diaper change to prevent IDD**. **Grade of recommendation – D**. All three studies used to develop this guideline are rated as level 4 (Atherton, 2004; Kuller, 2001; Nield & Kamat, 2007). While use of barrier preparations was a major topic of discussion for the prevention of IDD, frequency of application was a topic that was specifically researched. Several authors advocate for application of barrier preparation with each diaper change to ensure maximum coverage and, presumably, maximum prevention of breakdown.

2. **Using petrolatum (also called petroleum jelly or Vaseline™) provides a barrier to moisture and is helpful in the prevention of IDD. Grade of recommendation – B**.

Overall, the evidence included several studies rated 1+ as well as lower-ranked studies (Baldwin et al., 2001; Heimall et al., 2012; Hoggarth et al., 2005; Kuller, 2001; Nield & Kamat, 2007). Three of the studies used to develop this

guideline have a rating of 1+ and two of these (Baldwin et al., 2001; Heimall et al., 2012) are directly applicable to the study population. In the studies, administration of the petroleum jelly was done either through a diaper with petroleum jelly and zinc oxide embedded in the fibers (Baldwin et al., 2001) or topically (Heimall et al., 2012; Hoggarth et al., 2005). Petroleum jelly provides an effective barrier against moisture and helps prevent redness and irritation in the perineal area of diapered children.

3. **Zinc oxide preparations protect skin against irritants and aid in the treatment of skin already showing damage (redness or irritation) from moisture**. **Grade of recommendation – C.**

    The literature used to develop this guideline includes two studies with ratings of 1+ (Baldwin et al., 2001; Hoggarth et al., 2005) and one study with a rating of 2+ (Admiraal & Baatenburg de Jong, 2004). While this recommendation does include studies with higher ratings, only one of the studies used pediatric patients as the study population so results are extrapolated from findings on other populations (Admiraal & Baatenburg de Jong, 2004; Baldwin et al., 2001; Hoggarth et al., 2005).

    In the study by Admiraal & Baatenburg de Jong (2004), the effect of zinc oxide was tested on an adult population with positive results of reducing redness and maceration after application to the perineal area for 14 days. In the study by Baldwin et al. (2001), administration of zinc oxide and petroleum jelly demonstrated effectiveness at improving skin condition. In the laboratory study by Hoggarth et al. (2005), zinc oxide provided an effective barrier against irritants

but did not provide an effective barrier against moisture. Zinc oxide should be used in those patients who already have signs of skin irritation or redness, but petroleum jelly should also be used in order to provide a maximal barrier against irritation and moisture (Baldwin et al., 2001; Hoggarth et al., 2005). Use of zinc oxide in those patients who are not exhibiting signs of irritation seems to be unnecessary and would only add to the cost for these patients (Admiraal & Baatenburg de Jong, 2004; Baldwin et al., 2001; Hoggarth et al., 2005).

4. **Use 3M™ NSBF prior to adhesive application in all pediatric patients and on perineal area in diapered patients to reduce redness and prevent skin damage from epidermal stripping and IDD**. **Grade of recommendation – D**.

Two studies used to develop this guideline were done on adult patients (Admiraal & Baatenburg de Jong, 2004; Campbell et al., 2000) and only one study was completed on pediatric patients (Heimall et al., 2012). Therefore, results of these studies are extrapolated for the pediatric population.

The 3M™ NSBF is a relatively new product that has demonstrated effectiveness at providing a barrier against irritants and moisture in vulnerable patient populations. Administration is cost-effective and the product does not need to be used every day in order to be effective (Admiraal & Baatenburg de Jong, 2004; Campbell et al., 2000). Staff satisfaction with this product was shown to be higher than with other products because of ease of administration and the low frequency of application (Admiraal & Baatenburg de Jong, 2004). Use of the 3M™ NSBF may be especially useful prior to the application of adhesives because it will provide a barrier against irritation and moisture and, therefore, help

prevent epidermal stripping (Campbell et al., 2000). Use of the 3M™ NSBF as an adjunct to other methods may also be useful in the prevention of IDD (Heimall et al., 2012).

5. **Carefully remove adhesives and dressings with water or adhesive solvent to prevent skin stripping**. **Grade of recommendation – D**.

   Both studies used to formulate this guideline are rated as level 4 (Baharestani, 2007; Kuller, 2001). While this guideline does not receive a high grade, use of water or adhesive solvent to remove tape and dressings should be a standard of care both to reduce the pain associated with these procedures and because there is little evidence against the use of water or solvent. In younger neonates and infants, adhesive solvents have not necessarily been tested, so adhesives should be removed with gauze and warm water. In older pediatric patients, the use of adhesive solvent can help prevent epidermal stripping, especially in critically ill patients who may require the use of multiple adhesives and/or bandages (Baharestani, 2007; Kuller, 2001).

6. **Use barrier products such as hydrocolloids, silicone dressings, clear adhesive dressings, or foam dressings on body surfaces susceptible to shearing forces and pressure injury to prevent skin injury. Grade of recommendation – D**.

   All studies used to formulate the guideline were evidence level 3 or 4 (Baharestani, 2007; Baharestani & Ratliff, 2007; Bernabe, 2012; Quigley & Curley, 1996). Use of these barrier products on susceptible body surfaces can help prevent injury from shearing or pressure injury. In those patients who are

immobile or bed-ridden, use of these products in addition to frequent repositioning can be helpful in preventing skin breakdown.

Recommendations for Specialty Surfaces

1. **Place all at-risk pediatric patients on a pressure-reducing surface. Selection of the proper pressure-reducing surface should take into account the patient's size, stability, and mobility Grade of recommendation – D**.

   The evidence used to formulate this guideline includes information from studies with evidence levels of 2+, 2-, 3, and 4 (Butler, 2006; García-Molina et al., 2012; Garvin, 1997; Quigley & Curley, 1996; Schindler et al., 2011). Most specialty mattress surfaces were designed and tested for adult patients; however, use of sheepskin, egg crate, or other foam overlays is also an option for pediatric patients in the absence of specialty bed surfaces that have been approved for use in children (Garvin, 1997). Low air-loss and air-fluidized beds, when adjusted for the lighter weight of a pediatric patient, are effective in reducing pressure and helping to reduce the risk of skin breakdown (Butler, 2006; García-Molina et al., 2012; Garvin, 1997).

2. **Place gel pillows under the occiput of all pediatric patients with decreased mobility to help prevent pressure-related skin breakdown. Grade of recommendation – D**.

   Much of the evidence used to formulate the guideline is rated as level 3 or 4 (Baharestani, 2007; Baharestani & Ratliff, 2007; Bernabe, 2012; Butler, 2006; García-Molina et al., 2012; Garvin, 1997; Kuller, 2001; Quigley & Curley, 1996). Use of a gel pillow to protect the occiput, especially in the younger neonatal and

infant population, is a relatively simple intervention that could have a positive impact on the prevention of pressure ulcers and skin breakdown.

3. **When available, use pediatric appropriate low pressure mattresses with all high-risk pediatric patients. Grade of recommendation – D**.

    There is only one study related to the guideline. While the study completed by García-Molina et al. (2012) was completed on a pediatric population and presents compelling evidence for the use of low pressure mattresses, further research needs to be completed to verify these results. Use of pediatric appropriate mattress surfaces is important to ensure the pressure-reducing effects of the surface and enhance the pressure-relieving ability of the mattress.

4. **Use specialty surfaces designed to secure medical devices, such as arm boards for IVs, whenever possible to minimize the use of adhesives and provide stabilization for medical devices. Grade of recommendation – D**.

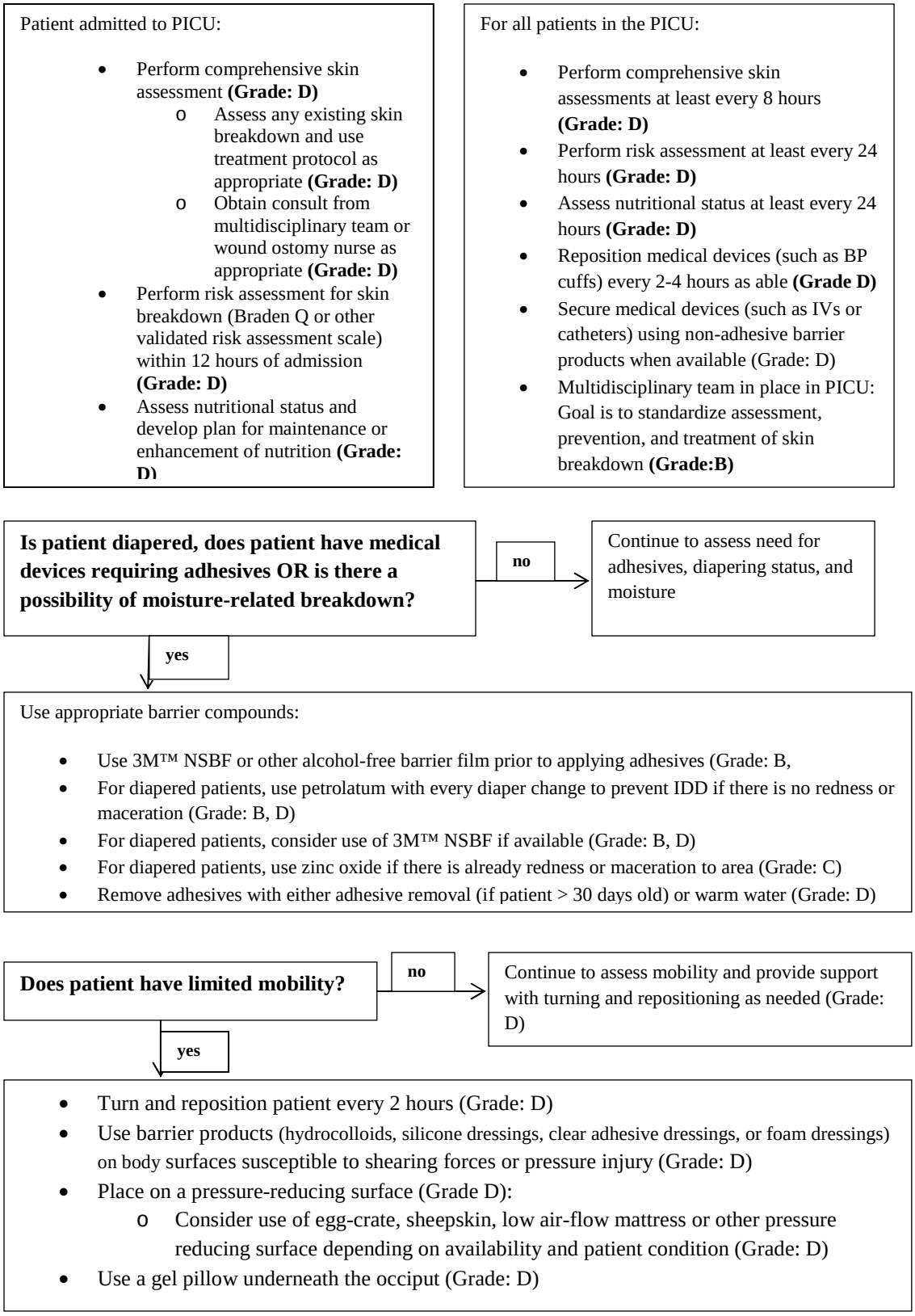
    There is only one study used to formulate this guideline, and the study used is rated as evidence level 4 (Baharestani & Ratliff, 2007). As the body of evidence grows, the use of securement devices for the prevention of skin breakdown should receive further examination. Use of these products could help prevent skin breakdown in pediatric patients by reducing the amount of pressure exerted by medical devices, reducing the risk for displacement or maladjustment of the device, and reducing the need for the use of additional adhesive use to secure a device.

Conclusions

Use of a standardized guideline for the prevention of skin breakdown in PICU patients will help determine effective interventions as well as help to guide future research efforts. The relatively low grades for many of the guidelines is a reflection of the need for further research efforts in this area. The lack of high quality research in this area presents an opportunity for further examination, and the standardization of skin care efforts will be helpful in proving which guidelines are effective in preventing skin breakdown.

Many of the guidelines presented are simple, cost-effective, and easy interventions that can be implemented quickly using products that should already be available in most hospitals with a PICU. Both the general recommendations as well as the recommendations for barrier protection should be feasible for units specializing in pediatric critical care. Coordination of the standardization of assessment, prevention, and treatment is an important component of the implementation of any of these guidelines and will require motivated and conscientious staff members with a genuine desire to affect change in the practice of pediatric skin care.

Table 3.1 – Algorithm for Prevention of Skin Breakdown in the PICU



CHAPTER IV

CONCLUSIONS AND RECOMMENDATIONS

This chapter contains the recommendations for outcomes and a discussion of the implications of the project on practice and research. The conclusions section will give final recommendations for practice as well as a summary of the information contained in the chapter.

Implication of Outcome on Practice

Barriers to Implementation

Barriers to implementation of the guidelines presented will likely come from staff resistance to change and standardization of care, availability of products, and instability of critically ill patients. The majority of the interventions presented will be implemented by nursing staff and changes in practice will rely on nursing acceptance of recommendations presented. In previous studies, both physician and nurse acceptance of new methods of practice have been cited as barriers to change. Some reasons for staff not accepting and not implementing new guidelines could include preconceived ideas about skin care, previous experience with one of the products suggested, ease of use of products, and time required to implement the changes (Lund et al., 2001; Schindler et al., 2011).

Availability of products is also a major factor in the successful implementation of guidelines. Hospitals that decide to use the guidelines in the PICU will need to be committed to consistent stocking of the products required, including petroleum jelly,

3M™ NSBF, zinc oxide, dressing supplies such as hydrocolloids, silicone dressings, clear adhesive dressings, or foam dressings, positioning devices, gel pillows, and appropriate specialty surfaces. Hospital staff must have easy and convenient access to encourage use of products suggested. In addition, the charting system used by the specific hospitals will need to be tailored to the needs of the unit and the staff and provide options for consistent and feasible documentation of skin assessments, pressure ulcer staging, interventions completed for skin care, and the Braden Q or other appropriate risk assessment scales. Staff education about the importance of consistent documentation will need to be completed prior to implementation of guidelines.

In the PICU, some guidelines will not be able to be implemented on the most critically ill patients. Children with severe hemodynamic instability or who are on specialized therapies such as high-frequency oscillatory ventilation (HFOV) or extracorporeal membrane oxygenation (ECMO) may not be able to be turned or repositioned every two hours and may not tolerate gel pillows or a low-air loss or fluidized bed surface (Schindler et al., 2011; Schmidt, Berens, Zollo, Weisner, & Weigle, 1998). The patient's ability to tolerate interventions designed to decrease skin breakdown should dictate which, if any, interventions are used for that particular patient.

Implication of Outcome for Research

Many studies discussed frustration over the lack of research on skin breakdown in pediatric patients (McLane et al., 2004). While there is a lot of research available on the adult population, it has consistently been recognized that the risk factors, anatomical sites, and consequences of skin breakdown differ for pediatric patients (Baharestani & Ratliff, 2007; Willock & Maylor, 2004). Further research is needed on the PICU

population because of the increased risk for skin breakdown in critically ill pediatric patients (Schindler et al., 2011). In addition, the potential consequences of increased potential for infection and increased risk of mortality make skin breakdown an important topic for further research in the pediatric population (Schindler, 2010; Schindler et al., 2011; Willock & Maylor, 2004).

Further research should focus on the effectiveness of standardization of skin care techniques. Specifically, the use of standardized assessment and risk categorization tools and the use of a multi-disciplinary skin care team in the PICU are two areas for exploration. In addition, the use of guidelines for the prevention and treatment of skin breakdown and the examination of rates of skin breakdown before and after implementation of the guidelines will help define the effectiveness of specific interventions.

Implications for Policy

In the hospitalized pediatric population, skin breakdown has been shown to increase mortality (Schindler, 2010). Interventions that reduce the incidence of skin breakdown will, therefore, reduce the risk of mortality in PICU patients. Policy changes should be based on the need to change factors that precede the development of skin breakdown. Accurate measurement of the incidence of skin breakdown both before and after implementation of the guidelines is important in determining the effectiveness of the interventions detailed in the previous chapter. To measure the incidence of skin breakdown, the literature has suggested use of a skin care team to perform audits and help staff members with comprehensive skin assessments (Bernabe, 2012; Butler, 2006; Heimall et al., 2012; Schindler et al., 2011). In order to accurately determine the

incidence of skin breakdown in hospitalized patients, a detailed assessment must be performed on every patient on admission to the PICU, preferably within twelve hours of arrival (Schindler et al., 2011). Subsequent skin care assessments should take place frequently and should include use of a standardized assessment tool in order to monitor the development of any skin breakdown over time (Bernabe, 2012; Butler, 2006).

Policies should also include the formation of a skin care team that will be responsible for compiling and monitoring the data across the unit. To determine if the interventions suggested in Chapter 3 are effective, baseline data will be compared to subsequent information as it is gathered. While an ideal research project would involve the implementation of one intervention at a time to determine the effectiveness of that specific intervention, it is possible that some of these guidelines are already in place. Therefore, multiple guidelines may be incorporated into the standard of care for the unit and effectiveness of all of the interventions would be measured by the assessment of development of skin breakdown.

Implications for Education

Staff education should be done prior to any policy changes to inform staff of new standards for assessing, monitoring, preventing, and treating skin breakdown. Ideally, the education for all new policy changes and expectations would be given by the skin care team that will be established. Education efforts should focus on specific, measurable interventions to be performed consistently across the unit in order to enhance the effect of prevention efforts (Bernabe, 2012; Butler, 2006; Heimall et al., 2012; Lund et al., 2001; Schindler et al., 2011).

Conclusion

Skin breakdown in the PICU population is an important issue that requires further attention and research. The consequences of breakdown in this critically ill pediatric population are costly, both financially and personally. Skin breakdown can have negative physical and psychological implications, especially in this young and vulnerable population (Agarwal et al., 2010; Schindler, 2010; Schindler et al., 2011). Implementation of specific and manageable guidelines can help standardize skin care in the PICU and help in the reduction of the incidence of skin breakdown (García-Molina et al., 2012). While barriers to implementation will exist, reducing skin breakdown in PICU patients is an important and achievable goal.

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Appendix A -- SIGN Criteria (2008)

Levels of Evidence

1++	High quality meta-analyses, systematic reviews of RCTs, or RCTs with a very low risk of bias
1+	Well conducted meta-analyses, systematic reviews of RCTs, or RCTs with a low risk of bias
1-	Meta-analyses, systematic reviews of RCTs, or RCTs with a high risk of bias
2++	High quality systematic reviews of case-control or cohort studies or high-quality case-control or cohort studies with a very low risk of confounding, bias, or chance and a high probability that the relationship is causal
2+	Well conducted case-control or cohort studies with a low risk of confounding, bias, or chance and a moderate probability that the relationship is causal
2-	Case-control or cohort studies with a high risk of confounding, bias, or chance and a significant risk that the relationship is not causal
3	Non-analytic studies, eg case reports, case series
4	Expert opinion

Table A.2 -- Grades of Recommendations

A	At least one meta-analysis, systematic review, or RCT rated as 1++, and directly applicable to the target population; or A body of evidence consisting principally of studies rated as 1+, directly applicable to the target population, and demonstrating overall consistency of results
B	A body of evidence including studies rated as 2++, directly applicable to the target population, and demonstrating overall consistency of results; or Extrapolated evidence from studies rated as 1++ or 1+
C	A body of evidence from studies rated as 2+, directly applicable to the target population and demonstrating overall consistency of results; or Extrapolated evidence from studies rated as 2++
D	Evidence level 3 or 4; or Extrapolated evidence from studies rated as 2+

Appendix B. – Search Terms and Databases

	Search Terms (Results/Relevant)							
Database	Pediatric skin care	Pediatric skin breakdown	Skin breakdown & Pediatric	Skin breakdown & screening & pediatric	Pressure ulcers & pediatric	Skin assessment & pediatric	Braden q scale	Pressure ulcer & children
CINAHL	3/1	5/4	14/9	0	37/21	8/2	6/5	45/28
Cochrane Library	3/0	0/0	2/0	0/0	0/0	0/0	0/0	0/0
PubMed	7/5	28/11	28/11	1/1	42/23	2/2	5/5	55/33
Joanna Briggs Institute	3/0	3/0	3/0	2/0	3/0	32/0	1/0	24/0
National Guideline Clearinghouse	0/0	0/0	16/2	0/0	3/2	3/2	3/0	27/2

	Search Terms (Results/Relevant)						
Database	Pressure ulcer & risk factors & children	Skin care & children	Skin breakdown & children	Skin assessment & children	Skin breakdown & risk factors	Medical devices & skin breakdown	Skin breakdown & Pediatric & prevention
CINAHL	9/7	21/4	20/13	3/3	33/9	1/1	7/7
Cochrane Library	0/0	7/0	2/0	7/0	0/0	0/0	0/0
PubMed	11/10	80/8	51/15	3/3	31/9	2/1	7/7
Joanna Briggs Institute	14/0	0/0	15/0	94/0	0/0	0/0	0/0
National Guideline Clearinghouse	0/0	0/0	4/3	69/0	0/0	0/0	0/0

	Search Terms (Results/Relevant)							
Database	Skin tear & pediatric	Diaper dermatitis	Diaper dermatitis & prevention	Diaper rash	Diaper rash & prevention	Barrier & skin breakdown	Barrier & Skin & Prevention	Skin breakdown & Surfaces
CINAHL	60/13	25/12	13/12	16/4	8/6	14/8	50/4	18/4
Cochrane Library	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
PubMed	1/1	223/TMTS	13/7	139/TMTS	6/2	17/6	37/0	11/3
Joanna Briggs Institute	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
National Guideline Clearinghouse	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0

Appendix C. – Evidence Table

Brief Reference	Quality rating	Purpose	Methods	Threats to validity/ reliability	Conclusions
Admiraal, H. (2004). Comparing cost per use of 3M Cavilon No Sting Barrier Film with zinc oxide oil in incontinent patients.	2+	To compare the cost of treatment, skin-condition management, and prevention of skin breakdown in incontinent patients receiving 3M Cavilon No Sting Barrier Film (Cavilon NSBF) versus zinc oxide oil	Prospective randomized study, N=40	Completed in a single location; patients selected already had at least moderate skin damage from incontinence; all patients were age 18 or older; small number of participants	Use of either 3M Cavilon NSBF or zinc oxide oil results in improvement in skin condition after 14 days.
Atherton, D. J. (2004). A review of the pathophysiology, prevention and treatment of irritant diaper dermatitis.	4	Review of pathophysiology, prevention, and treatment of irritant diaper dermatitis (IDD)	Non-analytic literature review	Expert opinion	Application of a barrier preparation with every diaper change can help prevent IDD. Further study is needed to determine the efficacy of specific barrier preparations.
Baharestani, M. M. (2007). An overview of neonatal and pediatric wound care knowledge and considerations.	4	Literature review of neonatal and pediatric wound types, physiology, prevention, and treatment	Non-analytic literature review	Further research is needed to determine clinical effectiveness of currently accepted practices for neonatal and pediatric wound care.	Comprehensive wound care including assessment, education, and pain assessment that is tailored for patient's age and wound type is essential in the prevention and treatment of neonatal and pediatric wounds. Special

Brief Reference	Quality rating	Purpose	Methods	Threats to validity/ reliability	Conclusions
					attention is needed to prevent pressure injuries from medical devices and protective barriers should be used (hydrocolliods, silicone dressings, or foam dressings) are useful. Specialty support surfaces are also useful in preventing pressure injuries. Using alcohol-free liquid skin barrier under adhesives in neonates under 30 days of age can help prevent epidermal stripping.
Baharestani, M. M. and C. R. Ratliff (2007). Pressure ulcers in neonates and children: an NPUAP white paper.	4	Summary of current knowledge and practices for the prevention and treatment of pressure ulcers in neonates and children	Non-analytic literature review	Limited clinical research has been done on pressure ulcers in neonatal and pediatric patients	Further research is needed in the neonatal and pediatric population to determine the effectiveness of products in the prevention and treatment of pressure ulcers. Specialty surfaces commonly used for adults may be inadequate in relieving pressure in pediatric patients and further study is warranted. Gel pillows

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					under the occiput are useful in neonates and children. Frequent assessment of medical devices and possible pressure injuries from these devices should be completed.
Baldwin, S., M. R. Odio, et al. (2001). Skin benefits from continuous topical administration of a zinc oxide/petrolatum formulation by a novel disposable diaper.	1+	To compare the clinical benefits of a disposable diaper designed to deliver a zinc oxide and petrolatum-based formulation continuously to the skin during diaper use.	Three separate independent blinded, randomized clinical trials were conducted. Study A confirmed transfer of the zinc oxide/petrolatum (ZnO/Pet) formulation from the diaper to the child's skin after wear of either one diaper for 3 hours or multiple diapers for 24 hours. Study B examined the prevention of skin irritation and barrier damage on an adult arm after application of the ZnO/Pet. Study C examined skin redness and diaper rash in infants after	Children who demonstrated more than a mild to moderate prior reaction to diaper dermatitis were excluded from the study.	The continuous delivery of the ZnO/Pet formulation resulted in improvements in skin condition (less redness and fewer instances of irritation) as compared to high quality conventional diapers.

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			use of the diapers for a 4 week period.		
Bernabe, K. Q. (2012). Pressure ulcers in the pediatric patient.	4	Summary of current practices for the prevention and treatment of pressure ulcers in children.	Non-analytic literature review	Limited research has been done on pressure ulcers in pediatric patients.	Current guidelines have largely been adapted from studies completed on adults and are insufficient in managing pressure ulcers in the pediatric population. Special challenges exist for critically ill patients as they may not tolerate conventional skin care practices. Development of a skin care team in the PICU has been shown to aid in assessment and education for pressure ulcer prevention. Use of a foam overlay has been proven effective at pressure reduction.
Butler, C. T. (2006). Pediatric skin care: guidelines for assessment, prevention, and treatment.	4	Literature review on current guidelines for assessment, prevention, and treatment of pediatric skin care issues	Non-analytic literature review	Skin care guidelines for pediatrics have largely been adapted from studies on the adult population	Pediatric patients have anatomic differences that increase their susceptibility to pressure injuries on the occipital region, sacral region, ear lobes, and heels. Length of intubation

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					time, time spent in the PICU, obesity, poor nutrition, and sedation or paralysis were all factors associated with an increased risk of pressure injuries. The use of therapeutic surfaces to reduce pressure should be considered in all critically ill pediatric patients. Selection of a surface should be based on the patient's size and stability for turning and positioning. An algorithm for accurate assessment of all skin-related concerns is proposed to aid in the development of appropriate interventions in pediatric patients.
Campbell, K., M. G. Woodbury, et al. (2000). A clinical evaluation of 3M No Sting Barrier Film.	2+	An evaluation of 3M™ No Sting Barrier Film was completed in an adult geriatric and spinal cord rehabilitation unit to determine if barrier film reduced redness, prevented	Descriptive study – an algorithm for using barrier film was introduced to the nurses to assist staff in determining at what point to consult the	Study results based on subjective reports from nursing staff. Selection of patients for study was not random and was based on algorithm. The 3M™ No Sting Barrier Film was not	Use of the 3M™ No Sting Barrier Film may be an important adjunct in skin care and appears to reduce redness and maceration and increase dressing adhesion; however, further study is

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		or reduced maceration, assisted in dressing adhesion, and/or had any adverse effects on patients	wound care nurse or physician. Using the algorithm, nurses determined whether or not to use the barrier film. Nurses were then asked whether erythema, maceration, and skin stripping were reduced, unaffected, or worsened by the application of barrier film.	compared to any other product in this study.	warranted to compare the usefulness of this product as compared to others.
García-Molina, P., E. Balaguer-López, et al. (2012). A prospective, longitudinal study to assess use of continuous and reactive low-pressure mattresses to reduce pressure ulcer incidence in a pediatric intensive care unit.	2-	To assess the effect of two pediatric-specific low-pressure mattresses on the incidence of pressure ulcers in a Pediatric Intensive Care Unit (PICU)	Prospective longitudinal study – patients who were determined to be at risk for pressure ulcers based on either a Braden-Q score of less than or equal to 16 or a Neonatal Skin Risk Assessment Scale score of less than or equal to 13 were placed on low-pressure continuous and reactive airflow	Patients were selected for inclusion in the study because they were deemed to be at high risk for pressure ulcers; small sample size (N=30); no control group for comparison	Only one participant (3.3%) developed a non-device related occipital pressure ulcer while on the specialty surface. This is favorable as compared to an existing PU rate of 20% in patients prior to use of the low-pressure mattresses.

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			mattresses according to their size		
Garvin. (1997). Wound and skin care for the PICU.	4	To describe the etiology, assessment, and methods of prevention for skin breakdown in the PICU population.	Non-analytic literature review	Few studies have been completed on specialty mattress surfaces and overlays in the pediatric population.	Specialty surfaces should conform to a bony prominence without resistance. A water mattress may be used with infants and gel pads are useful in evenly distributing pressure on prominences. Properly adjusted low air-loss and air-fluidized beds can be beneficial as long as they accommodate the size of the patient. A fluid mattress overlay also helps distribute pressure, especially on the occiput. The literature recommends that hospitals develop a site-specific plan for the use of specialty surfaces.
Heimall, L. M., B. Storey, et al. (2012). Beginning at the bottom: evidence-based care of diaper dermatitis.	1+	To determine a consistent and evidence-based method to approach the prevention and treatment	Systematic review of literature and synthesis of evidence-based prevention and	Standardization of prevention and treatment protocols relies heavily on staff and caregiver buy-in and represented a	Formation of an interdisciplinary team to standardize prevention and treatment for diaper dermatitis according to

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		of diaper dermatitis (DD)	treatment of DD	challenge. Few randomized trials exist and there is a lack of high-quality evidence on the subject.	evidence-based standards and introduction of a risk-based algorithm improved rates of DD in a pediatric hospital. Specifically, use of Vaseline as a standard of care with all patients was recommended with an optional adjunct of No-Sting Barrier Film™ for patients older than 28 days. Over a two-year period, DD prevalence rates dropped from 24% to 11% in high-risk units.
Hoggarth, A., M. Waring, et al. (2005). A controlled, three-part trial to investigate the barrier function and skin hydration properties of six skin protectants.	1+	Assessment of barrier and skin hydration properties of six available skin protectants	A controlled, three-part trial was conducted in a laboratory to assess each product's skin hydration potential and maintenance of skin barrier protection. A positive control (white petrolatum) was used in addition to a negative control (no	Studies were conducted in a laboratory setting on adult patients so usefulness in a pediatric clinical setting is unknown.	The water-in-oil petrolatum-based product (Vaseline) was the only product tested that was shown to be effective as a skin hydration agent that also provides a barrier to irritants and against maceration. Zinc oxide was shown to be most effective as a barrier to irritants but had limited usefulness as a skin

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			product).		hydration agent.
Kuller, J. M. (2001). Skin breakdown: risk factors, prevention, and treatment.	4	Literature review of risk factors, prevention, and treatment of skin breakdown in newborn and neonatal skin.	Non-analytic literature review	Limited research is available on products for prevention and treatment of skin breakdown in the neonatal population.	Special considerations are needed for the neonatal population because of the anatomical differences in skin structure. Limiting use of adhesives, slow and careful removal of adhesives, and use of a physical barrier such as Duoderm (Convatec, Skillman, NJ) have been shown to reduce incidence of epidermal stripping. Use of specialty surfaces such as waterbeds, sheepskins, and gel products can help prevent pressure sores. Emollients such as petrolatum during diaper changes can protect skin surfaces from moisture damage.
Lund, C. H., J. Kuller, et al. (2001). Neonatal skin care: evaluation of the AWHONN/NANN Research-Based Practice Project on	3	To develop and evaluate an evidence-based practice guideline for the assessment and care of neonatal skin, to design	After development of an evidence-based clinical guideline, implementation and evaluation of the	The project focused mostly on preterm infants and therefore may not be applicable to term infants or older infants and	Implementation of the guidelines was inconsistent among practice sites because of lack of nursing or physician acceptance,

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knowledge and skin care practices.		education for nurses about the scientific basis for practice guidelines, and to design and evaluate procedures to aid in the implementation of guidelines into clinical practice	guidelines was completed by a total of fifty-one sites. Surveys were completed by staff members to assess guideline implementation and effectiveness.	children.	inability to obtain specific products, or inability to change many aspects of clinical care at one time. Implementation of a skin care audit team seemed to improve clinical outcomes and allowed for more discussion about skin care during biweekly rounds.
Nield, L. S. and D. Kamat (2007). Prevention, diagnosis, and management of diaper dermatitis.	4	To provide a guideline for primary care physicians in the prevention and treatment of diaper dermatitis	Literature review and case report	Limited research is available for some preparations designed to prevent or treat diaper dermatitis.	A thorough history and assessment is essential for the treatment of diaper dermatitis. Use of appropriate barrier protection with products containing petrolatum or other water-impermeable cream or ointment is essential for prevention of diaper dermatitis.
Quigley, S. M. and M. A. Q. Curley (1996). Skin integrity in the pediatric population: preventing and managing pressure ulcers.	3	To summarize current knowledge about pressure ulcers in infants and children and to describe an approach developed at Children's Hospital,	A three-pronged approach to prevent, stage, and treat pressure ulcers was developed by a Skin Care Task Force. The Task Force developed	Algorithms and risk assessments were developed based on forms used in the adult population. The frequency of reassessment for pressure ulcer risk is unknown. Further research	Use of the Braden Q scale may be helpful in prevention of pressure ulcers in infants and children. All at-risk patients should be placed on a pressure reducing

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		Boston.	a risk assessment tool (the Braden Q scale), a skin care algorithm to help decrease variation in practice, and a pressure ulcer algorithm for staging and management.	is needed to assess the validity of the Braden Q scale in pediatric patients.	surface, the heels should be suspended off the bed, lifting devices should be used to reduce friction, and assessment of nutritional intake should be done to maximize adequate nutritional support. Patients on bed rest should be turned and repositioned every two hours and transparent dressings should be used to reduce friction on susceptible body surfaces. Use of a pressure ulcer algorithm for consistent staging aid in selection of treatment regimens.
Schindler, C. A., T. A. Mikhailov, et al. (2011). Protecting fragile skin: nursing interventions to decrease development of pressure ulcers in pediatric intensive care. .	2+	To determine the incidence of pressure ulcers in critically ill patients and the characteristics of patients who develop pressure ulcers, and to identify strategies to prevent pressure ulcers	This is a descriptive multisite study with a sample of 5346 children in 9 PICUs in the United States. Retrospective chart reviews were completed on every patient admitted and data collected	The number of patients enrolled at each clinical site differed according to number of admissions. Data was collected by the bedside nurses. No data was collected on staff experience levels or previous education on pressure ulcers. Data on specific therapies such as	Pressure ulcers incidence was 10.2% in patients surveyed. The greatest risk was associated with age greater than 2 years old, intensive care unit time for 4 or more days, mechanical ventilation, noninvasive ventilation, or extracorporeal membrane

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			included demographic data, treatment regimens and clinical data, and pressure reduction strategies.	use of sedation, modes of ventilation, or nutritional status were not collected. No data was collected about procedures done off the unit.	oxygenation. Prevention tactics include use of pressure-reducing surfaces such as specialty beds, egg crate or foam overlays, or gel pads, use of moisture reducing strategies such as dry-weave diapers, urinary catheters, or disposable underpads, and use of devices such as foam wedges, pillows, draw sheets, and blanket rolls.
Willock, J. and M. Maylor (2004). Pressure ulcers in infants and children.	4	To summarize current evidence and practices for the assessment and prevention of pressure ulcers in children	Non-analytic literature review	Limited information is available about the assessment and prevention of pressure ulcers in infants and children. Few studies have been completed to study this issue.	Frequent movement, appropriate pressure-relieving surfaces, and protection from equipment and objects that can cause friction or pressure are all useful in the prevention of pressure ulcers in pediatric patients.