Practical Guide to Pediatric Wound Care

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ABSTRACT

Much of pediatric wound care is based upon research studies, clinical experience, and products developed for use in adults. Although the principles of adult wound care apply in pediatrics, the management of wounds and application of adult products to pediatric patients can be challenging. Developmental characteristics of pediatric patients such as incontinence and inability to describe pain and participate in a wound care regimen must be considered. This article describes evidence-based wound care principles and the application of these principles and products for a variety of wounds seen in pediatric patients.

KEYWORDS: Pediatric wound care, wound care products, hemangioma, silver, negative pressure wound therapy

Children are not small adults. That fact is evident when it comes to caring for wounds in pediatric patients. In infants, the epidermal skin is loosely bound to the dermis, making infants more susceptible to epidermal tears and blisters; the infant's skin is more sensitive to product ingredients; pressure ulcers in infants and toddlers occur predominately in the occipital region; pain cannot always be expressed verbally in younger children; and children generally do not have the same comorbidities as adults.¹⁻⁴ Most products are developed from adult research studies, and in many instances the practitioner must adapt these products for use in children. The practitioner must be critical when reviewing the list of ingredients in wound care products and topicals to identify known irritants such as lanolin, balsam of Peru, alcohol, dyes, and fragrances. In addition, for many of these products we do not know the absorption or clearance in infants and children (silver, topicals) and must "cut to size" dressings or reduce the dosage of ointments and creams intended for adult use. All of these factors must be taken into consideration when managing pediatric wounds; however, many of the wound care principles that guide adult wound care

remain applicable and practical when caring for pediatric patients.

BASIC WOUND CARE MANAGEMENT PRINCIPLES

Eliminate the Cause

In children, the medical devices, dressings, and therapies that we use to treat their conditions may actually create a wound. Management of these patients should include (1) assessing for pressure caused secondary to medical devices (tracheostomy tubes and ties, gastrostomy tubes, braces, orthopedic shoes, wheelchairs); (2) decreasing pressure by implementing patient's turning or shifting weight at least every 2 hours and providing appropriate support surfaces based on the patient's weight and condition; (3) reducing friction by application of a hydrocolloid or transparent dressing to knee, elbows, and heels when appropriate and by maintaining the head of bed elevation equal to or below 30 degrees; and (4) reducing the risk of infection and maintaining healthy skin by providing skin conditioning regimens and by

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Dermatology for Plastic Surgeons; Guest Editor, Moise L. Levy, M.D.

Semin Plast Surg 2006;20:192-200. Copyright © 2006 by Thieme Medical Publishers, Inc., 333 Seventh Avenue, New York, NY 10001, USA. Tel: +1(212) 584-4662.

DOI 10.1055/s-2006-949119. ISSN 1535-2188.

eliminating the use of tape and products that strip the epidermis when possible.¹⁻³

Cleansing

Wound cleansing with normal saline or a wound cleanser that is normal saline based with an added surfactant to assist with loosening debris is recommended. Many skin cleansers and antiseptics used historically in wound cleansing are cytotoxic to white cells and fibroblasts and impair wound healing as demonstrated in many in vitro and in vivo studies.⁵⁻⁹ These are not limited to but include povidone iodine, Dakin solution, alcohol, and hydrogen peroxide. For many of these solutions, cytotoxicity to the cells is greater at full-strength concentration.

In the perineal area, cleansing with soap and water (intact skin or anal-genital areas), normal saline, or wound cleanser and avoiding diaper wipes and other chemicals that can irritate the periwound skin are recommended. Peri-bottles, spray cleansers, and "sitz baths" gently irrigate wounds and cleanse the skin without causing epidermal abrasion or reinjury. In the diaper area, parents and patients are instructed to remove only the soiled barrier cream and reapply. The patient is instructed to take a sitz bath once or twice daily and cleanse the area with a gentle pH-balanced soap to remove the cream, stool, and urine gently.

Débridement

Débridement of the wound decreases bacterial burden of the wound and promotes the release of leukocytes and macrophages to enter the wound as part of the inflammatory process, leading to fibroblast recruitment and the deposition of collagen. This sets the stage for the promotion of wound healing and reduces the number of bacteria. In children with small wounds or where surgical débridement is not feasible, autolytic débridement can be achieved using a hydrocolloid dressing or wound gel to facilitate a moist wound environment. When using a hydrocolloid dressing, a yellow exudate and mild odor are common byproducts during the débridement process and may sometimes be confused with infectious exudate. In addition, chemical débridement can be achieved by using a papain-derived enzyme (AccuzymeTM, Healthpoint, Fort Worth, TX.). The enzymatic cream is applied to the wound base and covered with a moist gauze dressing, covered with a secondary dressing such as transparent film, and changed daily. The benefits of autolytic and chemical débridement include reduced frequency of dressing change, decreased pain with dressing change, and selective débridement of devitalized tissue with no disruption of new granulation tissue. In patients with large necrotic wounds who can tolerate surgery and receive anesthesia,

sharp débridement may be the best alternative. Débridement, however, should not occur in patients diagnosed with pyoderma gangrenosum, where débridement may actually worsen the condition. In these patients, localized moist wound care, pain management, and administration of steroid and immunotherapy medications are indicated.

Provide Moist Wound Environment

Dry wounds do not promote granulation or epithelialization of wounds. Many studies over the past 40 years^{10,11} in both human and animal models have demonstrated wound healing in moist wounds at two to three times the rate in wounds left open to air. Studies have also shown that the moisture-retentive dressings such as clear polyurethane dressings (TegadermTM, 3M, St. Paul, MN) and hydrocolloid dressings (DuodermTM, 3M, St. Paul, MN) accelerate wound healing, decrease bacterial wound contamination and infection, and reduce scarring and pigmentary changes that can be associated with wound healing.^{10,12-16} Neutrophils were active for 24 hours and bacterial counts did not increase for 48 hours in a moist, occlusive environment. Some speculate that the wound pH is altered by these dressings or that the dressings themselves have antibacterial properties.¹² Topical creams and ointments may also provide moisture and protect the wound. For example, in dermabrasion wounds, triple antibiotic ointment has been shown to decrease scarring and pigmentary changes and promote more rapid wound healing compared with wounds treated with a gauze dressing.¹³

There are more than 350 types of moisture-retentive wound dressing products available on the market.¹¹ Most are placed in categories according to their composition and function.⁵ The dressing selection can be made based on the phase of wound healing, location of the wound, and amount of wound exudates (Table 1). Advantages of these new wound care products include provision of a moist wound care environment to facilitate granulation and epithelialization, protection of the wound from bacteria, pain reduction upon dressing removal, and débridement of devitalized tissue without disruption of new tissue. Comparatively, wet-to-dry dressings are now considered less effective for wound care because of the (1) increased cost associated with labor and frequency of dressing changes, (2) increased wound healing time, (3) higher infection rates than in wounds dressed with hydrocolloids or transparent films, (4) dispersal of bacteria into the air upon removal (particularly with dry gauze), (5) loss of newly formed healthy tissue and reinjury with removal, and (6) increased pain with dressing removal.¹⁰⁻¹⁶ By contrast, most of the newer dressings require only a daily dressing change depending on the amount of exudate in the wound, reducing labor and supply costs and preventing

Table 1 Common Wound Care Products at a Glance

Type of Product	Indication	Function	Dressing Change Frequency	Comments
Transparent film (e.g. Tegaderm TM)	Skin tears, IV and tube sites, partial thickness wounds, primary and secondary dressings	Provides moist wound healing, impermeable to fluid and bacteria, promotes autolytic debridement, nonabsorptive	Daily, up to 7 days	Seals wound from contaminants
Hydrocolloid (e.g. Duoderm TM)	Pressure ulcers, partial and full thickness wounds, skin tears, tape anchor	Occlusive, impermeable to bacteria and contaminants, promotes autolytic debridement, minimal absorption	Up to 7 days	Do not place over infected or heavily draining wounds
Alginates/ hydrofibers—calcium, collagen and silver (e.g. Aquacel, Fibrocel TM)	Moderate to large drainage, partial and full thickness wounds, dehiscence, infected, bleeding	Absorptive	Daily, but depends on amount of drainage; silver impregnated 3–7 days	Excellent for packing, tunneling, and undermining; trauma free removal
Barrier dressings (e.g. Stomahesive TM wafer, Coloplast TM wafer)	Protect periwound, tube/ tape anchor	Protect skin from drainage or adhesive stripping	Up to once weekly	Excellent around G tube sites, apply around wounds or on skin to attach tape
Barrier cream/ ointment (e.g. Sensicare TM , Criticaid TM , Laniseptic TM)	Perineal and diaper areas	Protects skin from moisture	With each diaper change	Some impregnated with antifungals, choose those formulated to stick to moist lesions
Foam (e.g. Lyofoam TM , Mepilex TM , Allevyn TM , Polymem TM)	Moderate/ heavy drainage, partial and full thickness wounds	More absorptive than gauze	Depends on drainage; up to 7 days	Excellent around leaking tubes and trachs, available with fenestration, comfortable, nonadherent, trauma free removal
Silver (e.g. Silvasorb dressing and gel TM , Arglaes powder TM)	Infected or colonized full and partial thickness wounds	Depends on dressing type; available in foam, hydrocolloid, hydrofiber, alginate and powder	Depends on dressing type; usually 3–7 days	Consider in wounds recalcitrant to previous treatments, controls odor
Wound gels (e.g. Curosal TM)	Dry, partial and full thickness wounds and burns	Adds moisture, promotes epithelialization, fills up deadspace	Once or twice daily	Easy to use, base frequency on wound moisture
Hydrogel dressing (Carragauze TM , Carradress TM)	Burns, partial and full thickness wounds, painful wounds	Adds moisture, aids autolytic debridement, minimal to moderate absorption	Daily	Nonadherent, trauma free and pain free removal
Beclapremin gel (Regranex TM)	Ulcers	Promotes granulation	Daily	Contraindicated in infected and necrotic wounds, refrigerate, expensive
Enzymatic debrider (Accuzyme TM)	Necrotic wounds in patients who are not surgical candidates	Selectively dissolves necrotic tissue	Once or twice daily	Cross-hatch eschar with a scalpel for enzyme penetration, cover with moist N/S gauze to activate, avoid use with silver or mercury
Gauze	All wound types	Minor absorption, mild debridement	3–4 times per day	Dries out, poor absorbency, can macerate periwound, increased labor costs and supplies secondary to dressing change frequency

This table does not endorse any product. It is intended to provide the practitioner an "at a glance" reference for products.

bacterial contamination of the wound by unnecessary manipulation.¹² The general rule is to add moisture to a wound that is dry and increase absorbance in a wound that is too wet.

Occasionally, children develop hypergranulation tissue in a healing wound. When the tissue grows above skin level, the epidermis will not grow over the area of hypergranulation and complete closure of the wound is impeded. To remedy this situation, after cleansing the wound, 0.1% triamcinolone cream is applied twice a day for 7 to 14 days and covered with a foam dressing. In our experience, the off-label use of triamcinolone cream gently reduces the hypergranulation tissue to skin level and allows complete closure of the wound. The pain of using silver nitrate is avoided.

Eliminate Dead Space

Packing wounds with absorptive materials reduces wound exudate and prevents skin maceration and abscess development. Alginates and hydrofibers are absorptive. They are both available in rope form for use in packing into tunnels and undermined wounds. In addition, alginates contain calcium, which can have a hemostatic effect in a bleeding wound. Foam dressings generally have 5 to 10 times the absorbance of a gauze dressing and are useful over ulcerations with moderate to large amounts of exudates. Because of their increased absorbance, these types of dressings decrease the frequency of dressing changes, lower the risk of contamination, and lower labor and supply costs.

Protection of the Wound Base and Periwound

Preventing maceration and skin breakdown of the periwound is paramount in the ability to heal a wound. Therefore, the frequency of dressing change should be based upon the amount of exudate, wound type and location, and presence of infection. Overly moist wounds promote bacterial production; drain onto the periwound, denuding and macerating the skin; and further decrease the natural protection provided by intact epithelium, often leading to dermatitis and candidiasis. This further complicates care of the wound as dressings do not adhere to a denuded surface. In addition, dermatitis and candidiasis may cause pruritus and discomfort for the patient. For stool incontinence, a bowel management program to increase stool bulk or creation of a diverting colostomy may be necessary to promote wound closure in the perineal area. For urinary incontinence, a urinary catheter assists in protecting the area from urine.

Skin Barriers

Skin barriers can protect the periwound from maceration and prevent epidermal stripping. A non-alcohol-based

skin preparation (No Sting BarrierTM, 3M, St. Paul, MN) can be applied to the periwound with each dressing change and is available in pledget squares, lollipops, or spray. These products have been used successfully to protect the skin from incontinence and assist in healing perirectal ulcerations. Because they cover the area with a plastic polymer, many patients have pain relief when they are used over perianal ulcerations before applying a barrier cream, ointment, or secondary dressing.

Barrier Creams

Barrier creams come in many formulations and can be particularly effective in healing wounds in the genital and sacral areas. Wounds in this area are easily contaminated with stool and feces, and dressing adherence is often not possible. Shallow wounds, contact dermatitis, and candidiasis usually respond well to medications—steroid, antibiotic, antifungal—impregnated in an ointment base that provides a soothing moisture barrier.

For ulcerations, a barrier cream or ointment impregnated with powder is needed for better adherence to the wound base (SensicareTM, Convatec, Bristol-Meyers Squibb, New York, NY). Alternatively, a powder can be applied to the base of the wound with the barrier cream then applied on top.¹⁷ In patients with diaper dermatitis for more than 72 hours, about 90% of these rashes are colonized with yeast.¹⁸ If erythema, erosion, and maceration are present, a typical candidal rash may not be appreciated. In these situations it is prudent to consider empirical use of a broad-spectrum antifungal powder under the barrier cream with each diaper change. Keeping the diaper open to air when possible can also be helpful. Cholestyramine in a petrolatum base is thought to decrease bile salts and provide a barrier against stool enzymes. However, we have found it to be a poor and expensive barrier ointment for routine use.

Barrier Dressings

When barrier creams fail, it may be beneficial to apply a hydrocolloid or barrier dressing to a perineal wound. The dressing is reinforced with a transparent dressing or waterproof tape (Hy-tape[®], Hy-tape International, Patterson, NY) to keep it secure and increase protection from urine, stool, and moisture. Barrier dressings are designed to be changed at 5- to 7-day intervals; however, with the incontinent patient, a daily dressing change is usually required.

Protection from Epidermal Stripping

Premature and newborn infants are more susceptible to epidermal stripping and skin tears because of the immature epidermal-dermal bond. Tape can be avoided by securing dressings with a stretchy overwrap (CoflexTM,

Andover Coated Products, Andover, MA; Spandage nettingTM, Medi-Tech International, Brooklyn, NY) or use of Montgomery straps. When the use of tape is unavoidable, the periwound skin can be painted with an alcohol-free skin preparation barrier (No Sting BarrierTM, 3M, St. Paul, MN) to prevent epidermal stripping, or a barrier dressing can be applied to the periwound in a "picture frame" style and the tape secured to the barrier dressing instead of the skin. The barrier dressing around the wound is usually changed once weekly or when loose or soiled. If using tape in infants and children, select a latex-free, hypoallergenic tape to reduce the chance of contact dermatitis and blistering (Medipore tapeTM, 3M, St. Paul, MN).

PREVENT PAIN

Pain medication may be required prior to dressing changes. Narcotics should be administered before dressing changes for painful wounds and burns and when dermis is exposed. Often, a sedative-anxiolytic is administered in conjunction with the narcotic to reduce anxiety, synergize the narcotic, and promote amnesia. If this is given with the first wound assessment and dressing change, the child is less fearful of subsequent dressing changes. For ulcerated areas a topical lidocaine gel or ointment can be used before the dressing change in addition to narcotics. This can be safely administered in a small "pea-sized" amount no more than four times per day.^{19,20} Epifoam, a topical analgesic and steroid used in postpartum mothers, can also be helpful in reducing pain and inflammation at wounds in the perineal area. Distraction techniques such as bubble blowing, music, or sucrose administration in infants may also be helpful during a dressing change in younger children.

NEW USE OF PRODUCTS IN PEDIATRICS

Negative-Pressure Wound Therapy

Negative-pressure wound therapy (NPWT) has been used for many years in adults. More recently, pediatric plastic and general surgeons are applying this therapy in infants and children. NPWT is applied via a pump to promote blood flow and contraction of the wound and to remove drainage.²¹ At Texas Children's Hospital (TCH), NPWT has been applied to 71 patients over the past 2 years with various conditions including pressure ulcers, sternal wounds, abdominal wall defects and fistulas, and surgical wounds including drained abscesses, amputations, and hemangioma excision.²² For example, NPWT was applied to an infant at TCH after excision of an ulcerated hemangioma between the labia and buttock. Within 6 days of therapy the wound had decreased in width by 1 cm. By day 11, the wound

base was filled in to skin level. A thin hydrocolloid dressing was ultimately used to promote epithelization, and complete wound closure was obtained by day 42.²³ NPWT pressures used ranged from 50 to 100 mm Hg in infants and up to 150 mm Hg in toddlers through adolescents. In these children, NPWT was tolerated well with only minor complications such as skin maceration, contact dermatitis, or candidal rash. The mean duration of therapy ranged from 14 to 35 days depending on the wound type.²² Negative-pressure therapy is safe and effective for promoting wound closure in infants and children and may help to avoid additional surgery for split-thickness grafting, muscle flaps, or other closures. Studies are needed to determine the most efficacious pressure to facilitate wound healing in infants and children.

Use of Silver Products

Silver products are used to decrease the bacterial "bio-burden" of wounds in adults. Many studies demonstrate the effectiveness of silver-based dressings in decreasing the bacterial count in wounds but do not always demonstrate the improved effect of wound healing in human subjects. In vitro conditions do not match the conditions of human wounds, in which multiple bacteria, wound exudate, and various host conditions reside. Most important, there are no in vitro studies using silver-based products in infants and children. Silver-based dressings come in various forms with various silver release rates and levels. Studies are needed to determine whether higher or lower amounts of silver promote more rapid wound granulation and whether the rapid release of silver versus a slow-release silver-based dressing is clinically significant.²⁴ Data are also needed to determine whether serum levels of silver are affected when applying these products in children.

A controlled, matched-pair study compared the effects of a foam dressing and a silver-based dressing over skin graft donor sites. The rate of reepithelialization was significantly slower in the wounds treated with the silver dressing.²⁵ In infants and children, silver dressings are chosen when the wound is considered to be contaminated or when the wound is recalcitrant to other dressing methods and treatments. For example, a 26-week premature infant with abdominal wound dehiscence and bowel evisceration after intestinal obstruction was treated with a silver dressing product (SilvasorbTM, Medline Ind., Mundelien, IN) at our institution.²⁶ Several dressing methods had been previously used in attempts to close the wound without success. Finally, the wound care plan was changed to include a silver dressing. The enterocutaneous drainage was contained by pouching the fistula, and the silver dressing was applied to the wound base to reduce wound contamination. A low-profile foam and a transparent dressing were applied to

Figure 1 Abdominal wound after use of Silvasorb™ dressing.

secure the dressing and absorb exudate. The dressing was changed every other day and as needed. This method contained the drainage well and provided moist wound healing and antimicrobial coverage. Three weeks into therapy, the wound decreased to approximately one fourth of its original size. The pain and discomfort experienced with frequent dressing changes were also reduced. The absorbent silver dressing provided antibacterial effects and a moisture balance to promote granulation and contraction of the wound. Most wound care companies carry silver-impregnated dressings in various forms that are reported to be active against bacteria for 3 to 7 days. Because the impact of silver absorption in infants and children is unknown, silver-based products should not be used for a prolonged period. Use of products with the lowest amount of silver and in children who have adequate renal function is prudent. Clinical applications of silver products in infants and children may include wound dehiscence, abdominal wall defects, various partial-thickness wounds, ulcerated hemangiomas, contaminated chronic wounds, burns, and pressure ulcers²⁶ (Figs. 1–3).

Figure 2 Abdominal wound—closure by secondary intention around abdominal fistula.

Figure 3 Abdominal wound dehiscence and enterocutaneous fistula.

Becaplermin Gel

Studies have described the use of becaplermin gel, a recombinant human platelet-derived growth factor, to treat ulcerated hemangiomas refractory to standard wound care measures. These ulcerations are difficult to treat and often not amenable to adherence of dressings because of the wound locations, with increased risk for secondary infection and pain. At our institution, 0.1% becaplermin gel (Regranex™, Johnson and Johnson Wound Management Worldwide, a division of Ethicon, Somerville, NJ) has been safe and effective as adjunctive treatment for ulcerated hemangiomas. Rapid healing achieved by the use of 0.1% becaplermin gel allowed reduction of secondary infection, pain, need for hospitalization, and associated costs of recurring follow-up visits and therapy.²⁷

To enhance patient comfort with cleaning, warmed water or saline solution is applied over the lesions. The ulceration is then patted dry. A topical anesthetic can be used such as a pea-sized amount of lidocaine jelly or benzocaine spray not to exceed four times per day. An oral analgesic such as acetaminophen with codeine can also be helpful in controlling the pain of these lesions prior to the dressing change for outpatients. The becaplermin gel can then be applied to the wound base and covered with a thick layer of barrier cream. Caregivers need to be instructed that becaplermin gel must be refrigerated to maintain its potency. A nonadhesive cover dressing is used to provide extra protection from urine and stool. The dressing should be thin, absorptive, and nonadherent (Mepilex Lite™, Molnlycke Health Care, Goteborg, Sweden). Usually, the barrier cream and fastening of the diaper are enough to secure the secondary dressing. Alternatively, the ulcer may be sealed from urine and stool by applying a barrier or hydrocolloid dressing. An intact periwound is necessary to anchor and seal the edges of the dressing. The hydrocolloid can be changed once weekly according to the manufacturer, although in the perineal area, where

Figure 4 Hemangioma prior to wound care and medical treatment.

Figure 5 Hemangioma after local wound care and medical treatment.

contamination is likely, the dressing is changed daily with medication administration. This approach can provide pain relief in many children (Figs. 4 and 5).

CONCLUSIONS

In summary, pediatric wound care employs many of the same techniques and principles used in adults, although some accommodations are required. Wound care products must be adapted for pediatric use and closely monitored. Pediatric clinical research studies are greatly

needed. For optimal wound healing to occur, principles of wound healing must be applied in daily practice.

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