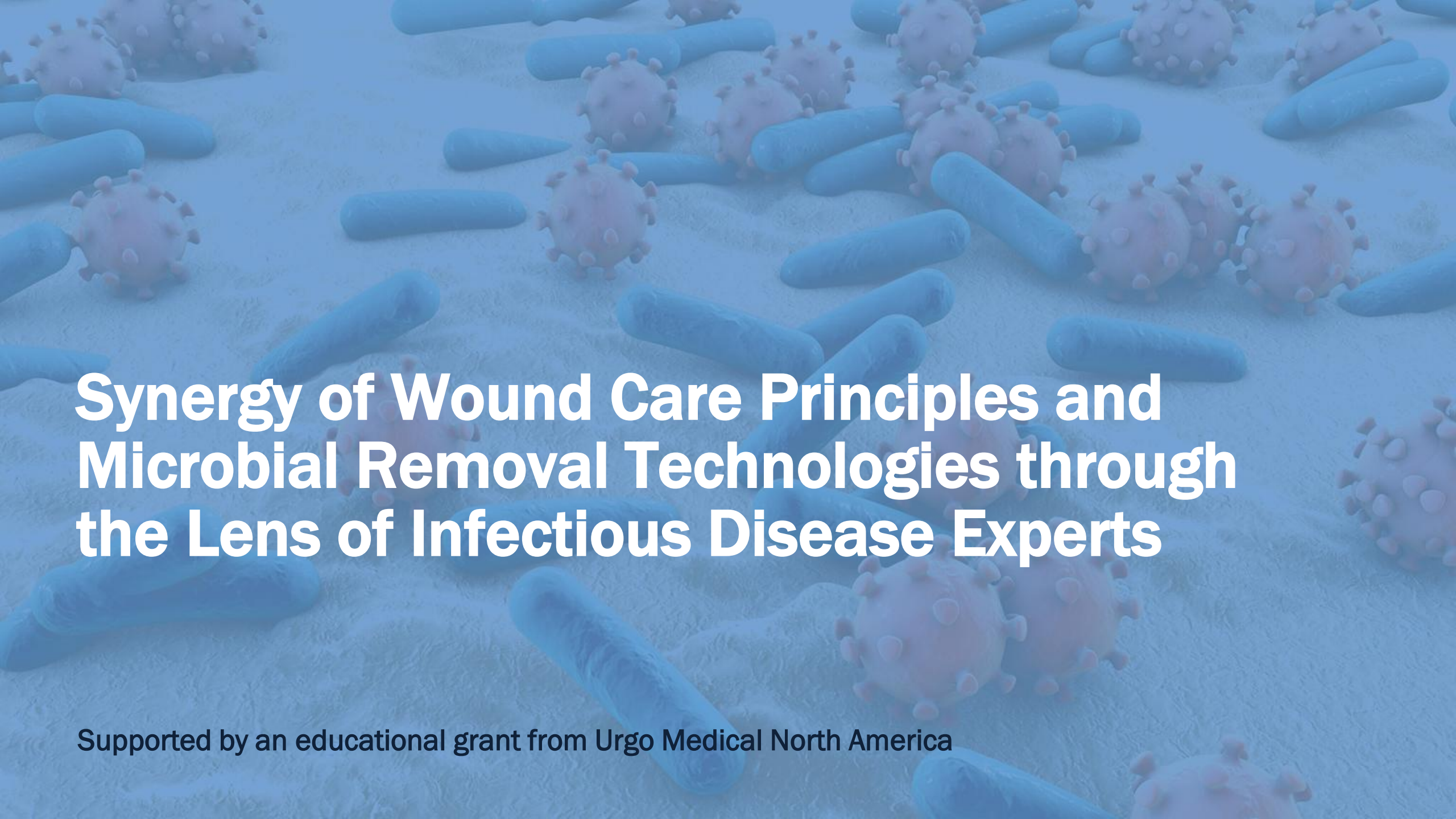

Synergy of Wound Care Principles and Microbial Removal Technologies through the Lens of Infectious Disease Experts

Supported by an educational grant from Urgo Medical North America

Faculty

- **Rene Amaya, MD**
  Practice Director – Pediatric Infectious Disease / Pediatric Wound Care
  Pediatrix Medical Group – Gulf Coast Division
  Houston, TX
- **Sujay Dutta, MD, MS**
  Infectious Diseases and Wound Care Physician
  Center for Advanced Wound Healing
  Private Practice
  Thousand Oaks, CA
- **Natalie E. Nierenberg, MD, MPH**
  Medical Director
  AND Solutions
  Boston, MA

Faculty Disclosures

- **Rene Amaya, MD**
  Speakers Bureau: Kerecis; Urgo Medical North America
- **Sujay Dutta, MD, MS** has nothing to disclose in relation to this activity
- **Natalie E. Nierenberg, MD, MPH**
  Consultant: Massachusetts Department of Public Health; Speakers Bureau: Urgo Medical North America

Disclosures

- The faculty have been informed of their responsibility to disclose to the audience if they will be discussing off-label or investigational use(s) of drugs, products, and/or devices (any use not approved by the U.S. Food and Drug Administration)
  - Applicable CME staff have no relationships to disclose relating to the subject matter of this activity
  - This activity has been independently reviewed for balance

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Learning Objectives

- Evaluate how the integration of wound care principles with microbial removal technologies can enhance infection prevention, optimize wound healing, and inform evidence-based decision-making from the perspective of infectious disease specialists
- Explain the role of hypochlorous acid–based, pH-controlled, and mildly acidic cleansers in optimizing wound bed preparation, highlighting their effectiveness in microbial reduction
- Examine the mechanism of action of negatively charged fiber technology in facilitating slough removal through physical binding and evaluate the potential synergistic benefits when combined with advanced cleansing technologies
- Appraise emerging clinical evidence demonstrating the synergistic effects of these technologies in real-world wound management with an emphasis on infectious disease perspectives and patient outcomes

Q&A

Submit your questions
via the question box
at any time

Integrating Wound Care Technologies with Infectious Disease Perspectives

Evidence-Based Approaches to Infection Prevention and Wound Healing Optimization

Natalie Nierenberg, MD, MPH
Infectious Disease and Wound Care Specialist
Boston, MA

Modern Wound Management Requires Integration of Multiple Disciplines

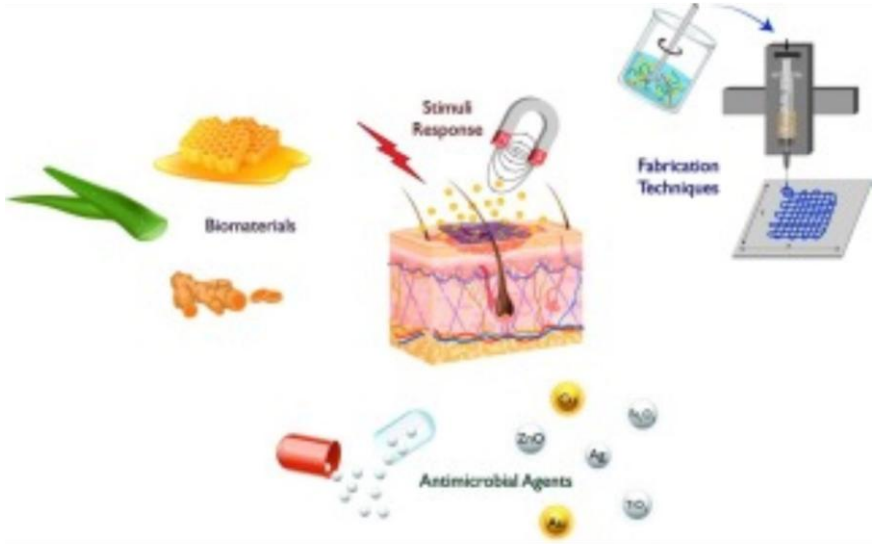
- **Traditional wound care** focused primarily on healing mechanics without comprehensive infection control, limiting effectiveness of treatment strategies in complex wound scenarios
- **Infectious disease perspectives** bring critical insights into pathogen behavior, biofilm formation, and antimicrobial resistance, enabling more targeted and effective interventions
- **Microbe removal technologies** (antimicrobial dressings, negative pressure therapy [NPT, NPWT], biofilm disruption) offer new tools for infection prevention that complement traditional wound care approaches
- **Integration of these approaches** creates synergistic effects that improve patient outcomes by simultaneously addressing wound healing physiology and infection control
- **Evidence-based decision-making** requires understanding both wound healing physiology and infectious disease (ID) principles to select appropriate technologies and treatment protocols

Effective wound infection, prevention, and control (IPC) bridges the gap between wound care and ID management

NPT, NPWT = negative pressure wound therapy; ID = Infectious Disease; IPC = infection, prevention, and control.

Wound Care Principles + Microbial Technologies = Enhanced Infection Prevention

- **Moisture Balance**
  Advanced dressings with antimicrobial properties maintain optimal wound environment and prevent bacterial colonization
- **Debridement**
  Mechanical and enzymatic debridement combined with biofilm-disrupting agents remove necrotic tissue and bacterial burden
- **Bacterial Load Management**
  Topical antimicrobials, silver-based dressings, and iodine formulations reduce pathogen concentration below infection threshold



- **Wound Bed Preparation**
  Integration of antiseptic cleansing with tissue-preserving techniques optimizes healing conditions
- **Barrier Protection**
  Advanced wound coverings prevent external contamination while allowing moisture vapor transmission

Microbial Removal Technologies Reduce Infection Rates when Applied with Clinical Precision

- **Antimicrobial Dressings**
  Silver, iodine, and PHMB-impregnated dressings reveal **30%-50% reduction** in wound infection rates in clinical trials across multiple wound types (surgical wounds, burns, chronic ulcers)
- **Negative Pressure Wound Therapy**
  Removes exudate, reduces bacterial load while promoting granulation tissue formation. NPWT with instillation (NPWTi) delivers antimicrobial solutions directly to wound bed with dwell time for enhanced infection control
- **Biofilm Disruption**
  Ultrasonic debridement and enzymatic agents break down biofilm matrix, making bacteria vulnerable to antimicrobials. Essential for chronic wounds where biofilm presence impedes healing.
- **Antiseptic Irrigation and Instillation**
  Controlled delivery of antimicrobial solutions (eg, PHMB, HOCl, dilute NaClO) reduces bacterial burden without tissue toxicity for safe, effective wound bed preparation
- **Combination Approaches**
  Layered strategies combining debridement, antimicrobial dressings, and NPWT/NPWTi show **superior outcomes** compared to single interventions, demonstrating the importance of integrated treatment protocols

Technology selection must be guided by wound assessment, bacterial burden, and patient-specific factors

PHMB = polyhexamethylene biguanide; NPWTi = negative pressure wound therapy with instillation; HOCl = hypochlorous acid; NaClO = sodium hypochlorite.

Infection Control Directly Impacts Healing Velocity, Quality

- **Reduced Inflammation**
  Lower bacterial burden decreases inflammatory cytokines that impair healing, allowing the wound to progress through normal healing phases more efficiently
- **Enhanced Cellular Migration**
  Clean wound beds allow fibroblasts and keratinocytes to migrate effectively across the wound surface, accelerating tissue repair and regeneration
- **Improved Angiogenesis**
  Infection control reduces tissue hypoxia and promotes new blood vessel formation, ensuring adequate oxygen and nutrient delivery to healing tissues
- **Faster Epithelialization**
  Antimicrobial strategies prevent wound edge infection that delays closure, enabling keratinocytes to resurface the wound more rapidly
- **Lower Complication Rates**
  Integrated approaches reduce dehiscence, chronic wound development, and systemic infection risk, improving overall patient outcomes and reducing healthcare costs

Optimal healing requires simultaneous attention to infection prevention and tissue regeneration

ID Principles Guide Technology Selection and Application

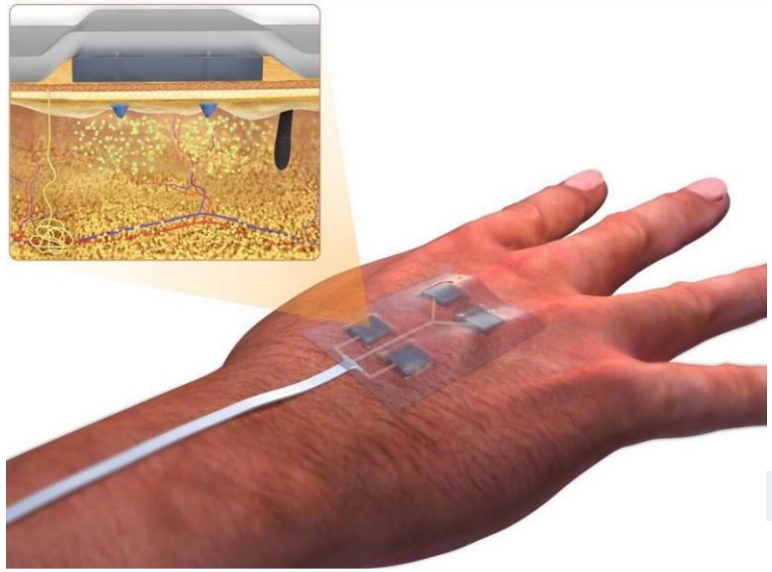
- **Pathogen Identification**
  Culture-guided therapy ensures appropriate antimicrobial selection and prevents resistance development through targeted treatment
- **Biofilm Recognition**
  Understanding biofilm physiology informs debridement frequency and antimicrobial choice, enabling effective disruption of protective bacterial matrices
- **Resistance Patterns**
  Local antibiograms guide empiric therapy and prevent ineffective treatment by aligning antimicrobial selection with regional resistance profiles
- **Host Factors**
  Immunocompromised status, diabetes, and vascular disease require modified infection prevention strategies tailored to patient-specific vulnerabilities
- **Stewardship Principles**
  Judicious use of antimicrobials prevents resistance while maintaining efficacy, balancing immediate treatment needs with long-term antimicrobial preservation

ID expertise transforms wound care from empiric to precision-based practice

Real-World Data Demonstrates Synergistic Effects of Integrated Technologies

Emerging Clinical Evidence

- **Systematic reviews and meta-analyses** provide high-quality evidence for technology combinations, demonstrating consistent benefits across multiple studies and patient populations
- **Prospective cohort studies** show improved outcomes when wound care and infectious disease principles are integrated in real-world clinical settings
- **Randomized controlled trials** demonstrate superiority of combination approaches over standard of care, with reduced infection rates and faster healing times



- **Real-world effectiveness studies** confirm laboratory findings translate to clinical practice, validating the practical application of integrated technologies
- **Cost-effectiveness analyses** support investment in advanced wound care technologies by demonstrating reduced overall healthcare costs through fewer complications

Evidence appraisal requires understanding both wound care and infectious disease literature

Silver and Iodine Dressings Show Consistent Infection Reduction in Multiple Wound Types

- **Meta-analysis findings:** Silver dressings reduce infection risk by **35%-45%** in surgical wounds, burns, and chronic ulcers, with consistent benefits demonstrated across diverse patient populations and wound etiologies
- **Mechanism:** Sustained antimicrobial release maintains sub-MIC concentrations that prevent bacterial proliferation without inducing resistance, creating a hostile environment for pathogen colonization
- **Spectrum of activity:** Broad coverage, including MRSA, *Pseudomonas*, and multidrug-resistant organisms (MDROs), makes these dressings valuable in settings with high-resistance prevalence
- **Safety profile:** Low systemic absorption and minimal tissue toxicity in properly selected patients, with contraindications limited to specific patient populations, such as those with silver allergies
- **Clinical application:** Most effective when applied early, before heavy colonization or biofilm formation, emphasizing the importance of proactive infection prevention strategies

Dressing selection should be based on wound characteristics, bacterial burden, and exudate level

MIC = minimal inhibitory concentration; MDRO = multidrug-resistant organism;

Negative Pressure Therapy Reduces Bacterial Load while Promoting Tissue Regeneration

- **Mechanism of action:** Continuous fluid removal decreases bacterial concentration and removes inflammatory mediators, creating an optimal environment for tissue regeneration and wound closure
- **RCT evidence: 25%-40% reduction** in surgical site infections (SSIs) when used prophylactically in high-risk wounds, demonstrating significant protective effects in vulnerable patient populations
- **Biofilm impact:** Mechanical disruption of biofilm structure enhances antimicrobial penetration, making NPWT particularly valuable in chronic wounds with established biofilm presence
- **NPWTi-d:** Advanced evolution combining negative pressure with cyclic instillation of antimicrobial solutions and dwell time, delivering topical agents directly to wound bed for enhanced infection control
- **Real-world outcomes:** Reduced hospital length of stay and lower amputation rates in diabetic foot infections, translating clinical trial benefits into meaningful patient and healthcare system outcomes

NPWT and NPWTi-d are most effective when integrated with comprehensive infection prevention protocols

SSI = surgical site infection; NPWTi-d = negative pressure wound therapy with instillation and dwell.

NPWTi-d with HOCl: Clinical and Economic Outcomes

International Consensus Recommendations

Expert panel: HOCl solution recommended as initial topical solution for NPWTi-d based on international consensus guidelines

Mechanisms of action: Automatic wound cleansing, solubilizing devitalized tissue, aggressive exudate removal, and bacterial load reduction

Safety profile: pH-controlled, antimicrobial properties, safe for acute and chronic wounds, pressure injuries, diabetic ulcers, and post-surgical wounds

Wound bed preparation: Ideally suited to remove microbes and debris from wound bed while preparing for skin grafts or promoting granulation tissue formation

Clinical Outcomes: HOCl vs Saline

Hospital LoS: HOCl 24.3 days vs Saline 37.9 days (36% reduction in severe and infected wounds)

OR visits: HOCl 3.3 visits vs Saline 4.1 visits (**24% reduction),** decreasing surgical burden and patient exposure to anesthesia

Total treatment cost: 56% lower with HOCl compared to saline, representing substantial healthcare cost savings ($27,906-$141,440 per patient depending on calculation method)

Cost efficiency: 19% lower cost per cubic centimeter of wound volume, demonstrating superior value in complex wound management

NPWTi-d with HOCl combines antimicrobial cleansing with negative pressure for superior infection control and cost-effectiveness

LoS = length of stay.

Kim PJ, et al. *Int Wound J.* 2020;17(1):174-186. Gallagher KE, et al. *Cureus.* 2022;14(4):e24321.

Technologies that Enable Antimicrobial Penetration and Wound Progression

Prevalence: 60%-80% of chronic wounds contain biofilm, which impairs healing and increases infection risk by protecting bacteria from host defenses and antimicrobial agents

Ultrasonic debridement: Low-frequency ultrasound disrupts biofilm matrix without damaging viable tissue, providing selective removal of pathogenic structures while preserving healing tissues

Enzymatic agents: Proteolytic enzymes degrade extracellular polymeric substance (EPS) that protects bacteria, exposing organisms to antimicrobial agents and host immune responses

Clinical evidence: Biofilm-based wound care protocols reduce time to healing by **30%-50%** in chronic wounds, demonstrating the critical importance of biofilm recognition and management

Combination strategies: Sequential debridement, antimicrobial application, and moisture management show best outcomes, emphasizing the need for comprehensive biofilm-targeted protocols

Biofilm recognition and management are essential components of modern wound infection prevention and control

EPS = extracellular polymeric substance.

Charged-Fiber Dressings Facilitate Slough Removal

MOA: "Magnet Technology"

Electrostatic attraction: In acidic wound environments, slough becomes positively charged; negatively-charged polyabsorbent fibers attract and trap slough, bacteria, and biofilm components through electrostatic forces

Continuous cleansing: Charged-fiber dressings provide sustained cleansing action for up to **7 days**, reducing frequency of dressing changes and maintaining wound bed preparation

High absorbency: Polyabsorbent fibers with acrylic core absorb exudate while trapping sloughy residue, achieving **75% reduction** in wounds with heavy exudate

Atraumatic removal: Lipido-colloid matrix ensures pain-free, atraumatic removal without damaging newly formed granulation tissue

Clinical Evidence from RCTs

EARTH RCT (Meaume, et al. 2014): Multicenter study of 159 patients with venous leg ulcers (VLUs) showed **65.3% slough reduction** vs 42.6% with hydrofiber control (p=0.013)

Debridement success: 52.5% of wounds debrided with UrgoClean® vs 35.1% with control (p=0.033) demonstrates statistically significant autolytic debridement

Chronic wound study (Dalac, et al. 2016): 62.5% relative reduction of sloughy tissue at wk 4, with 58.8% of wounds achieving debridement

Pressure injury (PI) outcomes: 75%-89% decrease in sloughy tissue in venous ulcers and stage 3-4 PIs, with marked improvement in periwound skin (Meaume, et al. 2012)

Effective slough removal is essential for infection prevention as slough harbors bacteria and impedes healing

VLU = venous leg ulcer; PI = pressure injury.

Meaume S, et al. *J Wound Care.* 2014;23(3):105-6,108-11, 114-6. Dalac S, et al. *J Wound Care.* 2016;25(9);531-538. Meaume S, et al. *Wound Repair Regen.* 2012;20(4):500-511.

Synergistic Effects: Combining HOCl in Real-World Practice

Mechanisms of Synergy

pH-dependent interaction: Both HOCl and negatively-charged fibers work optimally at acidic pH (4-6.5); in acidic wounds, slough becomes positively charged, enabling electrostatic attraction to negative fibers while HOCl maintains peak antimicrobial activity

Complementary actions: HOCl provides broad-spectrum antimicrobial coverage while negatively-charged fibers physically remove slough and manage exudate—addressing microbial and mechanical barriers to healing

Temporal synergy (bitherapy): HOCl liquid (100-500 mg/L) provides immediate bacterial reduction with minimal residual effect, followed by HOCl gel (60 mg/L) offering sustained antimicrobial protection for 1+ days

Multi-target approach: Simultaneously targeting bacteria, biofilm, slough, debris, exudate, and inflammation creates optimal conditions for wound bed preparation and healing progression

Clinical Outcomes: ID Perspective

Herruzo, et al. (2023) 346 chronic ulcers: HOCl bitherapy (liquid + gel) showed **4.8x higher probability** of complete healing compared to monotherapy—the strongest positive prognostic factor identified (OR=4.8, $p<0.001$)

Infection prevention: Bitherapy reduced infection risk by **70%** (OR=0.3, $p=0.01$); infection rate decreased from 14.0% at baseline to **3.1%** after 2 wks — a 77.9% relative reduction

Real-world healing outcomes: 59% of complex chronic ulcers achieved complete healing; 70% of healed ulcers used synergistic HOCl bitherapy approach

Patient-centered outcomes: Lützkendorf et al. (2022, 728 patients) demonstrated 78.9% reduction in local wound infections, 92.1% healed/improved wounds, and 65.7% periwound skin improvement with TLC-Ag (lipido-colloid matrix with silver).

Herruzo R, et al. *Wound Repair Regen*. 2023;31:401-409. Lützkendorf S, et al. *J Wound Care.* 2022;31(5).

Synergistic Effects: Combining HOCl in Real-World Practice

Addition of HOCl with other technologies:

1. **pH-dependent interaction (HOCl + negatively-charged fibers)** Both HOCl and negatively-charged fibers work optimally at acidic pH (4-6.5), where slough becomes positively charged and is attracted to negative fibers while HOCl maintains peak antimicrobial activity
2. **Complementary actions (chemical + mechanical)** HOCl provides antimicrobial coverage while negatively-charged fibers physically remove slough and manage exudate — addressing microbial and mechanical barriers simultaneously

Clinical Outcomes — ID Perspective:

TLC-Ag with Negatively Charged Fibers (Lützkendorf S, et al. 2022) 728 patients: 78.9% reduction in local wound infection prevalence; **92.1%** of wounds healed or improved; **65.7%** periwound skin improvement

Sequential Management: UrgoClean Ag → Healing Promotion (Vaidya, et al. 2021) All clinical signs of infection **substantially reduced at 2 wks**; wound healing achieved; improvement in quality of life

3. **Multi-target approach** Combined technologies simultaneously target bacteria, biofilm, slough, debris, exudate, and inflammation — creating a comprehensive wound bed preparation strategy

Lützkendorf S, et al. *J Wound Care.* 2022;31(5). Vaidya S, et al. *Wounds Int.* 2024;15(2):22-31.

Comparative Mechanisms and Clinical Integration of Microbe-Removal Technologies

Category	Mechanism	Biofilm/ Exudate Effect	Clinical Role/ Integration
Chemical (Oxidative) Liquid	Oxidative antimicrobials (HOCl liquid); rapid microbial kill, dissolve biofilm, reduce surface tension	Immediate microbial kill; lifts debris and slough; minimal residual effect	Foundational cleanser for all wound types; compatible with other modalities; use before other interventions
Chemical (Oxidative) Gel/Sustained Release	Sustained-release oxidative antimicrobial (HOCl gel); maintains antimicrobial activity for 24+ hours	Prolonged microbial suppression; residual antimicrobial protection; prevents recolonization	Post-cleansing maintenance; synergistic with HOCl liquid for bitherapy (4.8x higher healing probability); applied after liquid cleanser
Mechanical / Energy-Based	Low-frequency shear or cyclic wash–vacuum with HOCl instillation	Breaks up biofilm and removes deep debris and exudate	Enhances HOCl penetration; ideal for complex or infected wounds
Surfactant / Detergent-Based	Lowers surface tension to loosen debris and disrupt immature biofilm	Lifts and emulsifies organic material	Pre-cleansing phase to improve subsequent HOCl or antimicrobial efficacy
Electrostatic / Fiber-Based	Negatively-charged or hydroconductive fibers absorb bacteria and debris	Captures and sequesters biofilm remnants	Post-cleansing wound hygiene; maintains clean wound bed
Chemical–Absorptive Antimicrobial	Absorptive matrix or hydrophobic binding system removes exudate and microbes	Sustained or physical microbial reduction without cytotoxicity	Maintenance phase between cleansing cycles; ideal for bioburden control and sensitive skin

Synergy Flow — Sequential Integration:

➡️ **Pre-Cleansing** → **Active Debridement** → **Post-Cleansing / Biofilm Capture** → **Maintenance / Antimicrobial Control**

Integration across modalities promotes precision infection control and optimized healing

Multi-modal microbial-removal strategies address biofilm complexity and bacterial persistence through complementary mechanisms—
combining chemical disruption (HOCl liquid + gel therapy), mechanical removal, and sustained antimicrobial control for superior infection prevention outcomes

Real-World Clinical Cases: Published Evidence

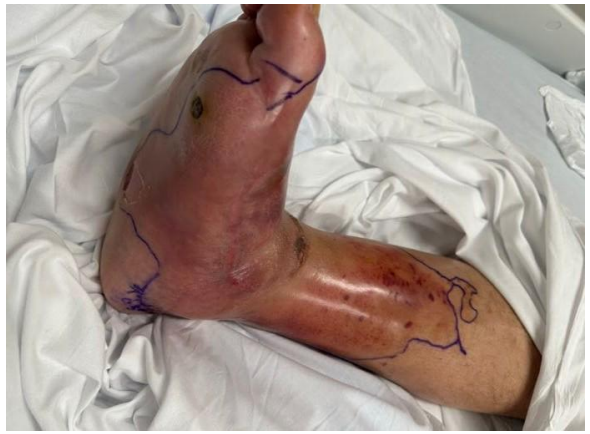
Case 1: HOCl for Infected Cavity Wound (Perianal Abscess)

Wongkietkachorn, et al. (2020) *Plast Reconstr Surg Glob Open*

Patient: Immunocompromised, horseshoe perianal abscess; failed povidone-iodine treatment (fever persisted, pain 10/10)

Treatment: Switched to HOCl lavage, daily irrigation

Outcomes: Fever subsided in **1 day**; infection cleared in **2 wks** (culture negative); pain reduced to **2/10**; wound volume reduced **>90%** in 5 wks; complete closure in **6 wks** (vs 10 wks with traditional treatment — **40% faster**)



Case 2: HOCl for DFU — Limb Salvage

Jalem & Usharani (2024), *Bioinformation*

Patient: 65y Male, diabetes 18 yrs, lost great toe; surgical wound with continual infection/pus, non-responsive to standard care **Counseled for total foot amputation.**

Treatment: HOCl + honey (2:1), 3x daily application

Outcomes: Infection controlled **3-8 wks**; wound volume reduced **>95%** in 6 wks; complete closure **15 wks**; **no skin grafting required**

Case 3: UrgoClean Ag for DFUs (Real-World Data)

Tiwari, et al. (2024) *Wounds Int.* Lützkendorf, et al. (2022) 728 patients

Patients: DFUs with local infection and heavy exudate in real-world settings (India, Europe)

Treatment: Negatively-charged fibers + silver dressing

Outcomes: Infection rate **14.0% → 3.1%** at 2 wks (77.9% reduction); all clinical signs of infection substantially reduced; **92.1%** of wounds healed or improved; **78.9%** reduction in local wound infections (728 patients); **65.7%** periwound skin improvement

Key Outcomes across Published Cases

Infection Control: Clearance in 2-8 wks; culture negativity 100%; fever resolution 1 day to 2 wks

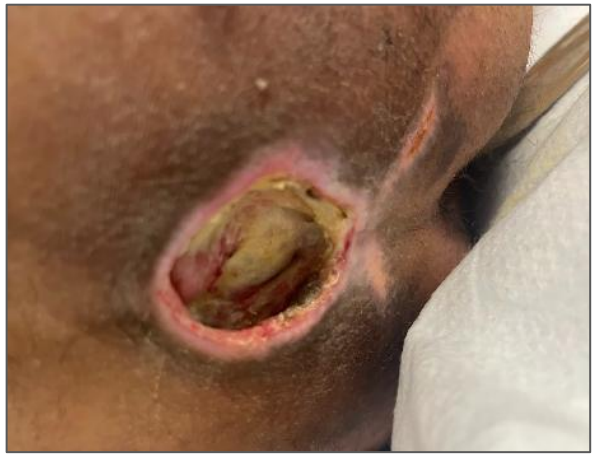
Healing Outcomes: Wound volume reduction 90%-95% in 5-6 wks; complete closure 6-15 wks; chronic wounds (10-35 yrs) successfully healed

Patient-Centered: Limb salvage in amputation candidates; pain reduction (10/10 → 2/10); quality of life improvement; avoided major surgery

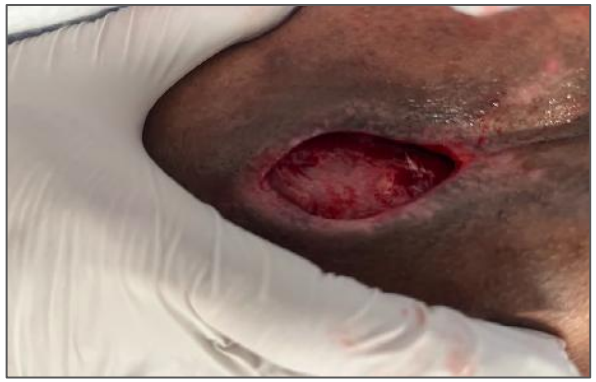
Clinical Cases: Collaborative Precision

Case 1: Stage 4 coccyx PI with osteomyelitis, MDRO, advanced cardiac life support, needs heart transplant STAT

BEFORE treatment



AFTER 1st 2 wks of treatment



Patient Profile

56y Male with diabetes, heart failure, life flighted from Puerto Rico, on ECMO, septic from coccyx wound, in life-threatening heart failure in urgent need of heart transplant. OSH tried many treatment modalities over the prior 8 wks with only worsening of the wound.

Treatment Protocol

HOCl, NPWTi with HOCl, antimicrobial wound cleanser with HOCl: changed TID and PRN for 2 wks (first phase, pre-transplant), then re-cultured deep tissue; then HOCl and antimicrobial wound cleanser with HOCl TID.

ID Outcomes

Clearance of MDRO *Klebsiella*, cessation of broad-spectrum MDRO antimicrobial coverage: role of wound care in **antimicrobial** stewardship and transplant medicine. MDRO never recurred pre- or post-transplant despite wound remaining open at time of transplant and in highly soiled area

Healing Results

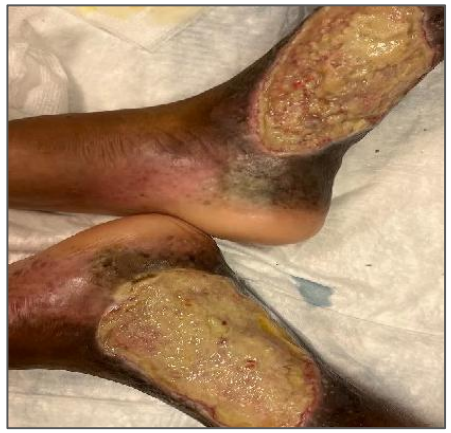
Wound began to granulate with bone coverage and 50% decrease in square area over 2 wks, non-surgical candidate due to cardiac anesthesia risk, surgical avoidance successful, marked reduction in pain, neurologic status back to baseline, cleared for cardiac transplant to save his life; 5 months later, discharged back to Puerto Rico, walking with completely closed wound - despite immunosuppression, ischemia, vasopressors, cachexia

Case 2: Sickle cell ulcers, cellulitis, thick adherent biofilm, excruciating pain

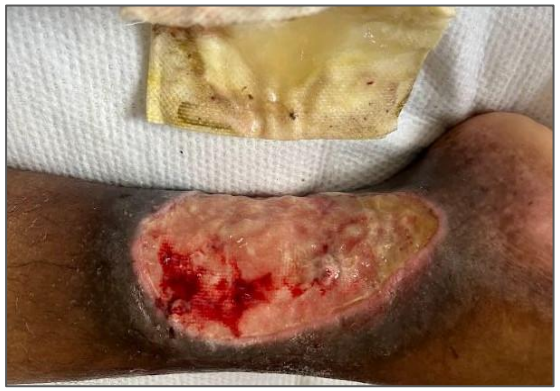
Patient Profile

32y Female from Cape Verde, immigrated at age 8 due to severe sickle cell crises, pain, and bilateral lower extremity painful repeatedly infected ulcerations. Previously treated at neighboring hospital with multiple skin grafts and repeated failures due to recurrent infection, inconsistent wound care, adverse reactions to wound care prescribed. Upon initial presentation to us, the wounds were large, copious drainage, 10/10 pain with associated erythema and streaking of adjacent skin, warmth, and cellulitis. She reported having tried all types of wound dressings, and everything was too painful.

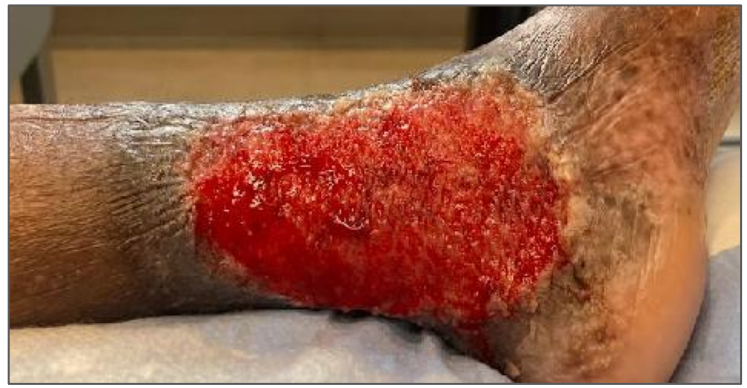
BEFORE treatment



Step 1: After bacterial reduction via HOCl TID + IV abx x1 wk



Step 2: After OR jet debridement + HOCl instillation



Treatment Protocol

IV abx for soft tissue infection, pain management for sickle cell crisis. At first, she could not tolerate anything touching the wound bed, including HOCl. After careful premedication, topical lidocaine, warmed liquid HOCl was applied — amount and frequency titrated up as tolerated to TID. IV abx directed to MRSA and GBS (cx beneath biofilm). Once infection cooled down after 1 wk of HOCl TID, IV abx, IV pain medication, went to OR for hydrosurgery HOCl debridement. Goal to remove all biofilm to reduce risk of recurrent soft tissue infection, stop systemic abx, return to maintenance infection prevention for eventual skin flaps.

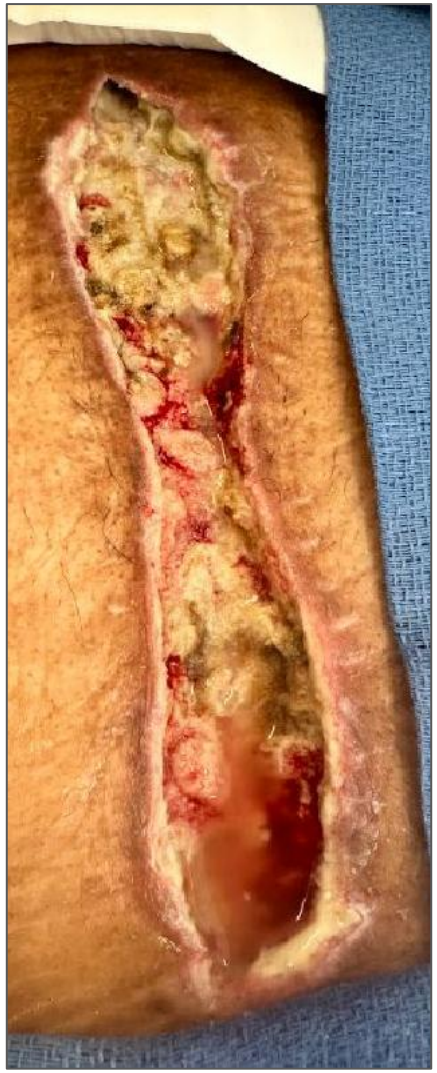
Infectious Disease Outcomes

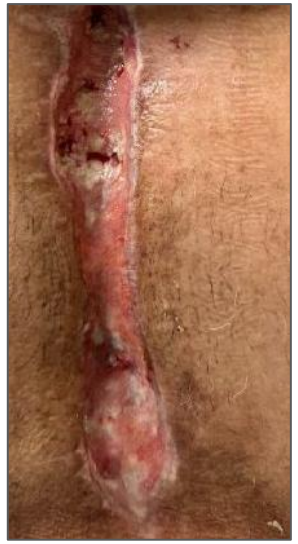
Cleared cultures; no further MRSA or GBS growth post OR HOCl hydrosurgery debridement and continued HOCl TID. Stopped IV abx. Started lifelong suppressive amoxicillin given asplenia from sickle cell. No recurrence of soft tissue infection.

Healing Results

Bilateral full-thickness skin grafts applied for closure. Infection control maintained prior with HOCl-moistened electrostatic fiber dressings. Pain maintained ≈2/10 without IV pain medication. QoL greatly improved, able to resume ADLs. Life-threatening MRSA + Strep soft tissue infection resolution with limb salvage and without major surgical intervention and minimal time on IV or broad-spectrum abx.

Case 3: *Candida, Enterococcal* Sternal Osteomyelitis, Mediastinitis Persisted… until….





After Urgo Clean AG+HOCL

After NPWTi with HOCL

Patient Profile

68y Male with diabetes, CAD, valvular disease, post-CABG complications from cardiac and bowel wall ischemia resulted in advanced cardiac life support, open abdominal surgery, ex lap x3. Developed infection of sternum, mediastinum, and abdominal wall. CT surgery could not achieve infection control despite multiple washouts. He had been on broad -spectrum antimicrobials x4 wks. Wound care consulted to assist. 10/10 pain with dressing changes to open sternal bone; could not start NPWT

Treatment Protocol

Used HOCl with negatively-charged fibers + silver first. Delicately debrided every other day any loosened slough from dressing. After 2 wks, could see granulation tissue and reduction in pain. At 4 wks, could use instillation NPWT with HOCl.

Infectious Disease Outcomes

Deep cultures grew *enterocci* and *Candida*. Systemic therapy initiated. Was still growing at 4 and 6 wks. At 8 wks, when no longer visible slough, cultures negative. closed. stopped systemic abx.

Healing Results

At 8 wks, could apply skin substitute and close the wound.

Real-world clinical cases demonstrate the practical application of evidence-based microbial removal technologies, translating published research into tangible patient outcomes and reinforcing the infectious disease perspective in wound management

Integration of Wound Care + ID Principles Optimizes Infection Prevention + Healing

Key Takeaways

- Wound care principles enhanced by microbial removal technologies create synergistic effects that improve patient outcomes through simultaneous attention to healing physiology and infection control
- Emerging clinical evidence from systematic reviews, RCTs, and real-world studies demonstrates significant reductions in infection rates and improved healing with integrated approaches
- Infectious disease perspectives guide appropriate technology selection, prevent antimicrobial resistance, and transform wound care from empiric to precision-based practice
- Evidence-based decision-making requires understanding both wound healing physiology and infectious disease principles to select appropriate technologies and treatment protocols
- Implementation of standardized, protocol-driven care ensures consistent application of evidence-based practices and translates research findings into real-world patient benefit

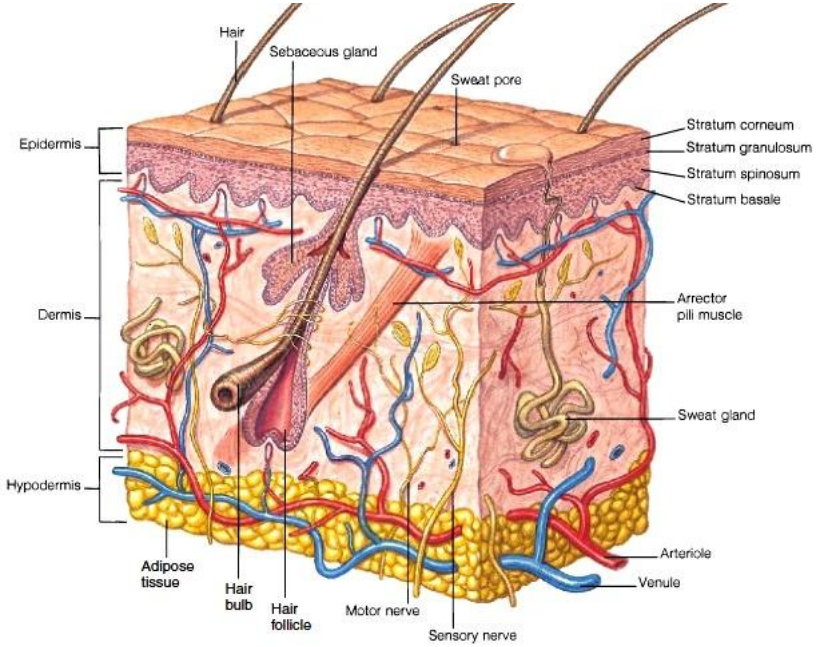
Pediatric Clinical Advocacy and Case Studies

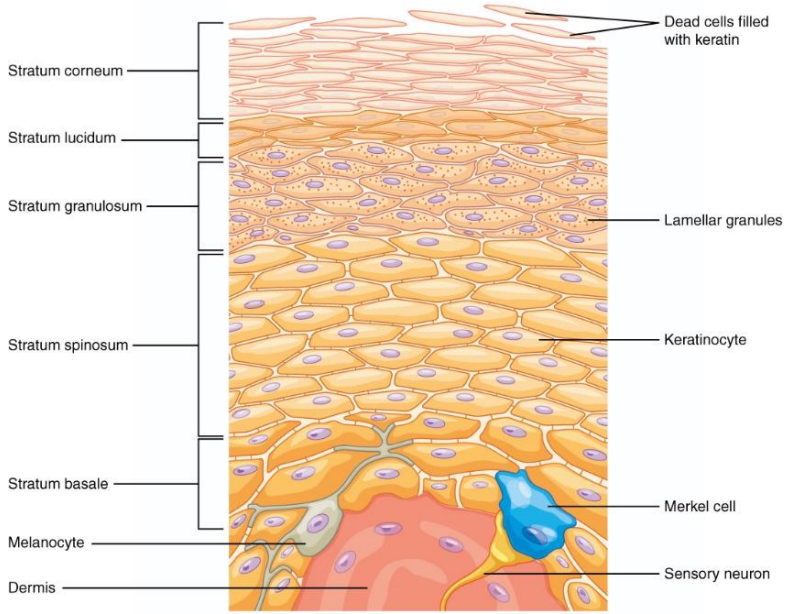
Rene Amaya, MD

Practice Director,
Pediatric Infectious Disease / Pediatric Wound Care
Pediatrix Medical Group – Gulf Coast Division
Houston, TX

Unique Features of Neonatal Skin

- Skin does not mature until 34 wks gestation
- Skin integrity of premature infants is weak and far from complete
- Stratum corneum is the outermost section of the epidermis
  - Composed of nonviable skin cells packed on top of each other to create a protective barrier
- Key functions of the stratum corneum are to control transepidermal water loss (TEWL) and to prevent absorption of toxic substances





TEWL = transepidermal water loss.

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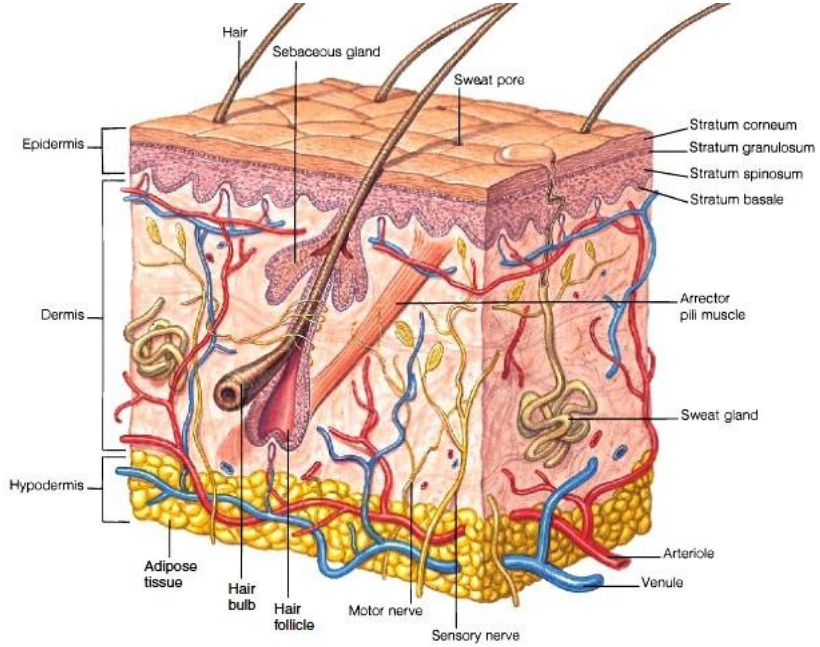
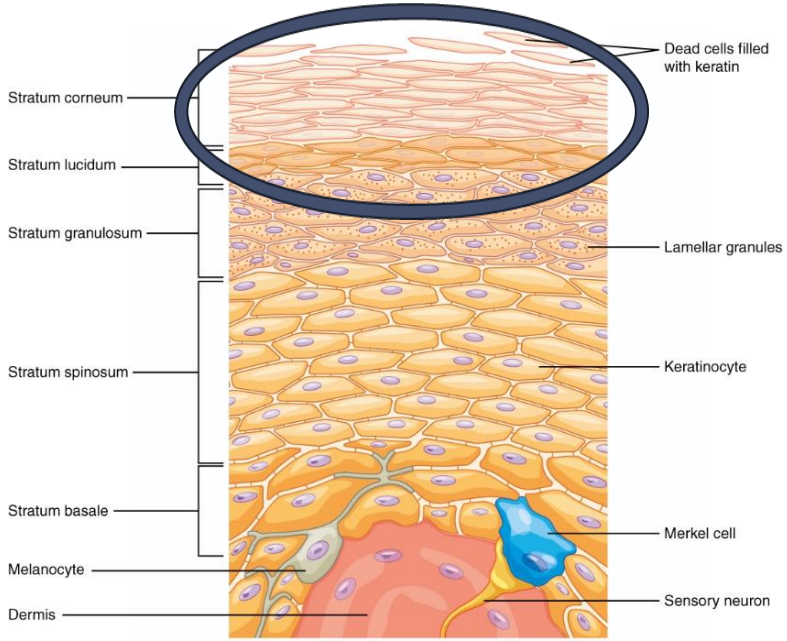




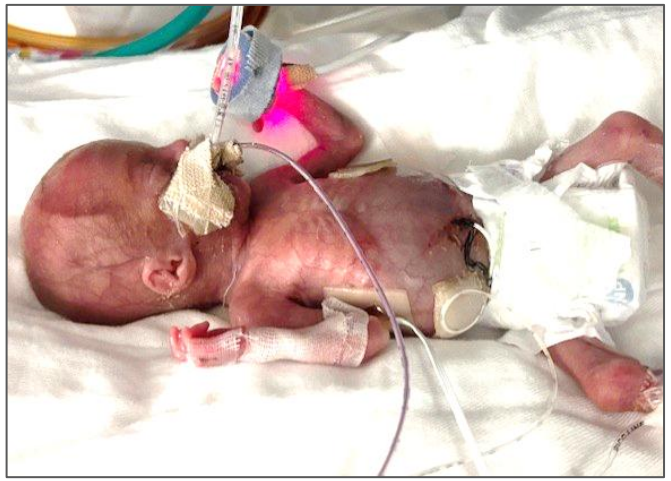
TEWL = transepidermal water loss.

Epidermis — Stratum Corneum

- In full-term infants and adults, the stratum corneum is 10-20 layers thick
- In premature neonates <30, the stratum corneum is less than 2-3 layers
- 23-24 wk premature infants have virtually no stratum corneum







The Problem

1. **Barely formed skin**
   The skin is thin and fragile, and the acid mantle is not fully developed.

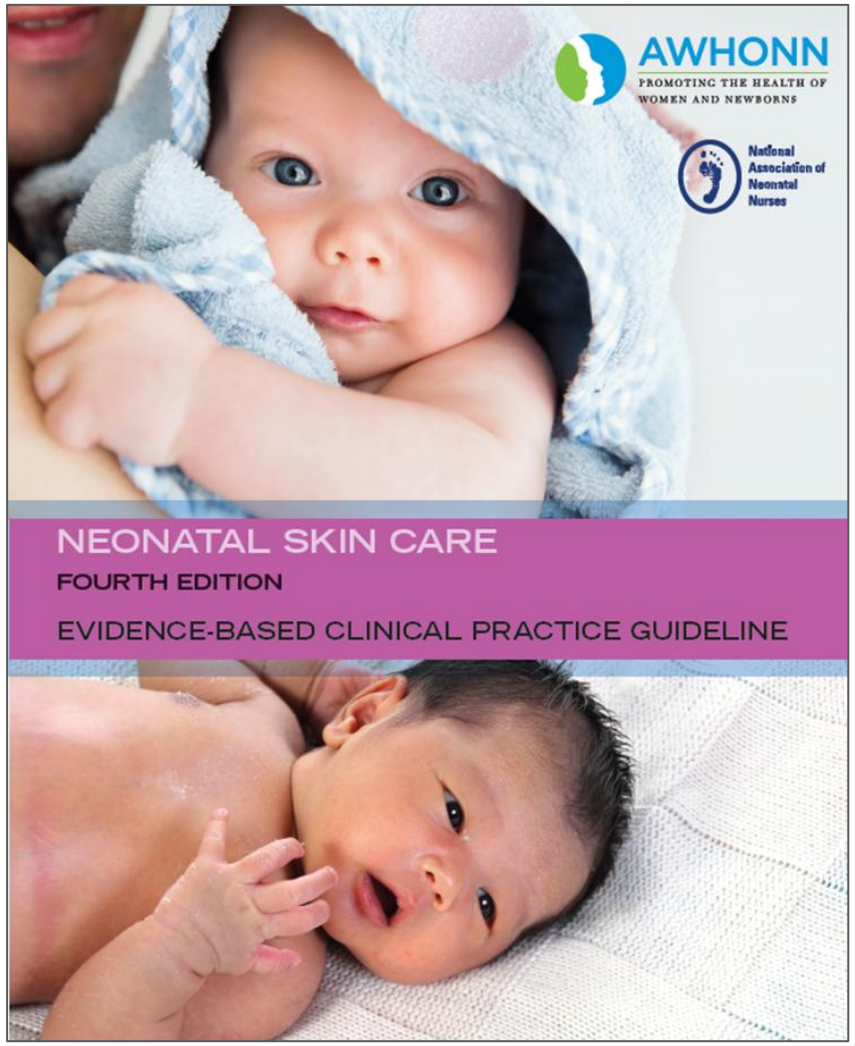
2. **Cannot thermo-regulate**
   This requires warmers, which can create conditions that promote yeast and bacterial growth, increasing the risk of neonatal infection.

3. **Infections happen**
   Many antiseptics and antimicrobials are contraindicated because they are easily absorbed through the thin skin

High-Risk and with Limited Options

Recommendations from Neonatal Skin Care, 4th Ed. AWHONN

- **Cleansers:** The role of cleansers is to emulsify oil, dirt, and microorganisms on the skin so they can be easily removed with water
  - Ideally, cleansers should not cause skin irritation, disrupt the normal pH or microbiome of the skin surface, or cause stinging or irritation of the eyes
  - Select mild liquid cleansers with a neutral or mildly acidic pH (pH 5.5-7) or those that have been shown to have minimal impact on the baby's skin surface pH
    - pH changes can affect bacterial composition
    - Lower pH products are best for infants with eczema
  - Choose cleansers with preservatives that have demonstrated safety and tolerability for newborns

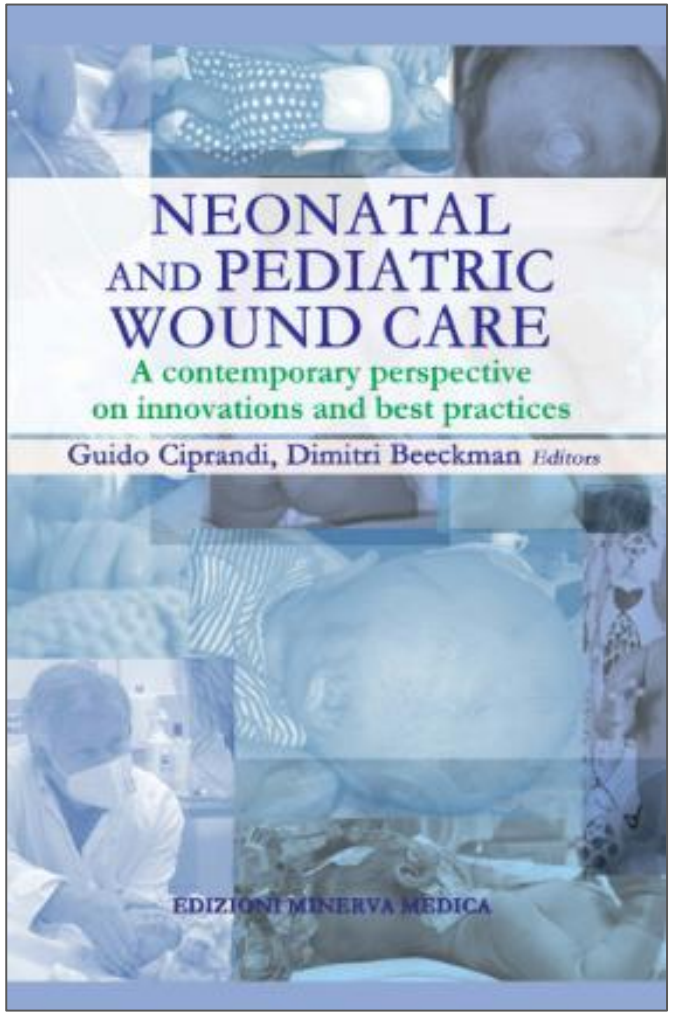


AWHONN = Association of Women's Health, Obstetric and Neonatal Nurses.

Neonatal and Pediatric Wound Care

Key Points on Hypochlorous Acid (HOCl)

- Commercially produced hypochlorous acid (HOCl) mimics the natural antimicrobial properties of HOCl produced by neutrophils in the body
- HOCl has a broad spectrum of antimicrobial activity with no known resistance and efficacy against bioburden
- HOCl is nontoxic to healthy skin cells
- Neutral pH of HOCl promotes favorable wound-healing environment as opposed to hypochlorite solutions, which can be cytotoxic
- HOCl is non-irritating upon application, making compliance easier for use in pediatrics
- No adverse effects have been seen with HOCl, even among extremely premature infants



HOCl = hypochlorous acid.

Ciprandi, Guido, and Dimitri Beeckman. *Neonatal and Pediatric Wound Care: A Contemporary Perspective on Innovations and Best Practices*. 2025.

The role of pure hypochlorous acid-based (pHA) cleanser for severe diaper dermatitis

Diaper Dermatitis: Focus on the Wound

- Whereas protecting injured skin from additional moisture and irritants is important, such interventions have passive impact on the wound itself
- Correcting the alkaline pH of the skin and reducing the microbial burden of the tissue will play a significant role in healing the open wound and reducing the inflammation present

Efficacy of Pure Hypochlorous Acid (pHA) Preserved Solution in the Treatment of Severe Perianal Contact Dermatitis in Infants

Rene Amaya, MD, FAAP, CWSP

Pediatrix Medical Group - Houston

Introduction

Premature infants in the neonatal intensive care unit (NICU) often suffer from severe perianal contact dermatitis (PCD). Multiple factors increase the risk for these painful wounds include the immaturity of the skin, caustic nature of the stool, alkaline breakdown products of urine, and secondary bacterial and fungal infections of the skin. Treatment of PCD in NICU patients has focused on application of various barrier products to protect the skin from ongoing irritation. The author sought to determine if in addition to traditional treatment, focusing on treatment of the wound itself might expedite healing.

Pure Hypochlorous acid (pHA) preserved wound cleanser solution has been shown to be effective towards reduction of bioburden of wound beds[1]. pHA also disrupts microbial colonies[2] and has a pH range aligned with the pH of the skin which helps in healing[3].

In this case series, infants with severe PCD were treated with a single daily application of pHA in combination with traditional barrier ointments and dressings. The goal was to determine if pHA might synergistically expedite PCD healing.

Methods

Ten infants in the NICU with severe PCD who had shown poor response to various topical barrier ointments and dressings were recruited. Gauze dressings were saturated with pHA solution, applied to directly to the affected skin, and left in place for 5-10 minutes. Thereafter, barrier ointment was reapplied to the site. The pHA was applied once daily for 7 days. Routine diaper changes and skin hygiene continued as usual. Photographs were taken for objective assessment and documentation.

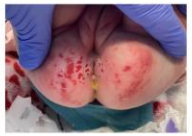
Patient Characteristics

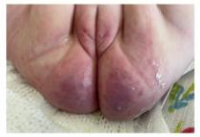
Patient #	Gestational Age	Chronological Age	Sex	Duration of condition prior to treatment	Percentage Resolution after 7 days treatment
1	25 weeks	5 months	Female	7 days	100%
2	23 weeks	4 months	Female	8 days	100%
3	25 weeks	16 days	Female	7 days	100%
4	38 weeks	2 months	Male	7 days	100%
5	23 weeks	20 days	Female	8 days	100%
6	23 weeks	4 months	Female	4 days	100%
7	34 weeks	14 days	Female	6 days	100%
8	38 weeks	1 month	Male	7 days	100%
9	23 weeks	1 month	Female	8 days	100%
10	25 weeks	5 months	Female	5 days	75%

Illustrative Cases

Case 1

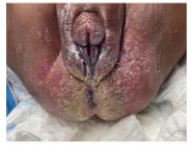
5 m/o 25-week premature female with history of intestinal perforation and bowel resection. Poor response to cyanoacrylate and zinc barrier. Open wounds resolved after 7 days pf treatment protocol.





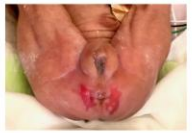
Case 2

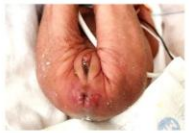
4 m/o 23-week premature female with recent cardiac-related surgery. Reduced direct care nursing intervention due to cardiac decompensation. Poor response to Questran/Aquaphor. Skin improved after 7 days treatment protocol and improved diaper hygiene.



Case 3

16 d/o 25-week premature female. Poor response to zinc oxide preparation. Open wounds healed after 7 days of treatment protocol.





Results

Regardless of the barrier ointment utilized, 90% of the infants showed complete resolution of the open wounds and inflammation after 7 days.

One infant reached this goal after treatment was extended for 14 days. In every case, patients exhibited no signs of complications from topical application of pHA to the skin.

Conclusions

This case series illustrates the synergistic benefits of utilizing pHA wound cleaner in healing severe PCD in combination with traditional application of barrier ointments and dressings. The simple intervention was purposely designed to improve nursing compliance and monitor the effects of single daily applications. The addition of pHA expedited healing in patients who were unresponsive to traditional methods alone.

In addition to the findings above, the small study illustrated the positive effects of focusing on basic skin care and diaper hygiene in NICU patients. Such simple routine interventions might prevent contact dermatitis from arising and avoid secondary pain and stress in these fragile patients.

Larger studies are planned to ensure the observed results are reproducible.

References:

1. Hiebert JM, Robson MC. The Immediate and Delayed Post-Debridement Effects on Tissue Bacterial Wound Counts of Hypochlorous Acid Versus Saline Irrigation in Chronic Wounds. Eplasty. 2016;16: e32. Published 2016 Dec 1.
2. Day A, Alkhalil A, Carney BC, Hoffman HN, Moffatt LT, Shupp JW. Disruption of Biofilms and Neutralization of Bacteria Using Hypochlorous Acid Solution: An In Vivo and In Vitro Evaluation. Adv Skin Wound Care 2017 Dec;30(12):543-551.
3. Nagoba BS, Suryawanshi NM, Wadher B, Selkar S. Acidic environment and wound healing: a review, Wounds 2015;27(1):5-11.

Vashe, Urgo Medical

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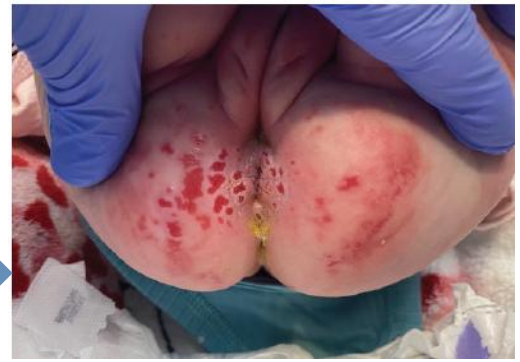
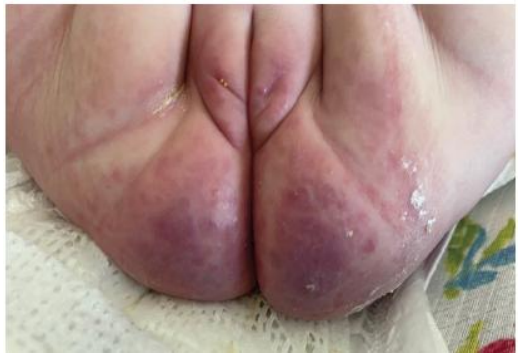


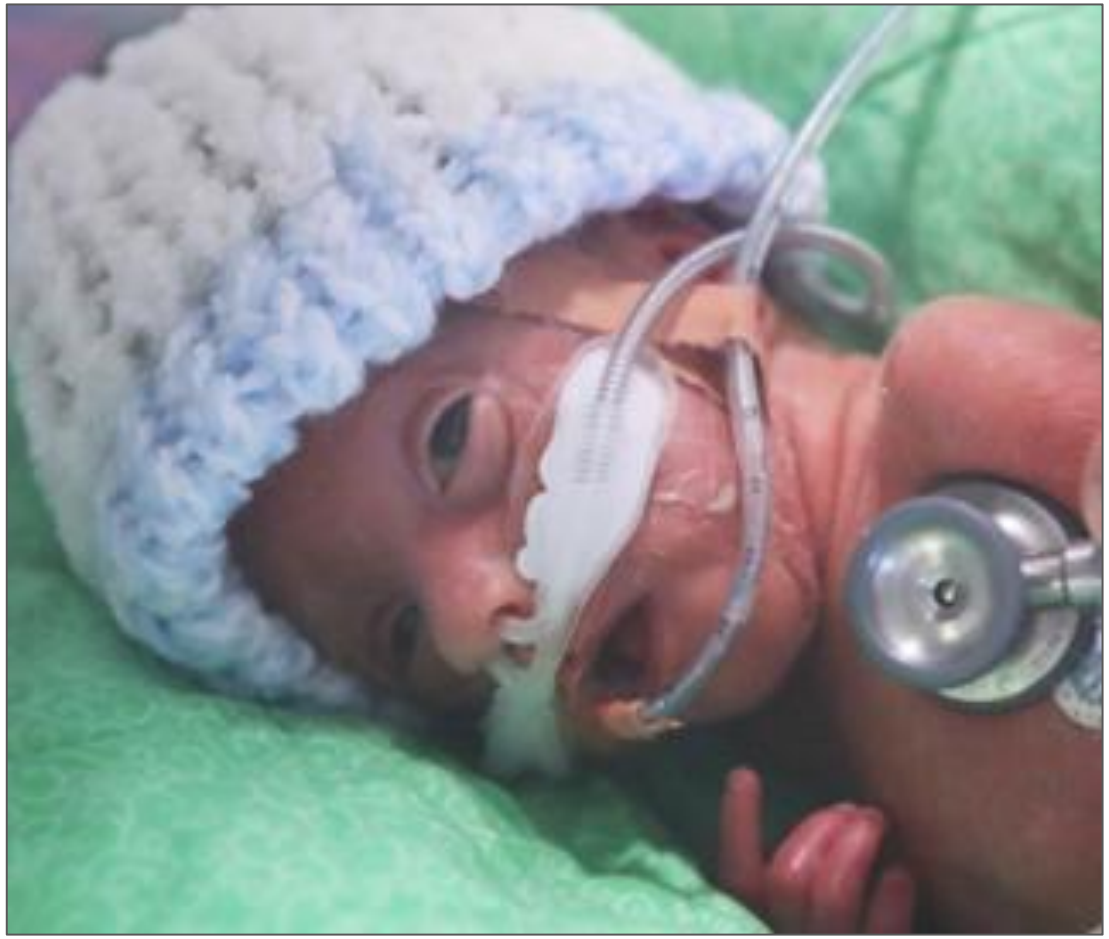


pHA Neonatal Safety Study

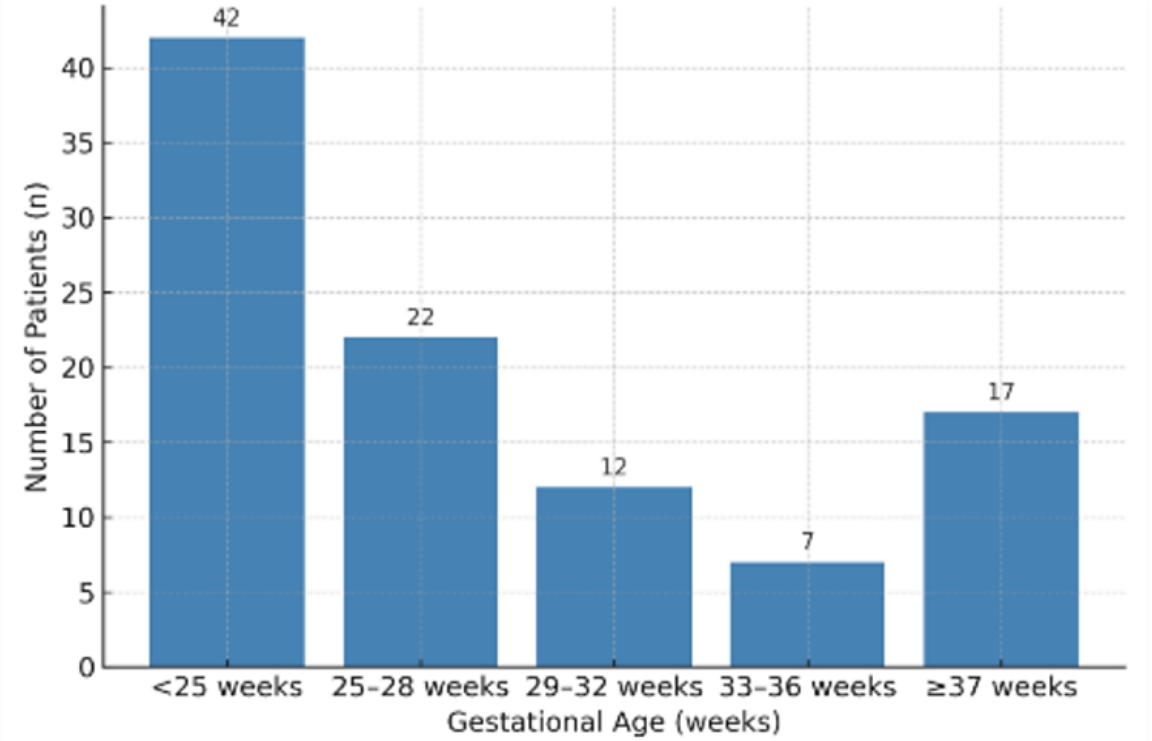
- There is a significant amount of published research in the adult population establishing the safety and efficacy of pHA
- There are also several studies that support the use of pHA in the pediatric population
- However, there are only 2 small studies that include neonates and premature infants
- Current literature: 2 reports in infants (5 premature infants, 5 patients – 1 premature and 4 pediatric infants)

Safety of Pure Hypochlorous Acid-Based Cleansers in Premature Infants (Submitted for Publication 2025)

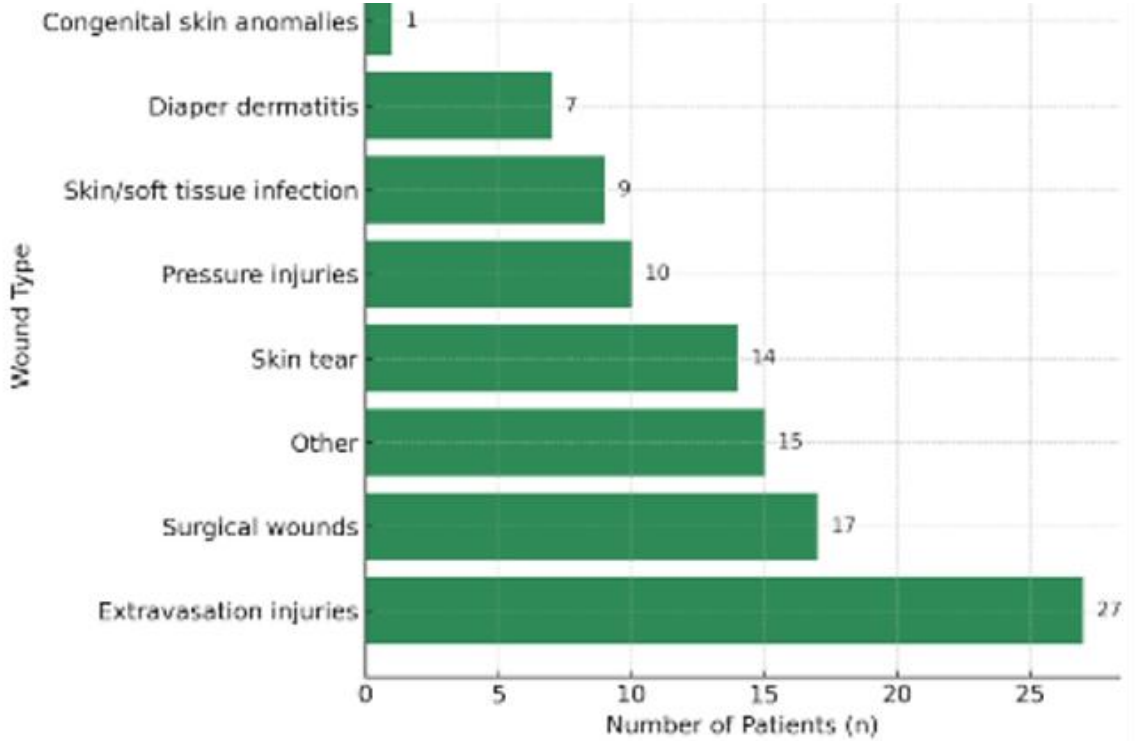
- 100 Patient Evaluation
- Hospitalized infants <12months of age
- 766 cumulative applications
- Largest documented study to date evaluating the safety of pHA in preterm infants and neonates with complex wounds



Gestational Age Distribution of Patients



Wound Type Distribution of Patients



Outcomes Measures

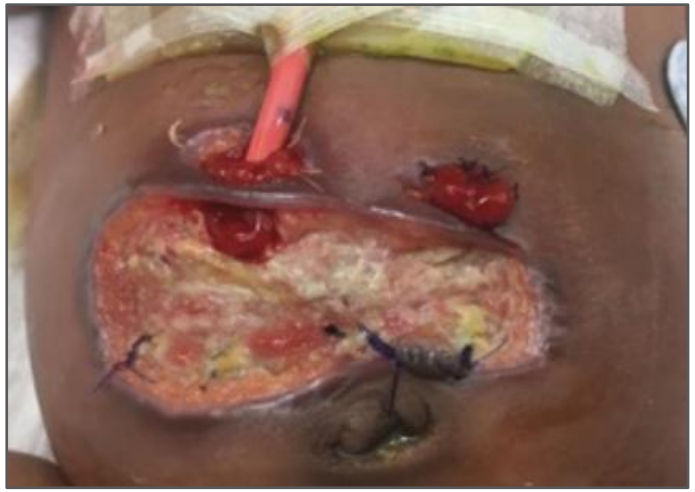
Adverse Effect Evaluated	Number of Patients Identified with Adverse Effect
Contact Dermatitis	0/100
Erosive Skin Injury	0/100
Wound Infection	0/100
Increase in Wound Size	0/100
Other Signs of Wound Worsening	0/100

- No pHA-related skin injuries were identified
- pHA was well tolerated across all patients, including those receiving concurrent therapies and treatments

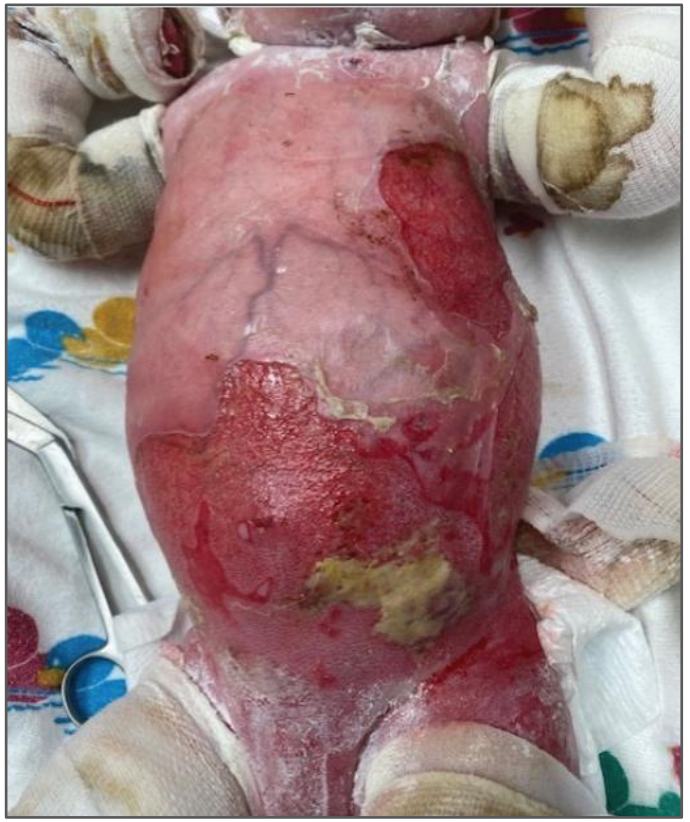
Healing without Harm: Study Findings

pHA was safely applied to wounds in infants as early as **21 wks gestation** across a broad spectrum of wound types with **zero identified adverse effects**.

23-wk gestation infant with skin tears



Abdominal surgical wound



Newborn with epidermolysis bullosa (EB)

EB = epidermolysis bullosa.

Summary: pHA in Pediatric and Infants

- Managing wounds in preterm infants is particularly challenging due to the immaturity of both the skin barrier and immune defenses
- Current therapeutic options are limited: while normal saline is widely used for its perceived safety, it provides little cleansing or bioburden-reducing effect
- Conversely, povidone–iodine, chlorhexidine, and sodium hypochlorite–based solutions are potent surface disinfectants but have demonstrated cytotoxicity in open wounds in addition to adverse outcomes, including delayed healing, chemical burns, thyroid suppression with iodine, and skin necrosis with chlorhexidine in preterm infants

Summary: pHA in Pediatric and Infants

- Within this context of limited safe disinfectant options in infants, the absence of adverse reactions in our cohort suggests that pHA may represent a clinically meaningful alternative to saline and cytotoxic disinfectants as wound/skin cleanser
- By extending these safety findings from adult patients to preterm and neonatal patients — whose skin barrier and immune function differ substantially — this series helps fill an important evidence gap
- Taken together, this study provides novel evidence supporting the safety of pHA in fragile neonatal populations where alternative cleansing options are limited
- This study sets the foundation for future studies to include the role of pHA in decolonization of infants with MRSA or MDR bacteria (2026)

The Role of Negatively-Charged Fiber Technology in Healing Chronic Wounds

Sujay Dutta, MD, MS

Infectious Diseases and Wound Care Physician
Center for Advanced Wound Healing
Private Practice
Thousand Oaks, CA

Goals of Effective Dressings

Remove	Remove the factors that promote chronic inflammation
Disrupt	Disrupt biofilm and prevent new biofilm formation
Inhibit	Inhibit the growth of microbes that create chronic inflammation and infection
Break down and remove	Break down and remove slough
Remove	Remove exudate
Restore	RESTORE pH TO A MORE ACIDIC STATE, (pH 4.0-6.0) away from the alkaline state of non-healing wounds

The Bed of Chronic Wound Complex

- Contain both positively and negatively charged components
- Bacteria themselves have a net negative charge, but are surrounded by positively charged ions
- Membrane-type matrix metalloproteinases (MT-MMPs) use metal cations
- Neutrophils and macrophages use cations to generate reactive oxygen species (ROS)
- Glycosaminoglycans (GAGs—negatively charged) bind to cationic proteases and chemokines

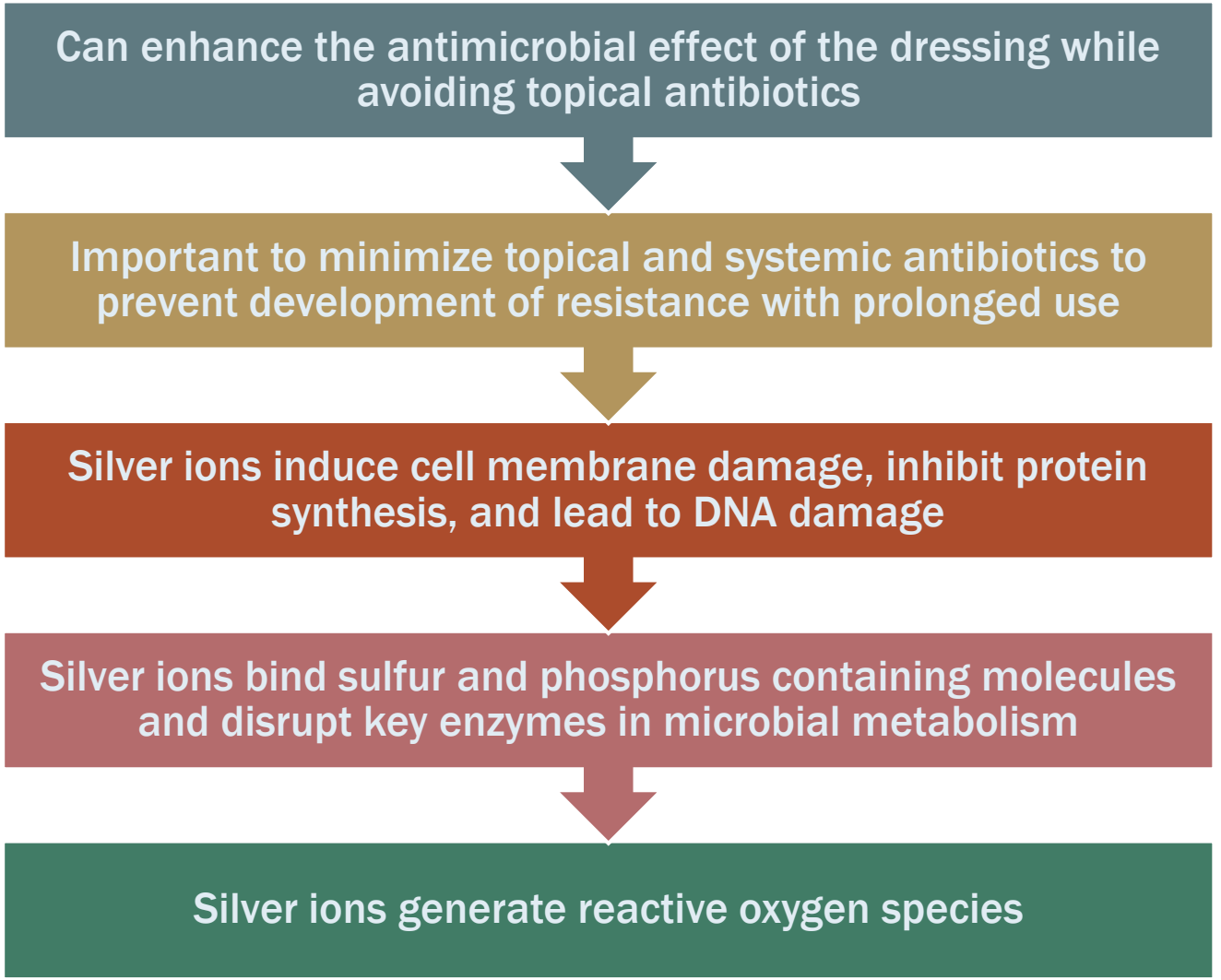
MT=MMP = membrane-type matrix metalloproteinases; ROS = reactive oxygen species; GAG = glycosaminoglycans.

Negatively-Charged Fibers Suppress Inflammation

- Bind and inactivate MMPs
- Inactivate ROS by binding active cations
- Interleukin-8 (IL-8): key neutrophil chemokine — found in excess levels in chronic wounds
- Monocyte chemoattractant protein-1 (MCP-1) — attracts monocytes and macrophages — excess levels perpetuate chronic inflammation
- Positively-charged dressings (eg, PHMB) can bind bacteria (negative charge) but may induce inflammation

IL-8 = interleukin-8; MCP-1 = monocyte chemoattractant protein-1; PHMB = polyhexamethylene biguianide.

Combining Negatively-Charged Fibers with Silver Ions



Combining Silver/Negatively-Charged Fiber Technology with HOCl

- pHA in combination with silver/negatively-charged fiber dressings works synergistically
- HOCl provides broad-spectrum antimicrobial effect vs bacteria, fungi, viruses without antibiotics
- Silver is also antimicrobial
- Negatively-charged fibers mechanically remove slough and exudate by binding key components
- HOCl and negatively-charged fibers reduce chronic inflammation (down regulates MMPs and cytokines)
- Both actively debride the chronic wound bed with minimal cytotoxicity

Summary

- Negatively-charged fiber dressings mechanically remove slough (dead cells) and components of exudate (MMPs, pro-inflammatory cytokines, positive cations used to generate ROS)
- Help to restore a more favorable acidic pH
- Can be combined with silver ions to enhance antimicrobial effect by disrupting bacterial and cell membranes, metabolism, and DNA
- Can be used in synergy with pure HOCl and mechanical forms of debridement
- Minimize toxicity to healing

Questions?

Thank You!