Children's Hospital of Orange County (CHOC)
Best Evidence and Recommendations (BEaR)

Topical Wound Debridement in Pediatric Patients

Gillian Levy, BSN, RN, CWOCN
glevy@choc.org

Abstract

Pediatric patients possess unique physiological and anatomical characteristics that distinguish them from adults. These differences impact the healing process and require specialized wound care approaches (McNamara et al., 2020). Debridement of non-viable tissue from a wound promotes a clean wound bed and optimizes healing (Bryant & Nix, 2016; Eriksson et al., 2022). The challenge of debridement in neonatal and pediatric wounds is in selecting safe and effective debridement products, while reducing the risk of toxicity and systemic absorption, and minimizing pain (Amaya, 2015). The purpose of this Evidence-Based Practice project was to review and appraise the literature regarding wound care products, with a particular emphasis on debridement of wounds in infants and children. The findings of the literature review were compared to the current wound care practices of a children's hospital's wound care team, and the wound care formulary was reviewed for any updates or gaps. Pediatric and neonatal wound care guidelines were reviewed for current guidelines. All products currently in use were deemed appropriate for children. The literature review identified one gap in practice at the facility. Honey and surfactant-based products should be considered first for debridement of pediatric wounds due to their safety, efficacy, and anti-microbial properties (Amaya, 2015; Kirsner et al., 2019). Even though evidence is limited, maggot debridement therapy may be considered for debridement of hard-to-heal wounds, especially after other advanced therapies have failed (Pérez-Acevedo et al., 2022). A synthesis table on debridement products was created using information from peer-reviewed studies and product guidelines. This table was structured as a tool to help clinicians select a debridement product and is being placed on every wound care cart for easy reference. Another significant discovery arising from this review is the notable scarcity of pediatric-specific wound care studies in the available literature. This underlines a significant gap in the field of pediatric wound care, necessitating further research and exploration.

Keywords

Debridement, non-viable tissue, pediatric, neonatal, autolysis, hydrogel, Manuka honey, surfactant, cadexomer iodine, collagenase, maggot therapy, silver.

PICO(T)

In pediatric patients, what are best practices for selection and use of topical products compared to current practice to optimize non-viable tissue debridement and wound healing?

Background and Significance

A wound bed containing non-viable tissue may benefit from a topical debridement product to promote a clean wound bed and to optimize healing (Bryant & Nix, 2016; Eriksson et al., 2021). Many wound care products promote debridement; however, few standardized guidelines exist regarding product selection. Though the manufacturers provide product information, evidence-based sources that compare products are not readily available. Many factors need to be considered in the selection of a debridement product, with careful review of evidence-based case presentations an essential component of this process. There is a need for consensus-based clinical knowledge that is backed by evidence and is easily accessible to wound care practitioners (Eriksson et al., 2022).

Management of pediatric wound care lacks standardization and guidelines regarding best practice (Amaya, 2015). There is no algorithm to date for treating pediatric wounds (McNamara et al., 2020). Neonatal and pediatric wound care guidelines are rudimentary and limited to basic principles of skin management, safety concepts, and developmental considerations (Association of Women's Health and Neonatal Nurses (AHWONN), 2018; McNichol et al., 2021). Limited attention is paid to pediatric wound care in the literature, even though this population requires unique considerations (Boyar, 2021b; Steen et al., 2020).

CHOC's Skin, Wound, and Ostomy Team (SWOT) is responsible for reviewing available wound care products and for maintaining a wound care formulary. SWOT has no set wound care algorithms or clinical practice guidelines that inform formulary selection. Wound care product selection is based on individual team members' clinical experience and patient preferences. In general, SWOT members endeavor to avoid overlaps in product selection and to be fiscally responsible in choosing products that are reasonably priced for patient use.

The goal of this Evidence-Based Practice (EBP) project was to review and appraise the literature on wound care products, with a focus on products that assist with debridement of wounds for pediatric patients. The findings from the literature review were used to evaluate SWOT's wound care practices and to review the current product formulary for any updates or gaps in wound care products that would improve patient care practices.

Pediatric and neonatal wound care guidelines were reviewed to ensure that the practices at CHOC aligned with current guidelines. An additional goal was to standardize the approach to wound care for all SWOT team members, and to create a synthesis table regarding product selection that could be used by team members to help guide clinical practice choices.

This project aligns with CHOC's mission and values through its desire to enhance best practices in patient care, to ensure fiscal responsibility in the use of patient care products, and to standardize care to ensure all patients receive equal and equitable services from SWOT.

Framework

This EBP project utilizes the "Translating Evidence into Practice: CHOC's Approach to EBP" model, adapted from Ecoff et al. (2020).

Search for the Evidence

Databases searched included PubMed, Wiley Online Library, and the Cochrane Library. Additional sources of information included Lexicomp Online, The Wound, Ostomy, and Continence Nurses (WOCN) Society™ Core Curriculum, and the AHWONN Neonatal Skin Care Evidence-Based Clinical Practice Guideline. Key words and search terms included debridement, pediatric, neonatal, autolysis, hydrogel, Manuka honey, cadexomer iodine, collagenase, silver, and maggot therapy. This search yielded 71 articles, including systematic reviews of randomized controlled trials, retrospective and prospective studies, case reports, and literature reviews. Of these articles, 29 were found to have applicable information. Websites reviewed included Wound, Ostomy, and Continence Nurses Society (WOCN.org), Wound Source, Smith + Nephew, Medline Industries, and Integra Life Science.

Critical Appraisal and Synthesis of the Evidence

- **WOCN & AWHONN have pediatric/neonatal evidence-based wound care guidelines that should be used as the foundation for pediatric wound care interventions** (McNichol et al., 2021; AHWONN, 2018)**.**
  - WOCN (McNichol et al., 2021) recommendations for pediatric wound care are:
    - Advanced dressings should be considered as first-line treatment in pediatrics to optimize healing.
    - Dressings that require infrequent changes are preferable, as are those designed to minimize pain.
    - Products should be safe and non-toxic.
    - Modifications may be made according to child development, to be sensitive to body image, and to promote family-centered care.
    - The wound care plan should be easy to follow.
  - AHWONN (2018) has published an evidence-based clinical practice guideline on neonatal skin care. The organization's recommendations regarding neonatal wound care are:
    - Irrigation is recommended to cleanse wounds.
    - Irrigation should be done using a 20 to 60mL syringe, a blunt tip needle or intravenous catheter, and body-temperature normal saline (NS).
    - Dressing recommendations include hydrocolloids, silicone-based adhesives, polyurethane films, hydrogels, and silver dressings.
    - Products should be designed to avoid skin stripping.
    - Medical grade honey is recommended for debridement.

- **Generalized findings from the literature search are:**
  - Few studies focus specifically on debridement, with wound healing as the end goal of

most studies.

- No studies comparing different debridement products were found.
- Some studies compare a product to autolysis (Raju et al., 2019), but most compare a product to standard of care (often a variety of treatments) (Jull et al., 2015; Ostlie et al., 2012; Sankar et al., 2020; Woo et al., 2021; Yilmaz & Aygin, 2020; Zölß & Cech, 2016).
- There are very few large wound care studies that include children, and those that do are mostly focused on burn wounds (Ostlie et al., 2012; Ozcan et al., 2002; Rashaan et al., 2014) or pressure injuries (Sankar et al., 2020).
- The literature on other types of pediatric wounds was comprised mainly of case studies, thus representing a low level of evidence (Amaya, 2015; Amaya, 2017; Birdsong et al., 2014; Boyar, 2014; Boyar, 2015; Boyar, 2018; Boyar, 2019a, Boyer, 2019b; Boyar, 2021a; Boyar, 2021b; Elsass, 2018; Faust, 2022; Huett et al., 2017; Kirsner, et al., 2019; Mohr et al., 2014; Perez-Acevado et al., 2022; Smaropolous et al., 2020).
- The debridement agents most used in pediatric studies are medical grade or Manuka honey (Amaya, 2015; Biglari et al., 2013; Boyar, 2014; Boyar, 2018; Boyar, 2019a; Mohr et al., 2014; Sankar et al., 2020; Smaropolous et al., 2020) and concentrated surfactant-based products (Amaya, 2017; Boyar, 2019b; Boyar, 2021a; Boyar, 2021b; Kirsner, et al., 2019; Pittenger et al., 2018).
- Few products are tested for safety in children, and most are used off-label (Steen et al., 2020).
- It is difficult to draw conclusions due to patient heterogeneity, multiple comparators, and low levels of evidence in existing research (Jull et al., 2015).
- No clear evidence exists to support the use of one topical debridement product over another.

- A **summary table of research articles** was made to demonstrate the distribution of recent wound care studies (see Table 1). The CHOC Level of Evidence guide was used to classify research.
  - Where no pediatric articles were found, adult or in vitro/ex vivo studies were used.

Table 1. Summary of the Levels of Evidence

	Hydrogel	Hydrogel + silver	Honey	Surfactant	Cadexomer Iodine	Collagenase	Maggot therapy	Hypochlorous acid	Silver sulfadiazine
Adult				IV, V	I, III, IV	I	I		
Pediatric	V	III, V	III, IV, V	V	-	II, III, V	V	V	I
In vitro/ex vivo			I	III					

- **Medical grade or Manuka honey:** Levels III, IV, and V evidence research were found supporting the use of honey in pediatric wound care (Amaya, 2015; Biglari et al., 2013; Boyar, 2014; Boyar, 2018; Boyar, 2019a; Mohr et al., 2014; Sankar et. al., 2020; Smaropolous et al., 2020). One level I in vitro study comparing the antimicrobial activity of medical grade honeys against multiple strains of bacteria found that MediHoney (the

brand used at CHOC) had a broad spectrum of activity, including against several multi-drug resistant strains (Nolan et al., 2020). A Cochrane review reports high levels of evidence that honey improves healing in partial thickness burns (Jull et al., 2015). These findings validate the routine use of honey as a debridement agent at CHOC.

- **Concentrated surfactant-based products:** Several case series were found on the use of concentrated surfactant-based products in pediatrics, including in neonates and in premature infants (Amaya, 2017; Boyar, 2019b; Boyar, 2021a; Boyar, 2021b; Kirsner, et al., 2019; Pittenger et al., 2018). Level III research demonstrated the non-cytotoxicity of this product, its ability to reduce biofilm and suppress inflammatory cytokines (Ohadi et al., 2023; Salisbury et al., 2018). Level IV research supports the ability of concentrated surfactant-based products to heal chronic, hard-to-heal wounds in adults (Palumbo et al., 2016; Zölß & Cech, 2016). SWOT does not currently include a concentrated surfactant-based product in its formulary, and this was identified as a gap.
- **Cadexomer iodine:** No studies were found on the use of cadexomer iodine in pediatrics, but a few studies have demonstrated good debridement ability in adults (Raju et al., 2019; Sharma et al., 2023; Woo et al., 2021). Product limitations of cadexomer iodine include no use on infants aged less than six months and caution with use in children aged six months to fourteen years, especially on larger wounds. The product guidelines also recommend use for no longer than two weeks duration (Smith & Nephew, 2020). These guidelines are followed by SWOT members. Clinical experience has demonstrated the efficacy of this product, and it remains an option for older children, especially for wounds that are highly exudative.
- **Collagenase:** A case series of infants in the NICU (Neonatal Intensive Care Unit) with wounds reported the safe and effective use of collagenase to debride and promote wound healing (Huett et al., 2017). However, two older studies of collagenase in pediatric burn wounds (Ostlie et al., 2012; Ozcan et al., 2002) found a higher rate of cellulitis associated with its use. A large level I study including mostly adults reported a higher incidence of cellulitis associated with collagenase than alternative therapies (Patry & Blanchette, 2017). Lexicomp Online cautions on a risk of systemic bacterial infection and recommends use of a topical antibiotic powder to the wound bed prior to application of collagenase if infection is present (Lexicomp, 2023). Collagenase is the most expensive topical wound care product included in this comparison of products. It is a prescription medication and is therefore not carried on the SWOT wound carts and is obtained through a pharmacy when used. Despite these limitations, research indicates that it is effective in debriding non-viable tissue and remains a safe choice in non-infected wounds (Patry & Blanchette, 2017).
- **Maggot debridement therapy:** One recent level I study exists on maggot debridement therapy in adults, and four studies were included in a meta-analysis (Mohd Zubir et al., 2020). A case study was found on the use of maggot debridement therapy in a 5-year-old boy with multiple traumatic wounds that became infected and failed to respond to other advanced therapies (Perez-Acevado et al., 2022) Another case study on a 6-year-old patient undergoing ECMO (Extracorporeal Membrane Oxygenation) after heart

transplant reported successful treatment of a large pressure injury that became infected with *Rhizopus oryzae* (Birdsong et al., 2014). However, due to the limited available evidence, and the lack of desirability of using maggot therapy, this therapy should be limited for select cases when other therapy has failed.

- **Hypochlorous acid:** Several case series were found on the use of hypochlorous acid in neonates and premature infants, but no larger, higher-level pediatric research exists (Elsass, 2018; Faust, 2022). The rapid antiseptic action, non-cytotoxicity, and non-irritating formula of hypochlorous acid make it a suitable product for wound cleansing, reducing inflammatory skin conditions, and wet-to-moist dressings to promote autolysis (Bernam & Nestor, 2017; Couch et al., 2016; Day et al., 2017; Del Rosso & Bhatia, 2018; Dissemond, 2023; Gold et al., 2017; Totoraitis et al., 2017). SWOT added a hypochlorous acid product called Vashe Wound Solution to the wound care formulary in 2020.
- **Silver sulfadiazine:** A recent level I study on the use of silver sulfadiazine in pediatric burn patients concluded that it may be less preferable than non-silver treatments for pediatric burns (Rashaan et al., 2014). Silver sulfadiazine is a prescription medication with several cautions associated with its use, including drug interaction, drug accumulation, age restrictions, allergy, and risk for superinfection (Pediatric and Neonatal Lexi-Drugs, 2023). Silver sulfadiazine is not used by SWOT, but it is a product used by some practitioners at CHOC and was therefore included in Table 2.

- A **synthesis table** was created to guide product choice (see Table 2).
  - The information included on the table was collected from the literature search, product inserts, company websites, and Lexicomp online.
  - Where no data was available, clinical experience was used.
  - The table was designed to be a double-sided sheet that could be placed on CHOC wound care carts.
  - The table is color coded:
    - Debridement product category is highlighted in gold.
    - Brand names are indicated with a white background.
    - Debridement type: The first five products fit into the category of autolytic debridement and are highlighted as an aqua color. The enzymatic product is colored purple, the biological product is colored gray, the chemical debridement product is colored blue, and the topical antibiotic is colored cream.
    - Exudate: lightest blue indicates products that are suitable for wounds with low level of wound exudate and darker blue indicates products suitable for higher amounts of exudate.
    - Green-yellow-red: green indicates most preferable status, yellow indicates intermediate status, red indicates least preferable status. For example, an ideal product would have antimicrobial properties, result in rapid debridement of non-viable tissue, require infrequent dressing changes, be non-cytotoxic, be available over the counter, have minimal adverse effects or contraindications, and be cost-effective. This ideal product would be color coded all green.

- Factors included in the green-yellow-red color-coding are:
  - Ability to treat infected wounds
  - Debridement rate
  - Cytotoxicity
  - Frequency of required dressing change
  - Prescription requirement
  - Pediatric safety approval
  - Cost
- The back side of the synthesis table includes more information relevant to SWOT members, including:
  - mode of action
  - types of wounds indicated
  - associated warnings
  - local adverse events
  - level of pediatric research on product

Summary

- Creating the synthesis table has helped to clarify strengths and limitations in products.
- As there is no clear evidence to support one product over another, the choice of product should be made according to wound symptoms including level of exudate and signs of infection, as well as clinician experience, cost, and patient preference.
- Use of the synthesis table is anticipated to create a more standardized approach to product selection.
- SWOT's current wound care practices follow the recommendations by WOCN and AHWONN for pediatric and neonatal wound care.
- The dressings and products in the wound care formulary are pediatric appropriate.
- The approach to wound care by SWOT is family centered.
- The available literature on pediatric wound care is limited, and further research is needed.

Practice Recommendations

- As no evidence exists to promote the use of one debridement product over another, choice should be made according to wound characteristics, clinical experience, and patient preference, with the guidance of the synthesis table.

- The synthesis table is to be placed on every CHOC wound care cart for easy reference.

- Honey and surfactant-based products should be considered first for pediatric wounds (Amaya, 2015; Amaya, 2017; Biglari et al., 2013; Boyar, 2018; Boyar, 2019a; Boyar, 2019b; Boyar, 2021a; Boyar, 2021b; Kirsner, et al., 2019; Mohr et al., 2014; Ohadi et al., 2023; Pittenger et al., 2018; Sankar et al., 2020; Smaropolous et al., 2020).

- Maggot debridement therapy may be considered for hard-to-heal wounds, especially after other advanced therapies have failed (Birdsong et al., 2014; Perez-Acevado et al., 2022). The therapy may be specially ordered as needed and does not need to be kept in stock. Monarch Labs was identified as a potential source that is local to Orange County.

- Literature on pediatric wound care is scant. Publishing pediatric case studies will help to support others in the wound care community and share experiences.

- CHOC is fortunate to have a team of certified wound care practitioners and resources to support staff to publish case studies.

Outcome Measures

- Collect qualitative feedback from the WOCN Team at 3, 6, and 12 months after dissemination of the synthesis Table 2: Summary of Pediatric Wound Care Products to validate accuracy of the information and consistency with current practice.

- Generate case studies/series of wound care products on wounds commonly found in children, such as surgical incision dehiscence, extravasation injuries, and pressure injuries. Outcomes to be measured would be debridement, wound healing, pain, adverse events, patient satisfaction, and cost effectiveness. Wound photography and chart review would be used to measure outcomes.

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Table 2: Summary of Pediatric Wound Care Products

Product category	Hydrogel	Hydrogel + silver	Honey	Surfactant	Cadexomer Iodine	Collagenase	Maggot therapy	Hypochlorous acid	Silver sulfadiazine
Brand	Skintegrity	Silvasorb	Medihoney	Plurogel	Iodosorb	Santyl	Monarch	Vashe	Silvadene
Debridement type	Autolytic	Autolytic +AM	Autolytic +AM ↓pH	Autolytic +AM	Autolytic +AM ↓pH	Enzymatic	Biologic	Chemical	Antibiotic
Exudate	Low	Low	Low - mod	Low - mod	Mod - high	Low - mod	Low-high	Low - mod	Low - mod
Infected wounds	no	adjuvant	adjuvant	Adjuvant (biofilm)	Adjuvant (biofilm)	No, apply abx powder first	adjuvant	Yes (biofilm)	yes
Debridement rate	Slow	Slow	Moderate	Moderate	Moderate	Moderate	Faster	Moderate	Moderate
Cytotoxic	no	no	no	no	no	no	no	no	yes
Dressing change	Up to 3 days.	Up to 3 days	Up to 7 days	Daily (rec) up to 3 days	3x week	1x daily	Every 2-4 days	3x daily	1-2x day
Prescription	no	no	no	no	no	yes	yes	no	yes
Pediatric approved/ safe	Off-label	Off-label	Off-label	Off-label (21+)	>6 month Use with care 6 mths – 14 yrs	Safety not established for pediatrics	Off-label	Per company website and literature	Burns; infants >2 months
Cost	$0.09/g Skintegrity gel (Medline)	$ 0.61/g Silvasorb (Medline)	$0.43/g MediHoney gel $9/sheet	$4/g PluroGel (Medline)	$1.80/g Iodosorb (Smith & Nephew)	$11.52/g (LexiComp)	$300/appl (Monarch Labs)	$2.82/oz	$0.30/g (LexiComp)
Benefits	Safe, non-sting	Non-sting, AM	Safe, AM, natural	pain, non-sting, biofilm/AM	Absorbent, biofilm/AM	Selective	Rapid, selective	AM/biofilm, non-cyto	Topical antibiotic
Contraindications	Infected wounds	Sensitivity to silver	Sensitivity to honey/ bee stings	3rd degree burns	Thyroid dx, iodine allergy	Hypersens, infected wounds	Allergy fly larvae/ yeast/soy	none	Hypersens, sulfonamide allergy

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