

Skin Integrity in the Pediatric Population: Preventing and Managing Pressure Ulcers

Sandy M. Quigley and Martha A. Q. Curley

PURPOSE. *To summarize clinical and empirical knowledge about pressure ulcers in infants and children and to describe an approach developed at Children's Hospital, Boston, to prevent and manage pressure ulcers*

POPULATION. *Acutely ill children with potential or actual alteration in skin integrity due to pressure ulcers*

CONCLUSIONS. *The three-pronged approach for pressure ulcer prevention and management developed by the Skin Care Task Force at the Children's Hospital, Boston, decreases unnecessary variation in practice surrounding the prevention and care of pressure ulcers in acutely ill children.*

PRACTICE IMPLICATIONS. *The Skin Care Task Force recommends use of the Braden Q for pediatric risk assessment, a skin care algorithm for prevention of pressure ulcers, and a pressure ulcer algorithm for staging and managing pressure ulcers.*

Key words: *Braden Q, child, infant, pressure ulcer, skin integrity*

Sandy M. Quigley, BSN, RN, CETN, is an Enterostomal Therapy Nurse and Martha A. Q. Curley, MSN, RN, CCRN, is a Critical Care Clinical Nurse Specialist, Multidisciplinary ICU, Children's Hospital, Boston, MA.

Integral to the practice of pediatric nursing are the prevention and management of alterations in skin integrity. When first considering the broad spectrum of skin care problems in infants and children, nurses may regard pressure ulcers as irrelevant. But, given the growing number of chronically ill and chronically critically ill infants and children, it is the opinion of the authors that the incidence of skin breakdown and pressure ulcer formation in acutely ill pediatric patients is increasing.

Pressure ulcer prevention and management is multifactorial and requires expert clinical judgment and skill. While there is a plethora of nursing research on the incidence, prevalence, and high cost of pressure ulcer prevention and management in adults (most of which is noted in the clinical practice guideline, *Pressure Ulcers in Adults: Prediction and Prevention*, Agency for Health Care Policy and Research, [AHCPR], 1992), little empirical data exist to guide pediatric nursing practice. Care for infants and children is extrapolated from practices developed primarily for adults. Adding to the complexity are numerous wound care products and specialty support surfaces of varying costs thought to help prevent or manage pressure ulcers, again, with trials conducted with adults.

This article provides a summary of clinical and empirical knowledge about pressure ulcer formation in infants and children. It also presents the work of the Skin Care Task Force at Children's Hospital, Boston, a 325-bed tertiary care pediatric hospital. The task force was formed to decrease unnecessary variation in nursing practice in the prevention and care of skin breakdown and pressure ulcer formation.

Pressure Ulcer Formation

Pressure ulcers are localized areas of tissue destruction that develop when soft tissue is compressed

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between a bony prominence and an external surface for a prolonged period of time (National Pressure Ulcer Advisory Panel [NPUAP], 1989). A conceptual schema (Braden & Bergstrom, 1987) identifies the intensity and duration of pressure as well as the tolerance of the skin and its supporting structure for pressure as two major factors responsible for pressure ulcer development. Decreased mobility, activity, and sensory perception contribute to the intensity and duration of pressure. Tissue tolerance, the ability of the skin and supporting structures to endure the effects of pressure without sequelae, includes both extrinsic and intrinsic factors. Extrinsic factors include moisture, friction, and shear, whereas intrinsic factors include nutrition, tissue perfusion, and oxygenation (Braden & Bergstrom, 1987). Patients who are immobile, neurologically impaired, critically ill, malnourished, suffering from debilitating disease processes, or who experience prolonged operative procedures are at risk for pressure ulcer formation (Bergstrom, Demuth, & Braden, 1987; Exton-Smith & Sherwin, 1961; Kemp, Keithley, Smith, & Morreale, 1990; Lamers, & Shurtleff, 1983; Maklebust, 1987; Maklebust & Magnan, 1994; Manley, 1978; Okamoto). In our hospital, pressure ulcers have ranged from nonblanchable erythema of intact skin, which may be reversible, to full-thickness ulceration requiring weeks or months to heal (Figure 1).

Many have examined the relationship between the duration and amount of external pressure required for pressure ulcer development in both animal and adult human models (Dinsdale, 1974; Kosiak 1959, 1961; Landis, 1930; Lindan, 1961). Tissue ischemia and damage occur when cells are deprived of oxygen and nutrients and there is an accumulation of metabolic waste products for a specific period of time (Kosiak; Lindan). High pressure maintained over a short period of time, as well as low pressure maintained for a long period of time, can cause soft tissue injury (Kosiak; Lindan). Using the microinjection method for determining blood pressure in single capillaries, Landis found the average pressure in the arteriolar limb to be 32 mmHg. As a result of this study, 32 mmHg is considered the *usual* capillary closing pressure in adults and is used to make decisions regarding the development, mar-

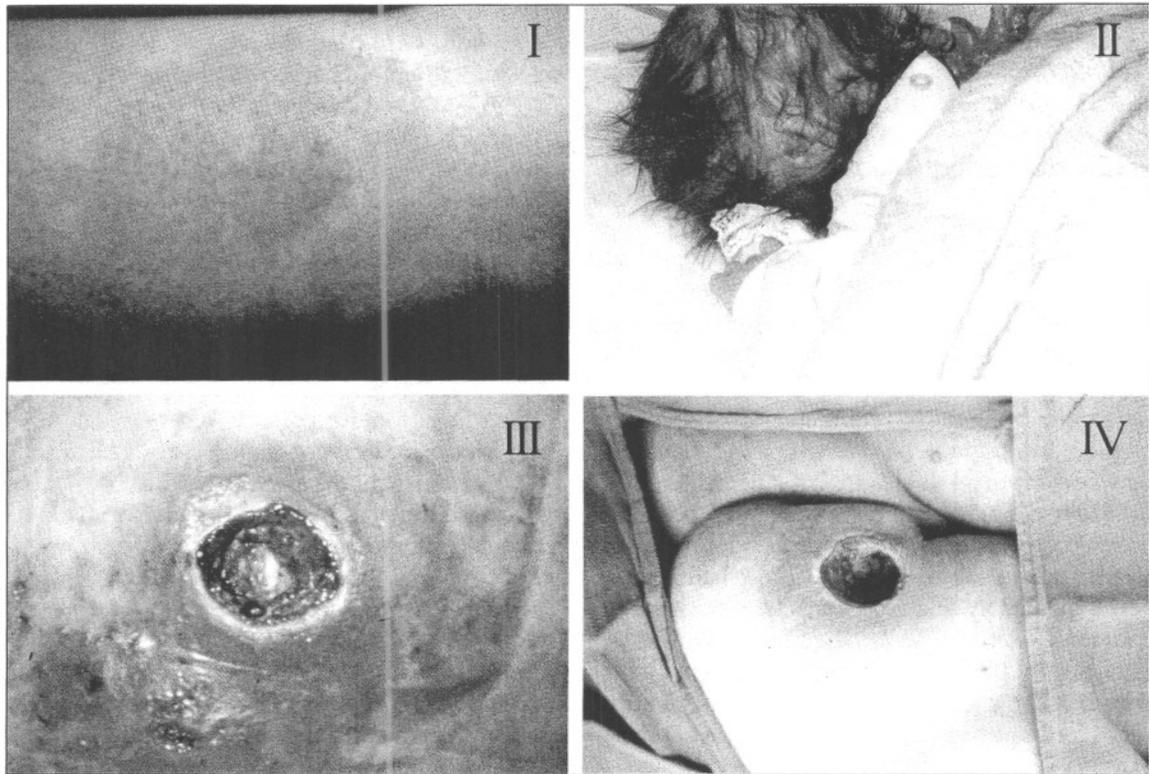
keting, and purchase of support surfaces (Oertwich, Kindschuh, & Bergstrom, 1995). Individuals usually shift their weight periodically to allow the tissues relief of compression. The diminished ability of some patients to change position increases the likelihood that external pressure will be maintained for a critical threshold period of time resulting in tissue damage (Kosiak). Similar data for infants and children are lacking. A value of 32 mmHg, while considered a safe upper limit for some patients, may not be a safe threshold for estimating tissue viability for all patients (Kemp & Krouskop, 1994).

Pressure ulcers can develop over any dependent skin surface. Meehan (1994) identified six prominent pressure sore locations in adults: sacrum, heel, elbow, lateral malleolus, greater trochanter of the femur, and ischial tuberosities. The occipital region of the scalp in infants and toddlers and the sacrum in children are primary sites for pediatric pressure ulcer formation (Gershan & Esterly, 1992; Neidig, Kleiber, & Oppliger, 1989; Solis, Krouskop, Trainer, & Marburger, 1988).

The occipital region is at increased risk for skin breakdown in infants and toddlers compared to adults because the head at that age constitutes a greater proportion of their total body weight and surface area (Hamill et al., 1979). When supine, the occipital region is a primary pressure point. Of unknown significance is the effect of immature dermal collagen and elastin on the ability of soft tissues to absorb and tolerate a mechanical load.

Neidig et al. (1989) identified four risk factors for occipital pressure ulcer formation in infants and children after cardiac surgery: age less than 36 months, those with ventricular septal defect repairs, intubation more than 7 days, and ICU stay more than 8 days. Three of the four risk factors (age, length of intubation, and ICU stay) are directly related to the development of sustained pressure and/or shearing force on the occipital region of the scalp. The researchers noted that the fourth risk factor, ventricular septal defect, was probably spurious since most younger patients had ventricular septal defect repairs. In a separate study (Gershan & Esterly, 1992), neonates supported on extracorporeal membrane oxygenation (ECMO) and those with hypoxia-hypoperfusion not supported on circula-

Figure 1. Staging of Pressure Ulcers



STAGE I (left trochanter): Nonblanchable erythema of intact skin not resolving within 30 minutes of pressure relief. Epidermis is intact. In individuals with darker skin, discoloration of the skin, warmth, edema, and induration may also be indicators.

STAGE II (occiput): Partial-thickness skin loss involving epidermis, dermis, or both. The ulcer is superficial and presents as an abrasion, blister, or shallow crater.

STAGE III (left trochanter): Full-thickness skin loss involving damage to or necrosis of subcutaneous tissue that may extend down to, but not through, underlying fascia. The ulcer presents as a deep crater with or without undermining of adjacent tissue.

STAGE IV (left ischium): Full-thickness skin loss with extensive destruction, tissue necrosis, or damage to muscle, bone, or supporting structures (e.g., tendon, joint capsule). Undermining and sinus tracts also may be present.

Pressure ulcers are staged according to recommendations made by the National Pressure Ulcer Advisory Panel (1989).

tory bypass, also were found to be at increased risk for occipital pressure ulcers resulting in scarring alopecia.

In another pediatric population, Okamoto et al. (1983) identified risk factors associated with a 43% incidence of

pressure ulcers in children with myelomeningocele. They included high paraplegia, high sensory impairment, mental retardation, large head size, kyphoscoliosis or kyphosis, abnormal neurologic examination of the upper

extremities, and chronic fecal or urinary soiling. They also noted that the rates for skin breakdown were not static but increased with increasing chronologic age until 10 or 11 years of age when the occurrence of pressure ulceration leveled off at 20 to 25% (Okamoto et al.). Given the psychological, social, and economic consequences of pressure ulcers for patients, their families, and communities, we believe that it is better to prevent pressure ulcers rather than treat them after they have occurred.

Strategic Initiative

In August 1994, as part of a hospital-wide operations improvement initiative at Children's Hospital, Boston, a Specialty Bed Utilization Task Force was formed to evaluate and make recommendations regarding the use of specialty beds throughout the institution. Driven more by aggressive marketing than empirical data, support surfaces are frequently considered an essential component of a pressure ulcer prevention program. The charge of the group was to reduce hospital cost associated with specialty bed rentals while maintaining quality care for patients with potential or actual alterations in skin integrity. The initial plan was to describe the current process for managing patients with altered skin integrity using a flow-chart process, identify opportunities for improvement, then redesign the process to reduce unnecessary variation in practice.

Inconsistent practices and processes in specialty bed utilization became evident during the first meeting. Operational budget analyses supported the group's initial assumption that all types of beds from a variety of vendors were being used indiscriminately throughout the entire system. Clinicians noted ambiguity surrounding the identification of patients thought to be at risk for skin breakdown and the lack of specific information about what might be helpful. Also challenging was a diverse population of patients thought to be at risk for skin breakdown throughout the entire system, for example, 25-week premature infants to 30-year-old complex surgical patients. In retrospect, the group found that patients who would have derived benefit from pressure reduction or pressure relief beds did not receive the

therapy on a consistent basis whereas the opposite was true for those who did not require the therapy. Also, processes to monitor utilization were not in place. Once patients were placed on a specialty bed, they often remained on the therapy until hospital discharge.

To address these concerns, a strategic plan was developed. First, considering that inappropriate specialty bed use was the *result* of the *real* problem—lack of clinical practice guidelines surrounding the prevention and care of pressure ulcers in infants and children—the Specialty Bed Task Force became the Skin Care Task Force. The Skin Care Task Force then devised a three-pronged approach to give staff nurses the tools to make sound clinical decisions for patients with potential or actual alterations in skin integrity. Components included a risk assessment tool for pressure ulcer formation, a skin care algorithm to decrease unnecessary variation in preventive care practices, and a pressure ulcer algorithm to decrease unnecessary variation in the staging and management of patients with pressure ulcers.

Risk Assessment

Effective implementation of pressure ulcer prevention protocols require early identification of at-risk patients. All patients with skin breakdown and immobile patients should undergo a risk assessment evaluation by a registered nurse upon admission and every 24 hours. Although several valid tools for pressure ulcer risk assessment are available for adults, none exist for infants and children. To remedy this, the authors adapted the Braden Scale (Braden & Bergstrom, 1989) for use in pediatrics, calling it the Braden Q (Table 1). The Braden Scale was selected because it has been extensively tested in diverse adult clinical areas, including intensive care, and contains vivid categorical descriptors (Bergstrom, Braden, Laguzza, & Holman, 1987; Bergstrom, Demuth et al., 1987).

The Braden Q is composed of seven subscales: mobility, activity, sensory perception, skin moisture, friction and shear, nutrition, and tissue perfusion/oxygenation. All seven subscales are rated from 1 (least favorable) to 4 (most favorable). Each level is mutually

Table 1. Modified Braden Q Scale

	Intensity and Duration of Pressure				Score
Mobility The ability to change and control body position	1. Completely immobile: Does not make even slight changes in body or extremity position without assistance.	2. Very limited: Makes occasional slight changes in body or extremity position but unable to completely turn self independently.	3. Slightly limited: Makes frequent though slight changes in body or extremity position independently.	4. No limitations: Makes major and frequent changes in position without assistance.	
Activity The degree of physical activity	1. Bedfast: Confined to bed	2. Chairfast: Ability to walk severely limited or nonexistent. Cannot bear own weight and/or must be assisted into chair or wheelchair.	3. Walks occasionally: Walks occasionally during day, but for very short distances, with or without assistance. Spends majority of each shift in bed or chair.	4. All patients too young to ambulate; OR, walks frequently: Walks outside the room at least twice a day and inside room at least once every 2 hours during waking hours.	
Sensory perception The ability to respond in a <i>developmentally</i> appropriate way to pressure-related discomfort	1. Completely limited: Unresponsive (does not moan, flinch, or grasp) to painful stimuli due to diminished level of consciousness or sedation; OR , limited ability to feel pain over most of body surface.	2. Very limited: Responds only to painful stimuli. Cannot communicate discomfort except by moaning or restlessness; OR , has sensory impairment that limits the ability to feel pain or discomfort over half of body.	3. Slightly limited: Responds to verbal commands, but cannot always communicate discomfort or need to be turned; OR , has some sensory impairment that limits ability to feel pain or discomfort in one or two extremities.	4. No impairment: Responds to verbal commands. Has no sensory deficit that would limit ability to feel or communicate pain or discomfort.	
	Tolerance of the Skin and Supporting Structure				
Moisture Degree to which skin is exposed to moisture	1. Constantly moist: Skin is kept moist almost constantly by perspiration, urine, drainage, etc. Dampness is detected every time patient is moved or turned.	2. Very moist: Skin is often, but not always, moist. Linen must be changed at least every 8 hours.	3. Occasionally moist: Skin is occasionally moist, requiring linen change every 12 hours.	4. Rarely moist: Skin is usually dry, routine diaper changes; linen only requires changing every 24 hours.	

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Table 1. *continued*

<p>Friction – Shear Friction: Occurs when skin moves against support surfaces</p> <p>Shear: Occurs when skin and adjacent bony surface slide across one another</p>	<p>1. Significant problem: Spasticity, contracture, itching or agitation leads to almost constant thrashing and friction.</p>	<p>2. Problem: Requires moderate to maximum assistance in moving. Complete lifting without sliding against sheets is impossible. Frequently slides down in bed or chair, requiring frequent repositioning with maximum assistance.</p>	<p>3. Potential problem: Moves feebly or requires minimum assistance. During a move, skin probably slides to some extent against sheets, chair, restraints, or other devices. Maintains relative good position in chair or bed most of the time but occasionally slides down.</p>	<p>4. No apparent problem: Able to completely lift patient during a position change; moves in bed and in chair independently and has sufficient muscle strength to lift up completely during move. Maintains good position in bed or chair at all times.</p>
<p>Nutrition Usual food intake pattern</p>	<p>1. Very poor: NPO and/or maintained on clear liquids, or IVs for more than 5 days OR albumin <2.5 mg/dl OR never eats a complete meal. Rarely eats more than half of any food offered. Protein intake includes only 2 servings of meat or dairy products per day. Takes fluids poorly. Does not take a liquid dietary supplement.</p>	<p>2. Inadequate: Is on liquid diet or tube feedings/ TPN, which provide inadequate calories and minerals for age OR albumin <3 mg/dl OR rarely eats a complete meal and generally eats only about half of any food offered. Protein intake includes only 3 servings of meat or dairy products per day. Occasionally will take a dietary supplement.</p>	<p>3. Adequate: Is on tube feedings or TPN, which provide adequate calories and minerals for age OR eats over half of most meals. Eats a total of 4 servings of protein (meat, dairy products) each day. Occasionally will refuse a meal, but will usually take a supplement if offered.</p>	<p>4. Excellent: Is on a normal diet providing adequate calories for age. For example, eats most of every meal. Never refuses a meal. Usually eats a total of 4 or more servings of meat and dairy products. Occasionally eats between meals. Does not require supplementation.</p>
<p>Tissue Perfusion and Oxygenation</p>	<p>1. Extremely compromised: Hypotensive (MAP <50mmHg; <40 in a newborn) or the patient does not physiologically tolerate position changes.</p>	<p>2. Compromised: Normotensive; oxygen saturation may be < 95 %; hemoglobin may be < 10 mg/dl; capillary refill may be > 2 seconds; serum pH is < 7.40.</p>	<p>3. Adequate: Normotensive; oxygen saturation may be < 95 %; hemoglobin may be < 10 mg/dl; capillary refill may be > 2 seconds; serum pH is normal.</p>	<p>4. Excellent: Normotensive, oxygen saturation >95%; normal Hgb; capillary refill < 2 seconds.</p>

Total: (If <23 refer to Skin Care Algorithm)

Adapted with permission from "Braden Scale for Predicting Pressure Ulcer Risk" ©Braden, B. & Bergstrom, N., 1988.

exclusive, with only one choice for each category. The range of possible scores for the Braden Q is 7 (highest risk for skin breakdown) to 28 (no risk for breakdown).

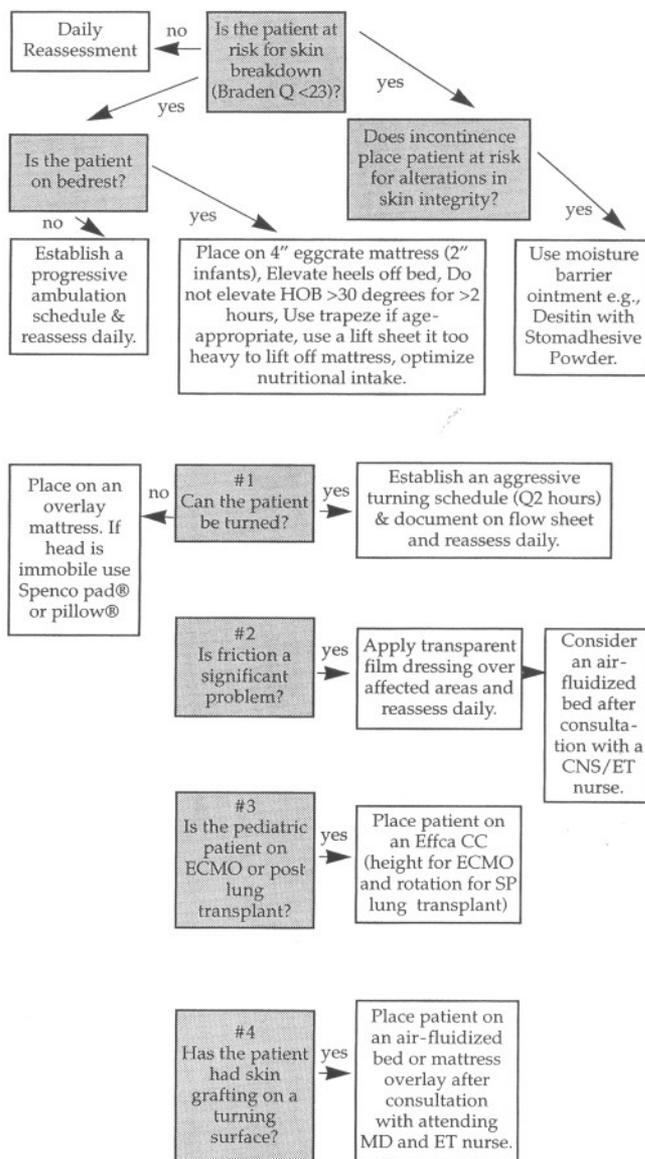
To help interpret the scores, a group of expert pediatric nurses scored 178 children on the Braden Q. At the same time, the nurses rated the child's level of risk for skin breakdown as high, moderate, or low. Comparing the Braden Q score to the subjective rating for each child showed that children considered at low risk for skin breakdown scored an average of 25 points on the Braden Q. Children at moderate risk averaged 21 points, and children at high risk for skin breakdown averaged 16 points. Confidence intervals indicated that children scoring less than 23 points were at moderate or high risk for skin breakdown. Thus, patients with a Braden Q score less than 23 points are considered at-risk for alterations in skin integrity.

The necessary frequency of reassessment of pressure ulcer risk is unknown. Braden and Bergstrom (1994) explored the issue of timing of assessment for optimal prediction of pressure ulcers in a nursing home population. They recommended that the interval for risk assessment should be determined according to the stability of the patient population (Braden & Bergstrom, 1994). Considering that our patient population consisted primarily of acutely ill pediatric patients, we recommended that all patients with skin breakdown and immobile patients undergo a risk assessment evaluation by a registered nurse upon admission and every 24 hours thereafter. Risk assessment, as the first step in the nursing process, cannot be delegated to assistive personnel (American Association of Critical-Care Nurses, 1990).

Skin Care Algorithm

A skin care algorithm (Figure 2) was developed to establish daily practice guidelines for the prevention of alterations in skin integrity. After a patient is identified as being at risk for skin breakdown based on a Braden Q score less than 23, patient mobility and continence are assessed. Patients not on bedrest are placed on a progressive ambulation schedule, and the prevention protocol is instituted for patients on bedrest. For incontinent patients

Figure 2. Skin Care Algorithm



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at particular risk for alterations in skin integrity, moisture barrier ointments and pH balanced cleansers are used.

Our pediatric prevention protocol was extrapolated from the recommendations in AHCPR's clinical practice guideline, *Pressure Ulcers in Adults: Prediction and Prevention* (1992). The criteria used to analyze the strength of evidence supporting each AHCPR recommendation include either (A) good research-based evidence (two or more randomized controlled clinical trials), (B) fair research-based evidence (two or more clinical trials), or (C) expert opinion (one clinical trial, and/or two descriptive studies, and/or expert opinion). Consistent with the AHCPR guideline, two of the following recommendations, support surfaces and turning schedules, are based on (B) fair research-based evidence, and the rest are based on (C) expert opinion.

All at-risk patients are placed on a pressure reducing surface consisting of an eggcrate foam overlay. This is consistent with the evidence that pressure-reducing devices can decrease the incidence of pressure and the lack of evidence that one type of pressure reducing device is better than another (AHCPR, 1992). When purchasing a foam overlay, the stiffness, density, and thickness of the product is considered. Kemp and Krouskop (1994) recommend a 25% indentation load deflection (ILD) of 30 pounds (an indicator of the foam's compressibility and conformability; 25% ILD indicates the force required to compress the foam 75% of its thickness), a density of 1.3 pounds per cubic foot (an indicator of the amount of foam in the product and its ability to support the patient's weight), and a thickness of 3-4 inches. Solis et al. (1988) documented total pressure relief using a 2-inch foam mattress in infants under 2 years of age, pressure reduction using a 2-inch foam mattress and total pressure relief using a 4-inch foam mattress in children 2 to 10 years of age, and pressure reduction using a 2- and 4-inch foam mattress in children 10 to 14 years of age. Solis et al. concluded that pressure relief devices effective in treating pediatric patients are significantly different from those effective in treating adults.

The patient's heels are totally suspended off the bed using a pillow because pressure is difficult to redistribute

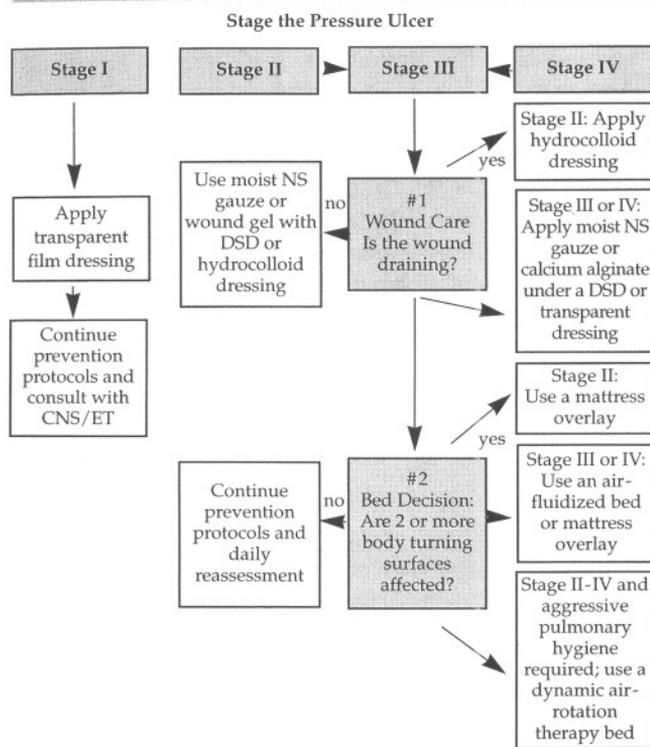
over the small surface area. The head of the bed is not elevated more than 30 degrees for more than two hours to avoid shear injury to the sacral area. Lifting devices, such as a trapeze and/or lift sheet, are used with all patients too heavy to lift off the mattress to avoid friction injuries. Assessment of nutritional intake and provision of adequate nutritional support maintains skin integrity and prevents pressure ulcers (AHCPR, 1992).

Further decision points for patients on bedrest (Figure 3) include whether the patient can be turned every two hours and if friction poses a significant problem. If the patient can be turned, an aggressive turning schedule is initiated, documented on the patient flow sheet, and reassessed daily. The practice of turning or repositioning patients every two hours resulted from a classic study by Norton, McLaren, and Exton-Smith (1975). They divided a sample of 100 hospitalized adult patients into three groups based on the number of times they were repositioned in 24 hours. The incidence of pressure ulcers in the group turned every two to three hours was lower than the group turned every four hours and the group turned two to four times a day. Murdoch and Storman (1994) found that turning to a variety of positions, including the prone position, was possible even in the most critical patients.

Also, there is evidence that small shifts in body weight can be used as an adjunct to the standard repositioning schedule to further decrease the exposure of at-risk individuals to high pressure (Oertwich et al., 1995). Neidig and colleagues (1989) significantly decreased the incidence of occipital pressure ulcers in a sample of postoperative cardiac surgery children from 16.9% to 4.8% by instituting a prevention protocol in which the primary intervention was repositioning the head at least every two hours.

In patients who cannot be turned, a pressure relief overlay mattress is placed over the patient's existing hospital mattress. If the head is immobile, a Spenco skin care pad® (Spenco Medical Corp, Waco, TX) or gel pillow® (Children's Medical Ventures Inc, S. Weymouth, MA) is used under the patient's occiput (Gershan & Esterly, 1992). If voluntary or involuntary movements lead to a friction injury, a transparent film dressing is placed over affected areas and reassessed daily. If extreme, the

Figure 3. Pressure Ulcer Algorithm



patient may be placed on an air-fluidized bed after consultation with the Clinical Nurse Specialist or Enterostomal Therapy Nurse.

Three patient populations that we believe warrant particular specialty supportive surfaces/beds include pediatric patients supported on ECMO, postoperative patients after lung transplantation, and those with skin grafting located on a turning surface (Figure 3). To promote gravity drainage into an ECMO circuit, pediatric patients require a bed that safely and rapidly modulates height — sometimes to five feet. Postoperative lung transplant patients benefit from continuous progressive lateral rotation therapy whereas complete pressure relief and meticulous positioning is required in patient with skin grafts and flaps.

Pressure Ulcer Algorithm

The pressure ulcer algorithm (Figure 3) was developed to standardize pressure ulcer staging and decrease unnecessary variation in treatment practices. Pressure ulcers are staged according to recommendations made by the NPUAP (1989) as derived from previous staging systems proposed by Shea (1975) and the Wound Ostomy and Continence Nurses (WOCN) (formerly the International Association of Enterostomal Therapy, 1988). Limitations to the classification system include difficulty in identifying a Stage I pressure ulcer in patients with darkly pigmented skin and accurate staging when eschar is present.

Systematic assessment and documentation of wound characteristics is an essential index in determining the trajectory of wound healing. Assessment includes anatomic location, stage (I-IV), size in centimeters (length, width, depth), type of tissue at the wound base (e.g., granulation, necrotic), presence of exudate or odor, presence and location of undermining or tracts (e.g., 1 o'clock), character of wound margins (e.g., gnarled edges, epithelialization), condition of periwound skin, and dressing type. Undermining is tissue destruction beneath intact skin along wound margins, which creates a "lip" of skin around the wound edges. Sinus tracts or tunneling can extend in any direction from the wound surface, resulting in "dead space" with potential for abscess formation if not cleansed and packed daily with a wound filler or dressing. An optimal wound environment is free of nonviable tissue, clinical infection, dead space, and excessive exudate, has a moist wound surface, is protected from bacterial contamination and reinjury, and provides pain relief (Braden & Bryant, 1990). The use of a pictorial body surface area chart (similar to a burn diagram) on patients with multiple pressure ulcers is recommended.

Expected outcomes from pressure ulcer care include healing, clinical improvement, comfort and pain relief, and reasonable costs (Allman, 1995). There has been an explosion of wound care products and support surfaces making product selection difficult and complex. Pressure ulcer dressing selection is based upon wound location,

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the presence or absence of infection, the presence of undermining and/or tunneling, the condition of the periwound skin integrity, ease or difficulty of dressing application, and cost or reimbursement factors (Table 2). No single dressing provides the optimal environment for all pressure ulcers. Pressure ulcers change over time and require ongoing reassessment of the effectiveness of the dressing in optimizing wound healing.

Consistent with the AHCPR clinical practice guideline, *Treatment of Pressure Ulcers* (1994), *Stage I* pressure ulcers are managed with a transparent film dressing to minimize epidermal friction and an aggressive prevention plan. *Stage II to IV* pressure ulcers are managed with consideration to the amount of exudate and the presence or

absence of infection. *Stage II* ulcers with exudate are managed with hydrocolloid dressings. *Stage III and IV* draining wounds are managed with normal saline moistened gauze or calcium alginate covered with a sterile gauze dressing, and whenever possible, secured with Montgomery strap dressings® (Johnson & Johnson Medical Inc., Arlington, TX) to minimize trauma to the periwound skin from frequent adhesive tape removal. Otherwise, a pectin-based wafer is applied on either side of the wound to serve as a tape anchor. A protective barrier (Skin prep®, Smith & Nephew United Inc, Largo, FL) is recommended under tape to protect the skin from further injury and irritation. Unlike most antiseptic skin cleansers, which are toxic to wound tissue, normal saline provides a

Table 2. Dressing Options: Clinical Features

• **Gauze, nonadherent.** Used to absorb wound exudate and protect a wound. Wet-to-dry technique used for nonselective debridement of wounds healing by secondary intention that require a secondary dressing. If a wet-to-dry dressing completely dries prior to a dressing change, the dressing should be moistened prior to removal to protect viable tissue. Can be used with a variety of solutions to maintain a moist wound environment and with infected wounds.

• **Transparent film.** Moisture/vapor permeable allowing for oxygen exchange; waterproof. Allows wound visibility, decreases friction to the epidermis if intact. Used for Stage I pressure ulcers to protect intact epidermis from friction injury. Also promotes moisture with eschar-covered wounds to create a moist wound environment that will autolytically soften and debride the nonviable tissue. Not recommended for wounds with fragile surrounding skin or infection. (Example: Tegaderm®; 3M Health Care, St. Paul, MN)

• **Hydrocolloids.** Adhesive wafers containing colloids and elastomers that "interact" with the wound exudate to form a gel and provide a moist wound environment. Used to absorb wound exudate or to aid in the liquification of eschar. If intact, may stay in place for 3 to 5 days. Also available in powder or paste form. Not recommended for wounds with sinus tracts or infection. (Example: Duoderm®; Convatec, Princeton, NJ)

• **Gels/Hydrogels.** Nonadherent, water-based polymer available in sheet or aqueous gel form to promote a moist wound environment, lower wound temperature, and often reduce inflammation. Used in nonexudating, dry pressure ulcers to hydrate or as a "filler" for wounds. Requires a secondary dressing. May macerate surrounding skin although some have varying degrees of absorptive capacity. (Example: Vigilon® Primary wound dressing, Bard, Murray Hill, NJ)

• **Foam dressings.** Nonadherent, conformable polyurethane dressings available in a variety of sheet sizes. Easy to apply and remove. Can be used with infected wounds although require secondary dressing, tape, or netting to hold in place. Not recommended for use with dry eschar, nonexudating wounds or wounds with sinus tracts unless packed. (Example: Allevyn® Smith & Nephew United Inc, Columbia, SC)

• **Calcium alginates.** Seaweed-based, nonadherent, high-absorbency dressing available in sheet or rope packing. Absorbs up to 20 times its weight in drainage. When mixed with wound exudate, converts to a firm gel/fiber mat that can be removed from wound atraumatically. May be used with infected wounds. (Example: Kaltostat® Fortex wound dressing; Merck & Co, Inc. St. Louis, MO).

safe and appropriate irrigant and cleanser for most pressure ulcers (AHCPR, 1994; Braden & Bryant, 1990).

The management of pressure ulcers also has involved the use of specialty support surfaces, such as foam overlays, static air or water flotation devices, dynamic pressure relief and pressure reduction mattress overlays, and low/high airloss or air fluidized specialty bed units. Doughty, Fairchild, and Stogis (1990) categorized specialty support surfaces as pressure reducing, pressure relieving, or providing kinetic therapy. *Pressure reduction* devices are those that lower pressure compared to a standard hospital mattress, but not consistently below capillary closing pressure of 32 mmHg. *Pressure relieving* devices consistently reduce pressure below capillary closing pressure. *Kinetic therapy* provides continuous passive side-to-side motion or oscillation therapy that shifts the patient's pressure points. These products include mattress overlays, replacement mattresses, or entire specialty bed units. Overlay mattresses (devices applied over a standard hospital mattress) are the least expensive. To date, empirically based universally accepted criteria for the use of specialty support surfaces in the prevention and management of pressure ulcers in any patient population do not exist (Aronovitch, 1992). Doughty et al. recommend *pressure reduction* in patients who have more than one turning surface, *pressure relief* in patients with only one turning surface, and *kinetic therapy* in those with pulmonary complications or who are difficult to turn.

To help guide practice, a trial was conducted at Children's Hospital, Boston, to evaluate three dynamic pressure reduction and pressure relief mattress overlays. The purpose of the trial was to evaluate whether a rented dynamic overlay mattress could effectively distribute a pediatric patient's weight, reduce moisture, shear and friction, and be cost effective.

The overlays were evaluated on a diverse group of medical/surgical and intensive care pediatric patients ranging in age from 29 months to 30 years who met our criteria for specialty bed utilization. The overlays were in clinical use from 3 to 48 days, with an average of 14.6 days. Ongoing dialogue regarding the selection and use of specialty mattress overlays and beds occurred

between the task force and clinicians. The therapeutic effectiveness, patient satisfaction, and institutional cost savings were significant during the trial. Pressure ulcers were either prevented or improved in children on overlays. Clinically, there were no differences in therapeutic effectiveness and in patient satisfaction among the three products. Reducing inappropriate or unnecessary use resulted in a 35% reduction in support surface usage and a 62% cost savings. The final decision among the three products was based upon cost and service agreements. Dynamic overlay mattresses are currently used on approximately 80% of patients requiring a specialty support surface at Children's Hospital, Boston.

Conclusions

This article provides a summary of what is known about pressure ulcer formation in the pediatric patient. Although a vast amount of information exists regarding pressure ulcer prediction, prevention, and treatment in adults, there is scant mention of the pediatric patient. The authors hope to encourage a dialogue among pediatric healthcare providers to further explore this phenomenon. The Braden Q assessment tool and the skin care and pressure ulcer algorithms are evolving. Studies to establish the validity and reliability of the Braden Q are in progress. We anticipate that pediatric patients identified as at risk and managed with consistent skin care practices will have a decreased incidence of pressure ulcer formation and improved quality of care. We welcome readers' critiques of this work.

Nursing research is desperately needed in such areas as development of tools to accurately identify pediatric patients at risk, incidence and prevalence in children, criteria for patient selection, and use of specialty support surfaces, as well as specific nursing interventions to decrease the incidence and severity of pressure ulcer formation. Examining practice, implementing standards of care, and standardizing the use of skin care products and specialty support surfaces have helped us strive toward clinical excellence in the care of patients with potential or actual alterations in skin integrity related to pressure ulcers.

Skin Integrity in the Pediatric Population: Preventing and Managing Pressure Ulcers

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Author contact: Sandy Quigley, BSN, RN, CETN,
15 Needhamdale Rd., Needham, MA 02192.
quigleys@a1.tch.harvard.edu

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