

Multidisciplinary Approaches to Wound Bed Preparation:

Bridging Wound Healing and The Reconstruction Ladder

Supported by an educational grant from Urgo Medical North America

Faculty

- **Abigail E. Chaffin, MD, FACS, CWSP, MAPWCA**
Professor and Chief, Division of Plastic Surgery, Tulane University
Medical Director, MedCentris Wound Healing Institute (Metairie, LA)
New Orleans, LA
- **Kara Couch, MS, CRNP, CWCN-AP, FAWC**
Director, Wound Care Services, George Washington University Hospital
Associate Research Professor of Surgery, School of Medicine and Health Sciences,
George Washington University
Washington, D.C.
- **Michael N. Desvigne, MD, FACS, CWS, FACCWS, MAPWCA**
Plastic and Reconstructive Surgery, Wound Care and Hyperbaric Medicine
Abrazo Arrowhead Hospital and Wound Clinic
Glendale, AZ

Faculty Disclosures

- **Abigail E. Chaffin, MD, FACS, CWSP, MAPWCA**
Consultant, Speakers Bureau: Aroa Biosurgery; Urgo Medical North America
- **Kara Couch, MS, CRNP, CWCN-AP, FAAWC**
Consultant, Speakers Bureau: Integra LifeSciences; Organogenesis Inc.; Reaplix; Solventum, Medical Surgical Business; Urgo Medical North America
- **Michael N. Desvigne, MD, FACS, CWS, FACCWS, MAPWCA**
Consultant, Speakers Bureau: Aroa Biosurgery; Integra LifeSciences; MolecuLight; MTF Biologics; Smith & Nephew; Urgo Medical North America
Advisory Board, Consultant, Speakers Bureau: Sanara MedTech; Solventum, Medical Surgical Business

Disclosures

- 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
- This continuing medical education activity may include device or medicine brand names for participant clarity purposes only. Product promotion or recommendation should not be inferred.

Learning Objectives

- Define wound bed preparation and explain its role in the wound healing process
- Explain how clinicians can benefit from maintaining a clean wound bed between episodes of sharp surgical debridement, and, in some cases, facilitating wound closure without the need for sharp debridement
- Examine how wound bed preparation – utilizing specialized cleansers and advanced slough-removal technologies – contributes to optimizing use of the reconstructive ladder
- Explore case studies that illustrate the multidisciplinary application of wound bed preparation across diverse clinical settings, healing wounds without needless climbing of the reconstructive ladder to get to healing

The Role of Integral Debridement in the Wound Healing Process

Kara Couch, MS, CRNP, CWCN-AP, FAAWC

Director, Wound Care Services, George Washington University Hospital
Associate Research Professor of Surgery, School of Medicine and Health
Sciences, George Washington University
Washington, D.C.



What Is a Complex Wound?

Simply put, it's a wound on a complex patient.

Other terms used are

Chronic

Hard to heal



What Is a Complex Wound?

Simply put, it's a wound on a complex patient.

Other terms used are

Chronic

Hard to heal

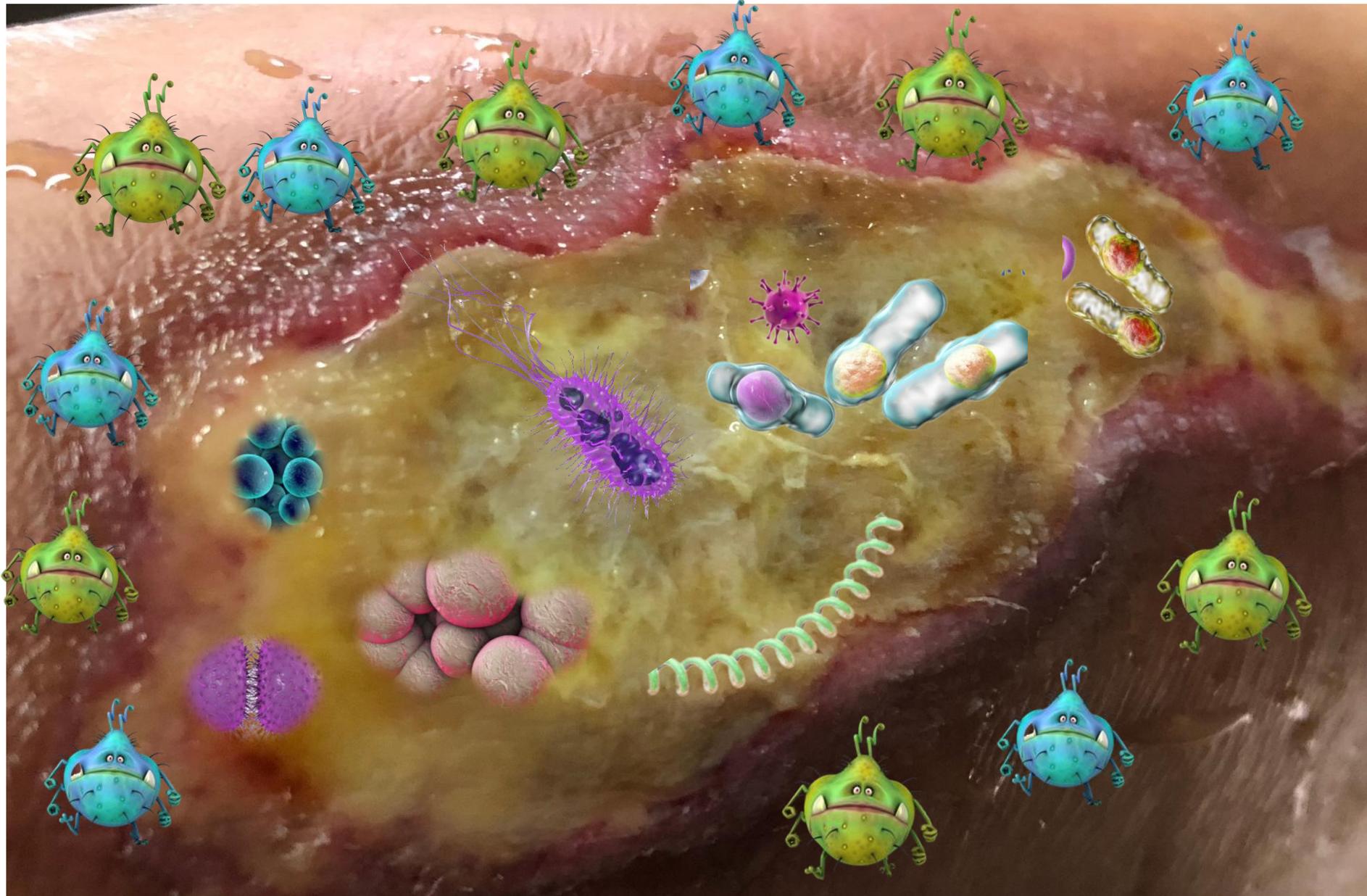
Hard to Heal Wounds – Wounds With Barriers

- Patient barriers that can be managed or at least mitigated
 - Access to the right care
 - Establish the right diagnosis
 - Improved nutrition
 - Improved glucose management
 - Improve perfusion
- Wound barriers are present that can be overcome
 - Uncontrolled or under-addressed etiology
 - Unhealthy tissue
 - Bacterial bioburden
 - Proteases
 - Edema
 - pH



Shutterstock

Necrotic Tissue Is a Buffet for Bacteria



What Is Debridement, and Why Is It Important?

Definition

- The removal of viable (living) and non-viable components, including necrotic tissue, slough microorganisms, biofilm, extracellular polymeric substance (EPS), and foreign materials

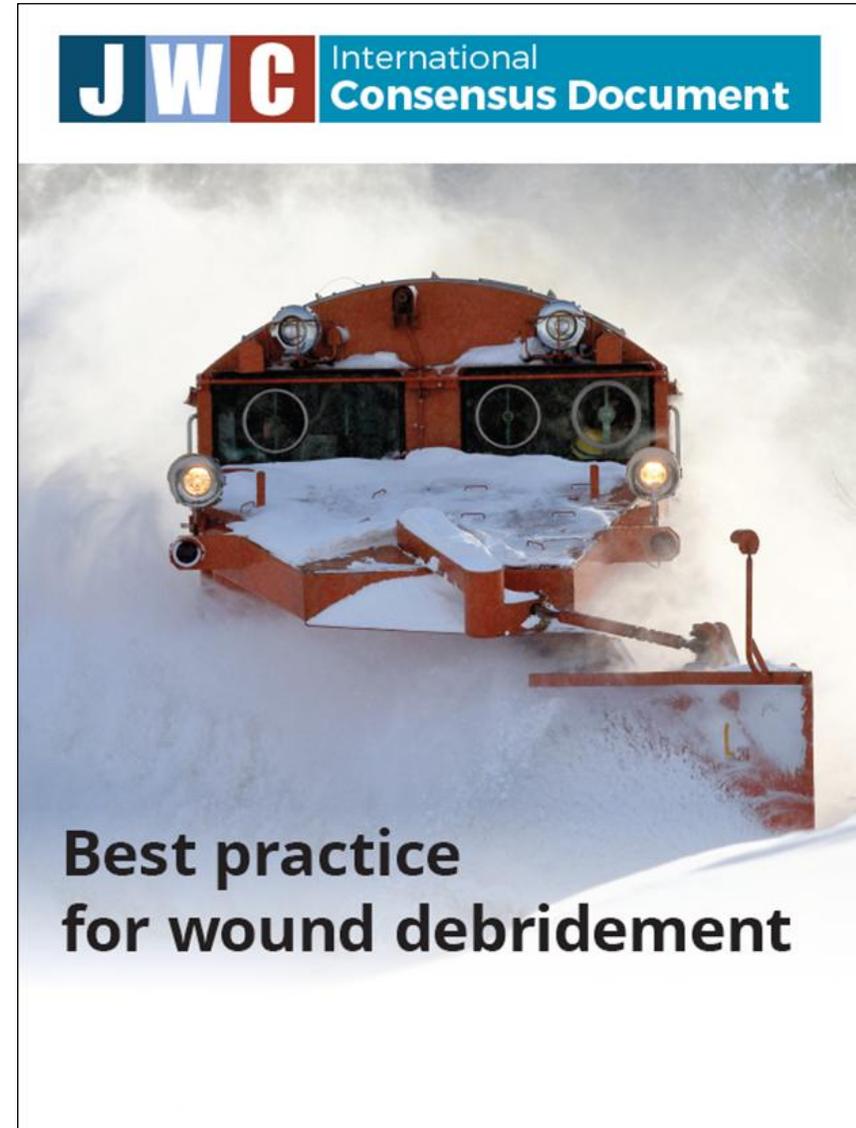
Goals

- Remove/reduce the presence of both microbial and non-microbial components using the most effective methods with the fewest side effects
- Promote growth of new tissue, reduce inflammation in the wound bed, improve effectiveness of topical treatments, and reduce risk of infection

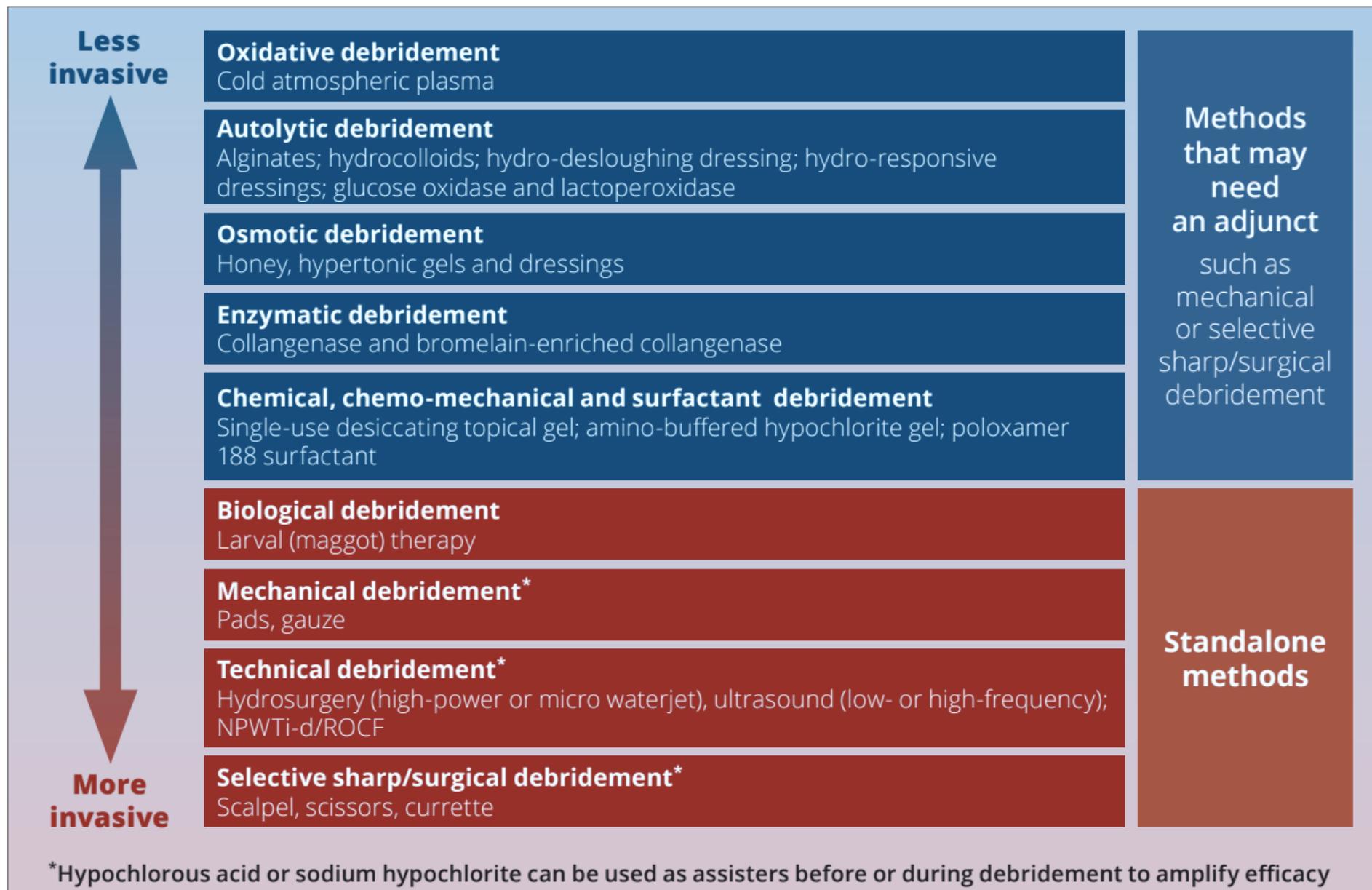
EPS = extracellular polymeric substance.

Best Practice for Wound Debridement. *J Wound Care*. 2024;33(6):Sup C.

Slide courtesy of Terry Swanson NP, FAWMA, FMACNP



Methods of Debridement



Surgical vs Selective Sharp Debridement

Table 2. Standalone debridement methods

Method	Example	Mechanism of Action	Key Indications	WBP	Referral
Selective Sharp**	Scalpel, scissors, or curette	Selective cutting away of devitalized tissue to promote wound healing and prevent infection while avoiding the excision of viable tissue	May be used for most wound types and in combination with gentler debridement methods to accelerate debridement. Wounds with a solid layer of necrotic tissue, slough, biofilm, or eschar, often when the devitalized tissue is starting to separate from healthy tissue	Not needed	See note*; wounds in challenging anatomical locations
Surgical**	Scalpel, scissors, or curette	Complete removal of necrotic tissue, slough, or eschar using precise incisions while excising into viable tissue where bleeding is observed	Extensive necrotic tissue, loose or adherent devitalized tissue, involvement of deep structures, biofilm, or complications, such as damage to blood vessels. When other methods of debridement have been ineffective or when immediate reconstruction is required. Wounds in functionally and cosmetically important areas, such as the face, hands, perineum, and feet. Often needed as an adjunct for gentler debridement methods.	Not needed	Specialist procedures

Note: *Refer in extensive, deep wounds, exposed tendon or bone, chronic venous insufficiency, clinical signs of deep or systemic infection, worsening wound or no progress after 2-4 wks of treatment; **HOCl or NaClO can be used as assisters before or during debridement to amplify efficacy; DFU, diabetic foot ulcer; NPWTi-d with ROCF, negative pressure wound therapy and instillation with dwell time with reticulated open-cell foam; WBP, wound bed preparation.

Factors that Influence Choice of Debridement Method

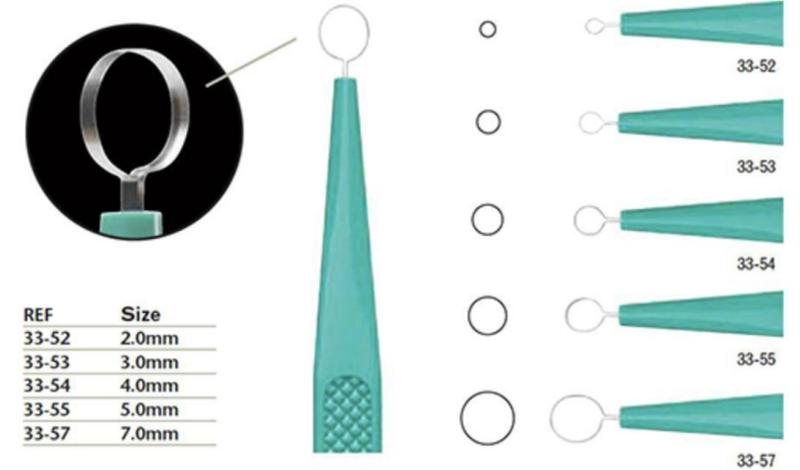
- Clinical need
- Clinical experience and competency
- How quickly devitalized tissue needs to be removed
- Level of inflammation
- Local access
- Patient age and level of health

- Patient perspective
- Presence of infection
- Risk of exposing non-tissue structures
- Treatment objectives
- Treatment setting
- Wound depth and type



Selective Sharp Debridement

- Commonly performed in outpatient setting as part of routine wound care
- **Confined to non-viable tissue**, so low blood loss is anticipated
- If patient has bleeding tendencies, appropriate precautions are taken
- Identify and manage procedural pain
- Skilled healthcare professional with necessary competency
- Equipment: Sterile scissors, curette, scalpel, and forceps
- Cleanse before and after



Surgical Debridement

- Performed in operating room, designated procedure room, or bedside in post-acute settings
- Completed by a surgeon or trained wound care professional
- **Excision into viable tissue**
- Can include full-thickness wounds with extensive necrotic tissue, deep structures, or complex patients requiring debridement
- **Requires anesthesia** (depending on the patient and setting)



After Surgical Debridement... Now What?



J Wound Care. 2024;33(6):SUP C.

New Concept: Integral Debridement

Consensus statement: This consensus document proposes a new approach referred to as integral debridement, which the authors define as 'the combined use of different but complementary methods of debridement on the same wound'.

Adjunctive Therapies/Assisters (Amplifiers) for Debridement

Method	Example	Mechanism of Action	Key Indications	WBP	Referral
Oxidative	Cold atmospheric plasma	Oxidizing agents that break down biological structures in bacteria, yeast, and fungi, as well as non-microbial components including cytokines and proteases, or generate ROS and nitric oxide to remove devitalized tissue and reduce bioburden	Infected wounds	Needed	See note*
Autolytic	Alginates; hydrocolloids; hydro-desloughing wound dressings; hydro-responsive wound dressings; glucose oxidase and lactoperoxidase	Promotes moisture balance that facilitates the body's own breakdown of devitalized tissue	Moist wound types. When more effective debridement methods are not available or acceptable to patient; to avoid maceration, do not use on highly exuding wounds; best used as an adjunct with mechanical debridement; glucose oxidase and lactoperoxidase; hard-to-heal wounds	Not needed	See note*
Osmotic	Honey; hypertonic gels and dressings	Induction of hyperosmotic environment in wound bed; the hypertonic (excess) fluid helps soften and liquefy devitalized tissue, making it easier to remove	Pressure ulcers/injuries; DFUs; venous leg ulcers; highly exuding wounds; infected wounds; wounds with high bacterial burden	Not needed	See note*
Enzymatic	Collagenase and bromelain-enriched collagenase	Specific enzymes break down devitalized tissue	Neuroischemic DFUs, hard-to-heal wounds; bromelain; burns	Not needed	See note*
Chemical	Single-use topical gel with desiccating properties	Desiccation of devitalized tissue and biofilm, which sloughs off in 1-5 days	Most wound types	Needed	See note*
Chemo-mechanical	Amino-buffered hypochlorite gel	Special sodium hypochlorite gel creates a highly alkaline and oxidative environment that kills pathogens and biofilm; application time is 2-5 min and primary function is to remove or soften tissue	DFUs and leg ulcers	Needed	See note*
Surfactant	Poloxamer 188 (pluronic F68), non-ionic, amphiphilic surfactant	Hydrophilic surface attracts, softens devitalized tissue and debris, which is then trapped by the hydrophobic core; it is washed away with water or saline	Most wound types	Not needed	See note*

Note: *Refer in extensive, deep wounds, exposed tendon or bone, chronic venous insufficiency, clinical signs of deep or systemic infection, worsening wound, or no progress after 2-4 wks of treatment

Adjunctive Therapies/Assisters (Amplifiers) for Debridement

Method	Example	Mechanism of Action	Key Indications	WBP	Referral
Hypochlorous acid (HOCl)	Stabilized solutions or gels	Mechanical disturbing of devitalized tissue and microbes during irrigation or in conjunction with mechanical debridement	Assists mechanical debridement in wounds with high bacterial burden	Needed	See note*
Sodium hypochlorite (NaClO)					

Note: *Refer in extensive, deep wounds, exposed tendon or bone, chronic venous insufficiency, clinical signs of deep or systemic infection, worsening wound or no progress after 2-4 wks of treatment.

HOCl-Based Cleanser: Assister/Amplifier of Mechanical Debridement

- Mechanical disruption of devitalized tissue and microbes during irrigation or in conjunction with mechanical debridement

Table 3. Summary of assisters (amplifiers) of various debridement methods

Method	Example	Mechanism of Action	Key Indications	WBP	Referral
Hypochlorous acid (HOCl)	Stabilized solutions or gels	Mechanical disturbing of devitalized tissue and microbes during irrigation or in conjunction with mechanical debridement	Assists mechanical debridement in wounds with high bacterial burden	Needed	See note*
Sodium hypochlorite (NaClO)					

Note: *Refer in extensive, deep wounds, exposed tendon or bone, chronic venous insufficiency, clinical signs of deep or systemic infection, worsening wound or no progress after 2-4 wks of treatment.

Slough

Complex mixture of

- Exudate proteins
- Degraded extracellular matrix (ECM) proteins
- WBC
- Planktonic microorganisms
- Biofilm microorganisms

- Common occurrence in hard-to-heal wounds
- May **impair healing**



Slough

Loose slough

- Lightly adherent to wound bed
- Yellow or tan
- Usually easily removed from wound bed
- Dead cells, debris, fibrin

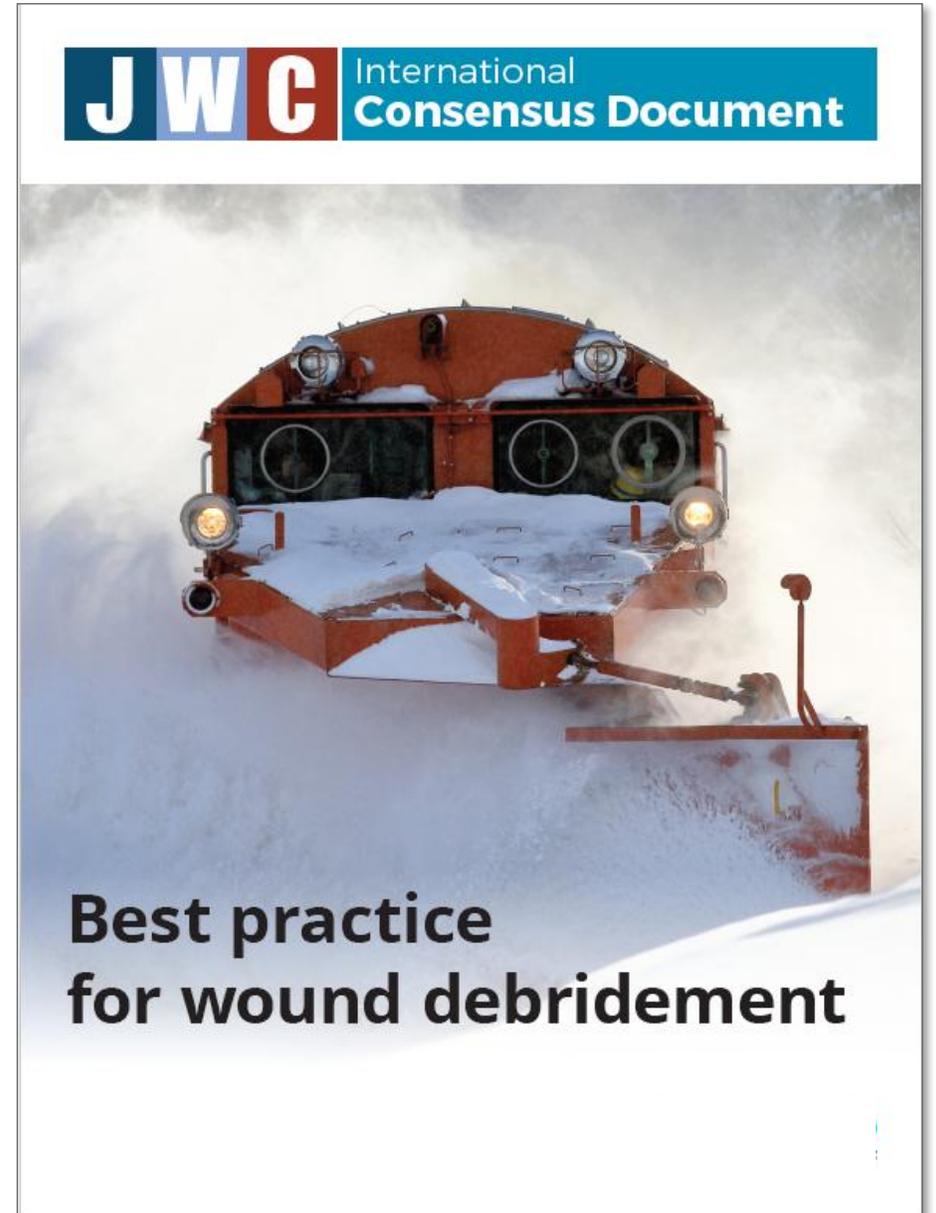
Adherent slough: **PRO-INFLAMMATORY**

- Layer of devitalized tissue tightly adherent to wound bed
- More challenging to remove
- Fibers, degraded ECM proteins, exudate, WBC, bacteria



Recently Published Data

- Dieter Mayer, et al. *J Wound Care*
- HOCl can be used to **assist (amplify)** various standalone debridement methods, such as mechanical debridement, selective sharp/surgical debridement, and technical methods, including NPWTi-d with ROCF
- Its properties enable it to remove germs and debris in a way that differentiates it from saline
- **SYNERGISTIC technology** with other forms of debridement



Integral Debridement

- Emphasizes importance of **tailoring debridement methods to individual patient needs**, preferences and environments, local resources, skill levels of different caregivers/clinicians
- DIFFERENT CARE SETTINGS MAY REQUIRE DIFFERENT APPROACHES
- Health professional's level of training may limit scope of practice
- CONSIDER the clinical context and patient perspectives when selecting the appropriate debridement method
- Ensures that debridement care is not only **effective** but also **aligned with the unique needs and goals of each patient**

NPWT and Instillation (NPWTi) with HOCl

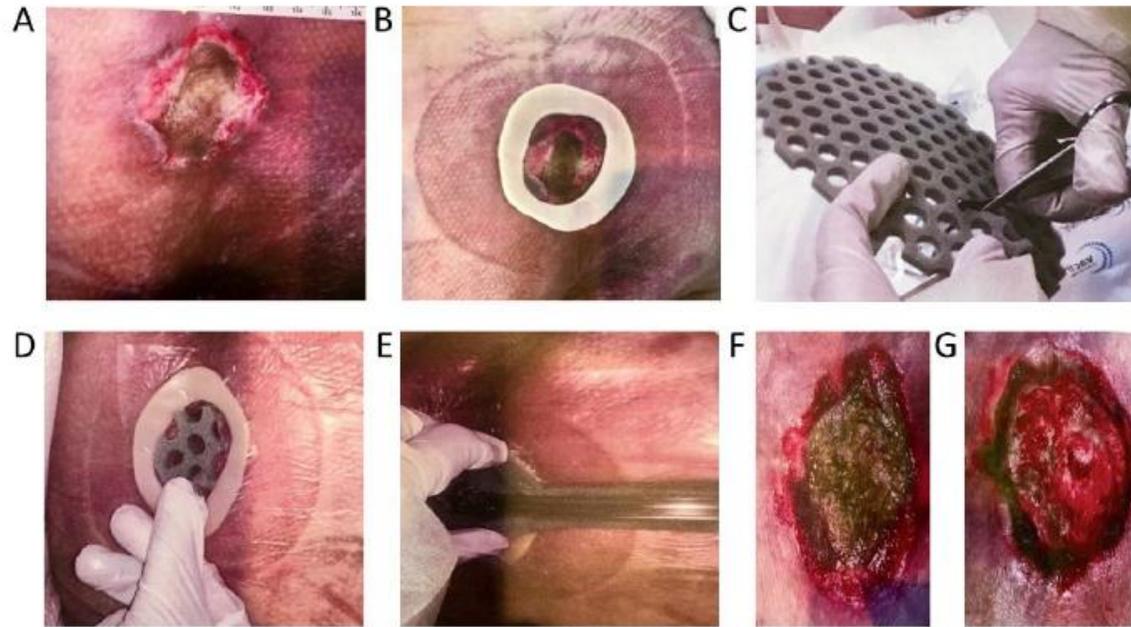


Figure 2: Wound management of coccyx pressure ulcer. A) Wound at presentation. B) Protected wound edges. C) ROCF-CC contact layer cut to fit wound. D) ROCF-CC contact layer applied to wound. E) Dressing applied and NPWTi-d initiated. F) Wound appearance after 3 days of NPWTi-d. G) Wound appearance after 6 days of NPWTi-d.

 **Journal of Trauma & Treatment**
Fernandez et al. J Trauma Treat 2017, 6:5
DOI: 10.4172/2167-1222.1000410

Case Report Open Access

Initial Experience Using a Novel Reticulated Open Cell Foam Dressing with Through Holes during Negative Pressure Wound Therapy with Instillation for Management of Pressure Ulcers

Luis Fernandez*, Cynthia Eliman and Patricia Jackson
Trauma Surgical Critical Care Unit, Trinity Mother Frances Health System, TX, USA

*Corresponding author: Luis Fernandez, Associate Trauma Medical Director and Chief of Trauma Surgical Critical Care Unit, Trinity Mother Frances Health System, 910 East Houston St Suite 530, Tyler TX 75702, USA, Tel: +903(593-8441); E-mail: mbeigkahuna115@gmail.com

Rec date: December 11, 2017; Acc date: December 21, 2017; Pub date: December 23, 2017

Copyright: © 2017 Fernandez L, et al. This is an open-access article distributed under the terms of the creative commons attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Abstract

Several published reviews and recommendations exist for the use of negative pressure wound therapy (NPWT) with instillation and a dwell time (NPWTi-d) in acute and chronic wounds. Specific dressings for use with NPWTi-d have also been developed, including a reticulated open cell foam dressing with through holes (ROCF-CC) that assists in removing thick wound exudate and infectious materials. ROCF-CC is especially helpful for wound cleansing when debridement is not possible or appropriate in patients.

We report our initial experiences in using NPWTi-d with ROCF-CC in patients with pressure ulcers. An algorithmic approach was used to determine appropriate treatment to reach the goals of therapy (i.e., wound bed preparation, granulation tissue formation, and removal of infectious materials). Previous therapies included honey and gauze soaked in Dakin's solution. All patients received antibiotics and debridement when possible.

Five patients (3 females and 2 males) received NPWTi-d with ROCF-CC (instillation of saline or a hypochlorous solution with a dwell time of 10 minutes, followed by 2-3 hours of -125 mmHg NPWT). Patient comorbidities included obesity, diabetes mellitus, hypertension, and peripheral artery disease. Mean age of patients was 65.2 years (range: 50-82 years). After an average of 6 days of therapy (range 2-9 days), all wounds treated with NPWTi-d with ROCF-CC showed rapid granulation tissue formation.

We also noted improved removal of devitalized tissue and subsequent granulation tissue formation in patients receiving hypochlorous solution compared to patients receiving saline during NPWTi-d with ROCF-CC. All patients were eventually transferred to a skilled nursing facility. In our clinical practice, NPWTi-d with ROCF-CC provided effective and rapid removal of the thick exudate and infectious materials and promoted excellent development of underlying granulation tissue.

Keywords: Negative pressure wound therapy; Instillation; Thick exudate; Devitalized tissue; Wound cleansing

hypoxia-inducible factor-1), which has also been shown to increase the rate of re-epithelialization [3-5].

Introduction

Pressure ulcers (PrUs) are challenging complex wounds that develop due to localized injuries to the skin, particularly over bony prominences, because of pressure or when pressure is combined with shear and/or friction [1]. Although the definition and staging of PrUs was recently redefined by the National Pressure Ulcer Advisory Panel (NPUAP) in 2016 [2], there is still much debate regarding these changes among the healthcare community.

In our institution, high-risk operative patients with complex chronic wounds, such as PrUs, have been treated with a variety of dressings. Traditional dry/moist gauze wound dressings, low adherent dressings, and semipermeable films mitigate against fluid and environmental microbial penetration but allow the egress of air and water vapor. Moist occlusive dressing have been utilized, as these dressings support the inflammatory phase by creating a low oxygen tension environment (thereby increasing angiogenesis, iron metabolism, glucose metabolism, cell proliferation/survival and activating factors such as

Hydrocolloids and hydrogels have also been used in our institution. Under the appropriate setting, these dressings absorb a certain amount of exudate but keep a moist environment; hydrocolloids are impermeable to air and are long-lasting but do not function well in exudative wounds. In a dry wound environment, hydrogels may be used to help promote moisture in the wound.

For highly exudative wounds, alginate dressings (a seaweed-derived non-woven fiber dressing) are typically used because of their ability to absorb copious amounts of fluid. We have also used autolytic debridement in wounds with a moist wound environment; however, this form of therapy is not capable of removing devitalized tissue as well as surgical debridement and is not an adequate replacement for sharp surgical debridement [6-8].

Negative pressure wound therapy (NPWT) is commonly used for the management of both acute and chronic complex wounds at our institution. This therapy has typically been associated with higher costs; however, several studies have shown an overall savings in direct and indirect costs, in a large part due to decreases in operating room

J Trauma Treat, an open access journal
ISSN: 2167-1222

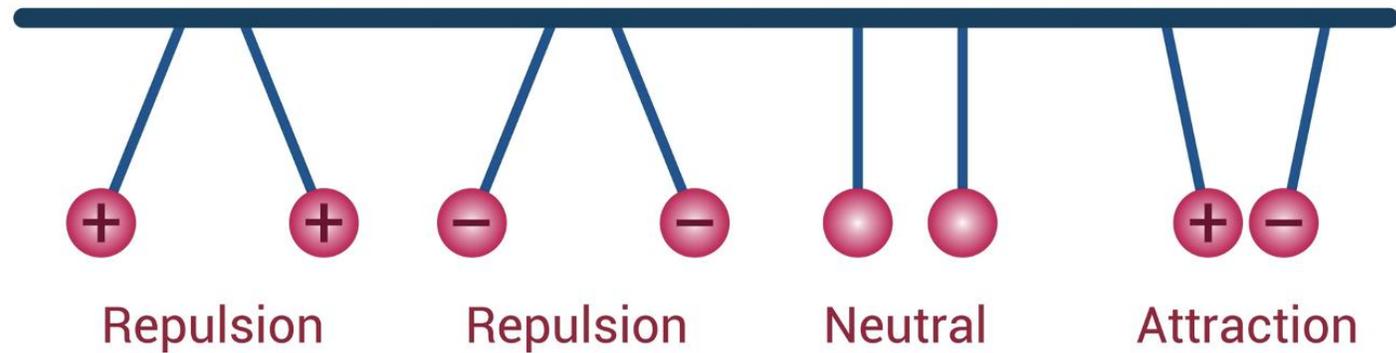
Volume 6 • Issue 5 • 1000410

Laws of Charges

Opposites Attract

Works by electrostatic interactions

Laws of attraction and repulsion



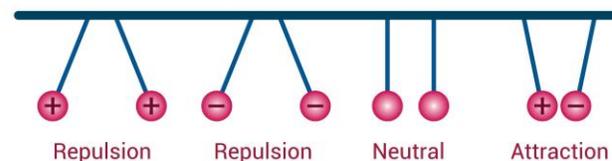
How Do Charged Fibers Work in Supporting Autolytic Debridement?

Biomaterial-absorbent devices behave in predictable ways within the complex wound environment

- Steric exclusion
- Hydrophobic interactions
- Hydrogen bonds

During autolytic debridement, negatively charged fibers are highly attracted to positively charged fibers in slough

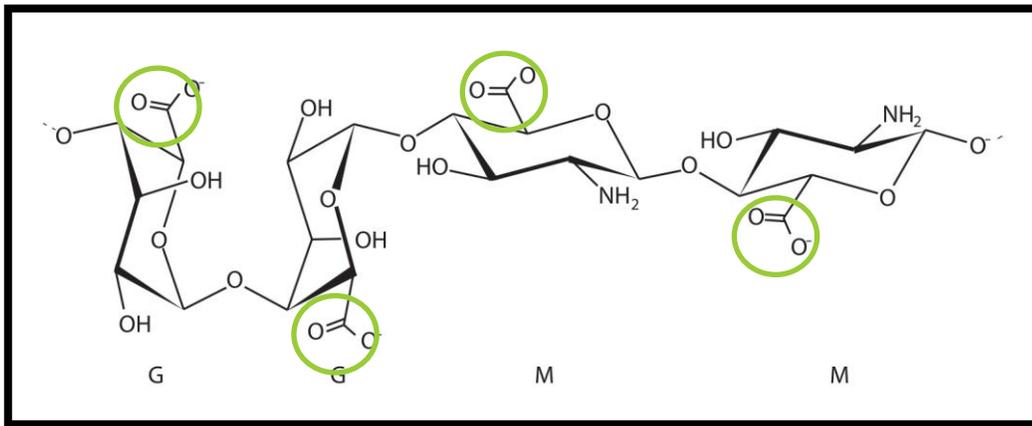
Laws of attraction and repulsion



Let's Compare Other Dressings

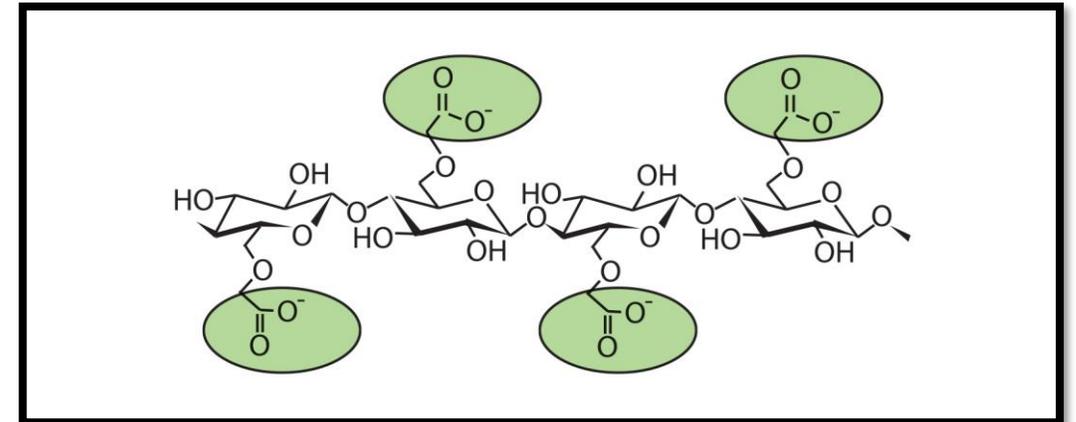
Alginate:

Negative charges are far apart

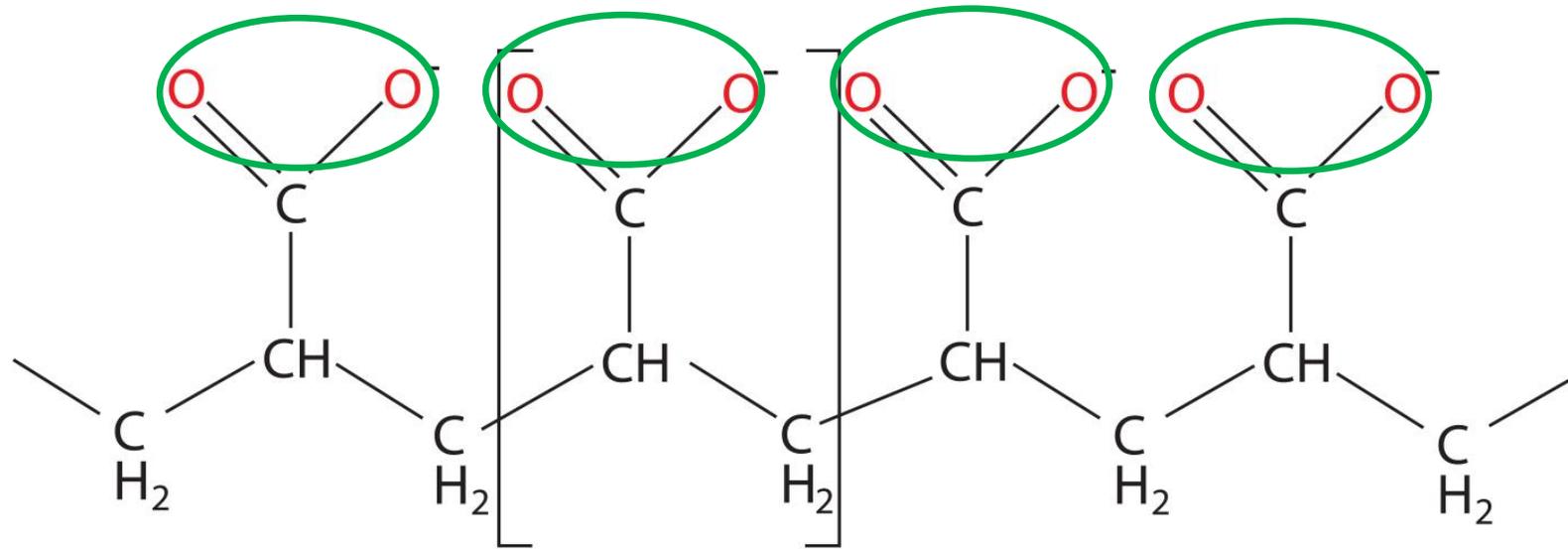


Carboxymethylcellulose (CMC):

Negative charges are far apart



NCF Dressings Negative Charges are VERY CLOSE

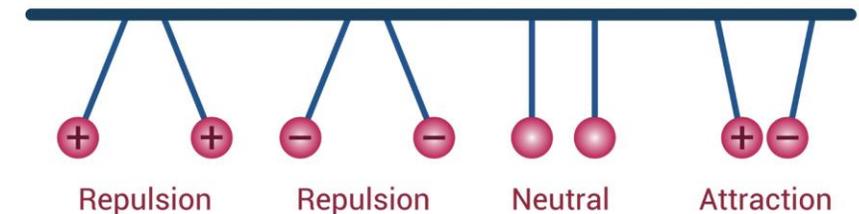


Negatively Charged Fiber (NCF) Technology Dressing

- Absorbent fiber dressing with TLC-Ag matrix
- Lipido-colloid technology with silver salts
- Cleaning action plus antimicrobial barrier protection
- **HOCl can increase positive charge of slough,** amplifying effectiveness of the negatively charged dressing to remove slough

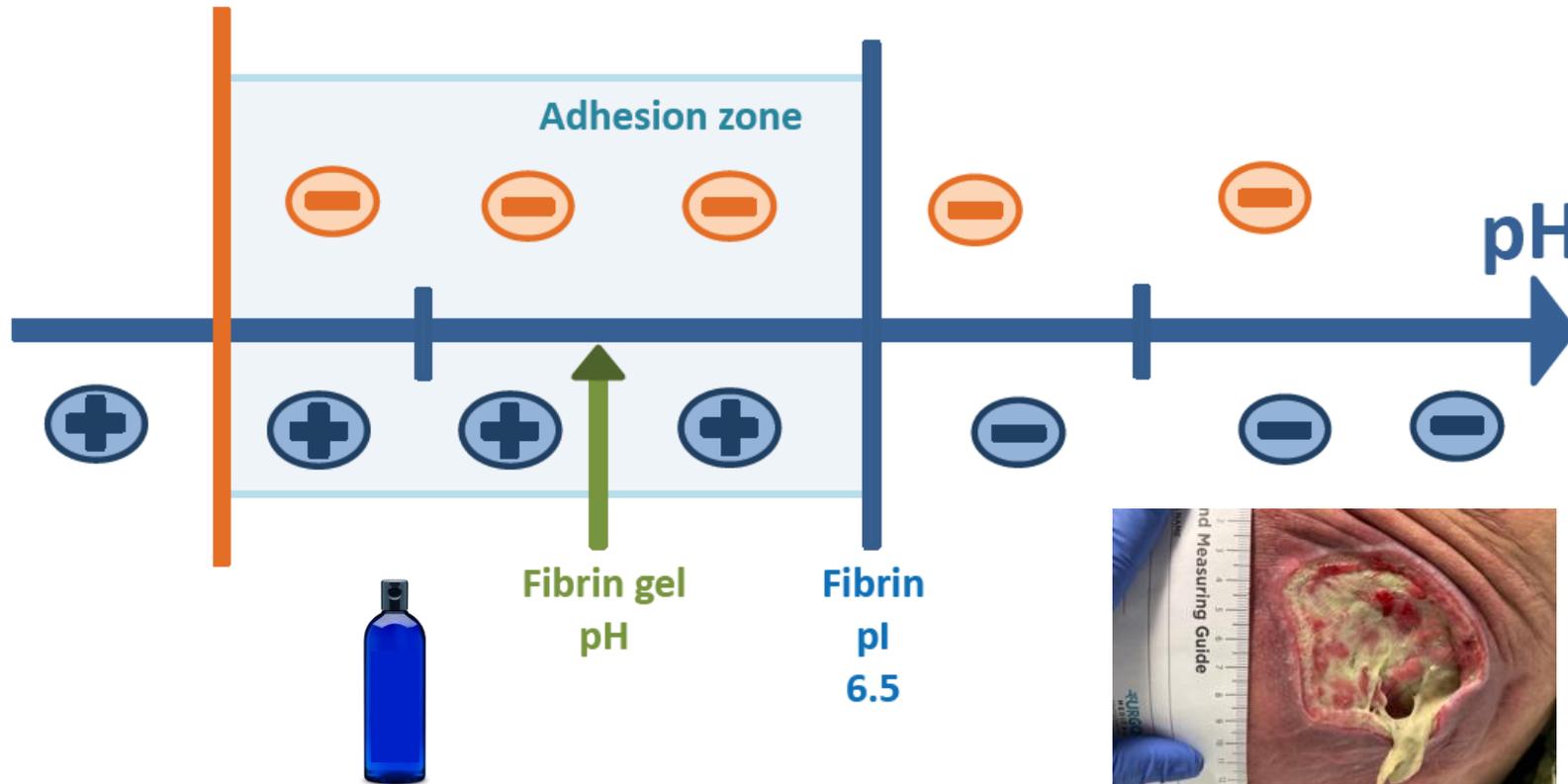


Laws of attraction and repulsion



How pH and Chemistry Play into Healing Wounds

Poly-absorbent fibres pKA



Cases

Case: Sacral Pressure Injury

- 55y with chronic desmoid tumors, EC fistula, chronic pain, and malnutrition developed unstageable hospital-acquired pressure injury (HAPI) on the buttock 2/2 deconditioning
- Was having 2x/wk OR dressing changes of ECF. OR debridement of ulcer was planned, but improvement with NCF was too fast



Case: Right Leg Knee Burn

- 46y with T2DM and HIV kneeled on his deck during the summer while sealing it and didn't realize he was sustaining full-thickness burns
- Patient is severely neuropathic



Case: Left Leg Knee Burn

- Same patient, this is the other leg



Case: Chest Tube Non-Healing Wound

- 14y Male with Ewing's sarcoma developed wound from chest tube after rib resection
- Patient needed to start radiation therapy and was on chemo
- Mother tried collagenase ointment, honey, and hydrogel without success.



Case: Pyoderma Gangrenosum

- 39y Female with BRCA gene underwent preventive mastectomies bilaterally with immediate reconstruction using DIEP flaps
- Postop day 4: Fevers, chills
- Postop day 7: Redness, blistering along sternum, which grew progressively worse
- Saw plastics daily x2 days, started cefadroxil
- Admitted on postop day 10, biopsy showed pyoderma gangrenosum (PG)
- Started cyclosporine \approx 2 wks after symptoms started
- Wounds treated with HBO x30 dives; HOCl compresses daily and NCF covered with bordered silicone foam dressings
- Initial debridement at day 6 of NCF dressing

Case: Pyoderma Gangrenosum (Day of Admission)

- Cellulitis (superinfection)
- Treated with vancomycin, ceftriaxone, daptomycin
- PO doxycycline, cephalexin



Case: Pyoderma Gangrenosum



Case: Pyoderma Gangrenosum

- Rapid dissolution of slough and eschar
- Drainage contained with bordered foam dressings
- Started cyclosporine 5 days after admission when biopsy came back



Case: Pyoderma Gangrenosum – 2 Wks into Issue



Case: Pyoderma Gangrenosum - 2 Wks



Case: Pyoderma Gangrenosum – DIEP Donor Site

- Donor site for DIEP also broke down centrally
- Managed also with HOCl compresses, NCF, and bordered silicone foam dressings
- Changed 2x/wk



Case: Pyoderma Gangrenosum – 1 Month



Case: Pyoderma Gangrenosum – 6 Wks



Case: Pyoderma Gangrenosum - 2 Months



Integral Debridement



- 65y Male with venous insufficiency, lymphedema, multidrug-resistant (MDR) *Pseudomonas* colonization
- Extremely compliant with all treatments

Pre NCF: HOCl, Absorptive, Compression



11/21/23



11/28/23



12/5/23



12/12/23



12/19/23

+ NCF Aug. 2024



8/23/24



8/23/24



8/27/24



8/27/24

Nov. 2024



11/19/24



11/19/24



11/26/24



11/26/24

April 2025



4/8/25



4/8/25



4/15/25



4/15/25

Same Patient, Same Leg, Lateral



9/26/23



10/3/23



10/10/23



10/10/23

April 2024, Pre-NCF



4/2/24



4/9/24



4/16/24



4/23/24

Sept 2024: + NCF



9/3/24



9/10/24



9/10/24



9/10/24



9/17/24

April 2025



4/1/25



4/1/25



4/1/25



4/8/25



4/8/25

pHA Gel: Trauma Patient

5/28/2025



5/30/2025



6/4/2025



6/9/2025



pHA Gel: Road Rash to the Elbow



Day of injury: 8/8



4 days later: 8/12

Clinical Pearls

- Wound bed preparation is the standard of care we all need to be using
- HOCl is an excellent amplifier of debridement techniques
- Negatively charged fibers bind to the positive charge of slough and are very effective in maintaining the wound bed between dressing changes and provider evaluations

How Integral Debridement Contributes to Use of the Reconstructive Ladder

Abigail E. Chaffin, MD, FACS, CWSP, MAPWCA

Professor and Chief, Division of Plastic Surgery, Tulane University
Medical Director, MedCentris Wound Healing Institute (Metairie, LA)
New Orleans, LA

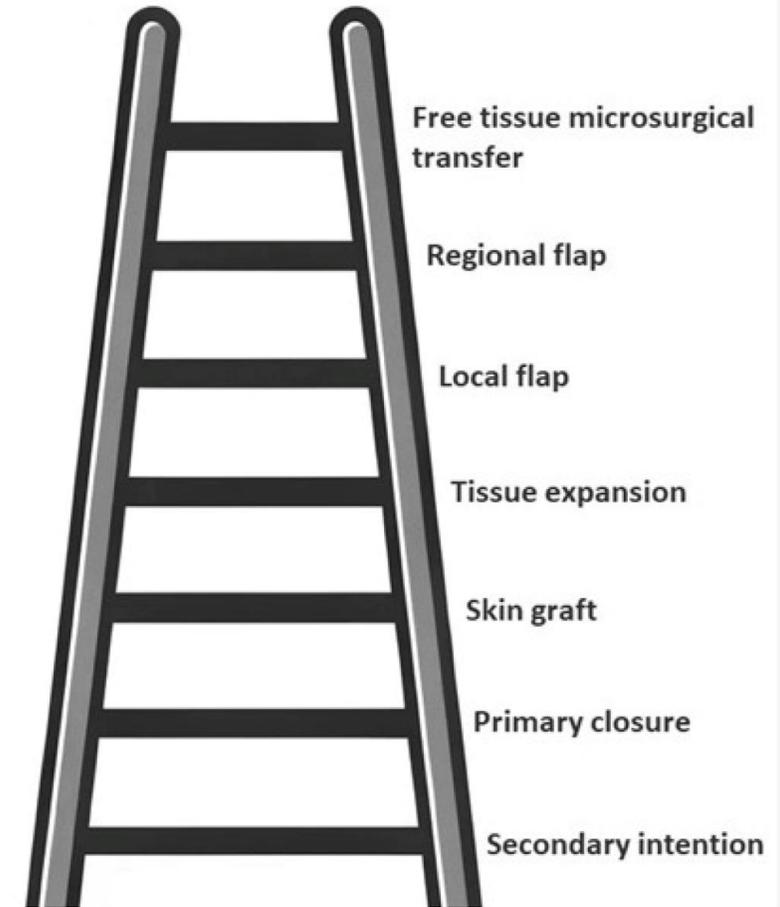
The Complex Wound Patient

- **A Growing Population:** An increasing number of patients present with complex wounds due to factors like diabetes, vascular disease, and aging
- **The Revolving Door of Care:** These patients often navigate a fragmented healthcare system, moving between home health, outpatient, acute care, and long-term care facilities
- **The Cost of Complexity:** Complex wounds are associated with significant morbidity, mortality, and staggering healthcare costs
- **Our Imperative:** To heal patients more rapidly, effectively, and with the least invasive means possible



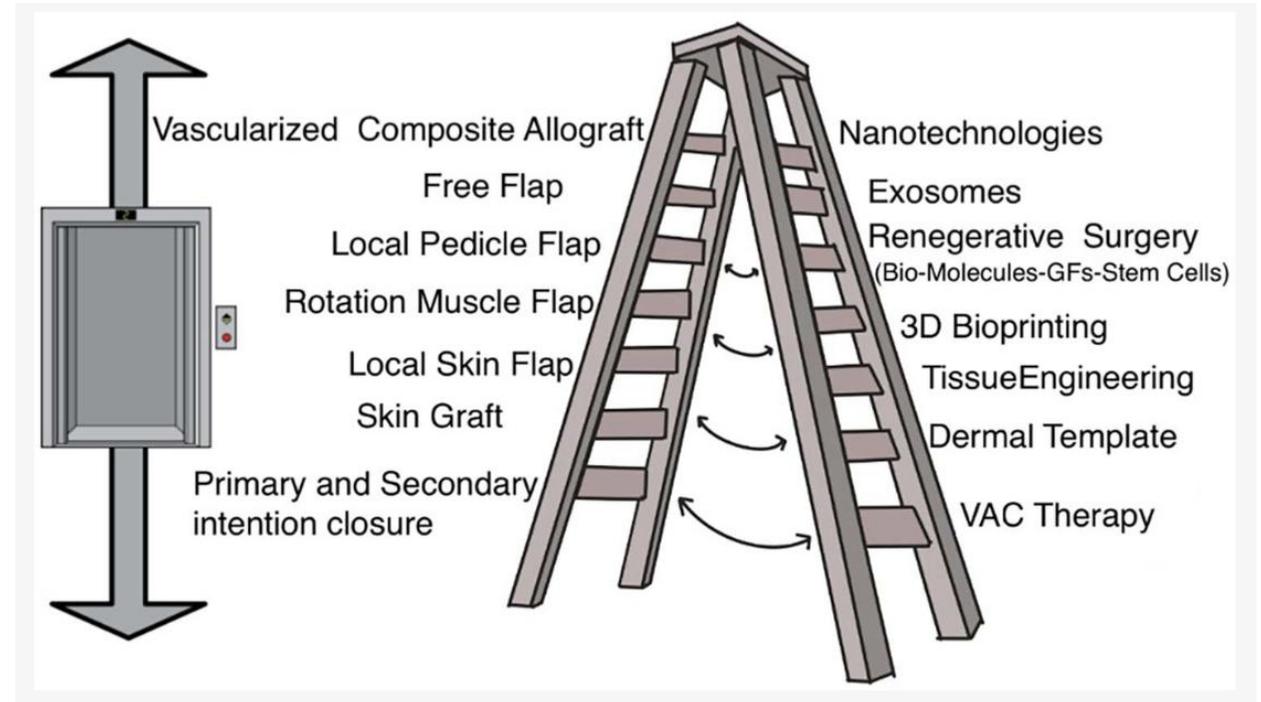
The Foundation: The Traditional Reconstructive Ladder

- **The Reconstructive Ladder:** A classic framework that organizes wound closure options from the simplest to the most complex
- **The principle is sound:** To start at the lowest appropriate rung. But is it the whole story?



A Paradigm Shift: The Amended Reconstructive Ladder of Wound Healing

- The modern approach isn't just about climbing the ladder; it's about **strengthening the rungs** to keep patients lower down
- Adjunctive technologies are not just steps on the ladder; they are the **tools that allow us to pause, and even descend, the ladder of complexity**
- These technologies empower a wider range of clinicians to contribute to optimal wound bed preparation and healing



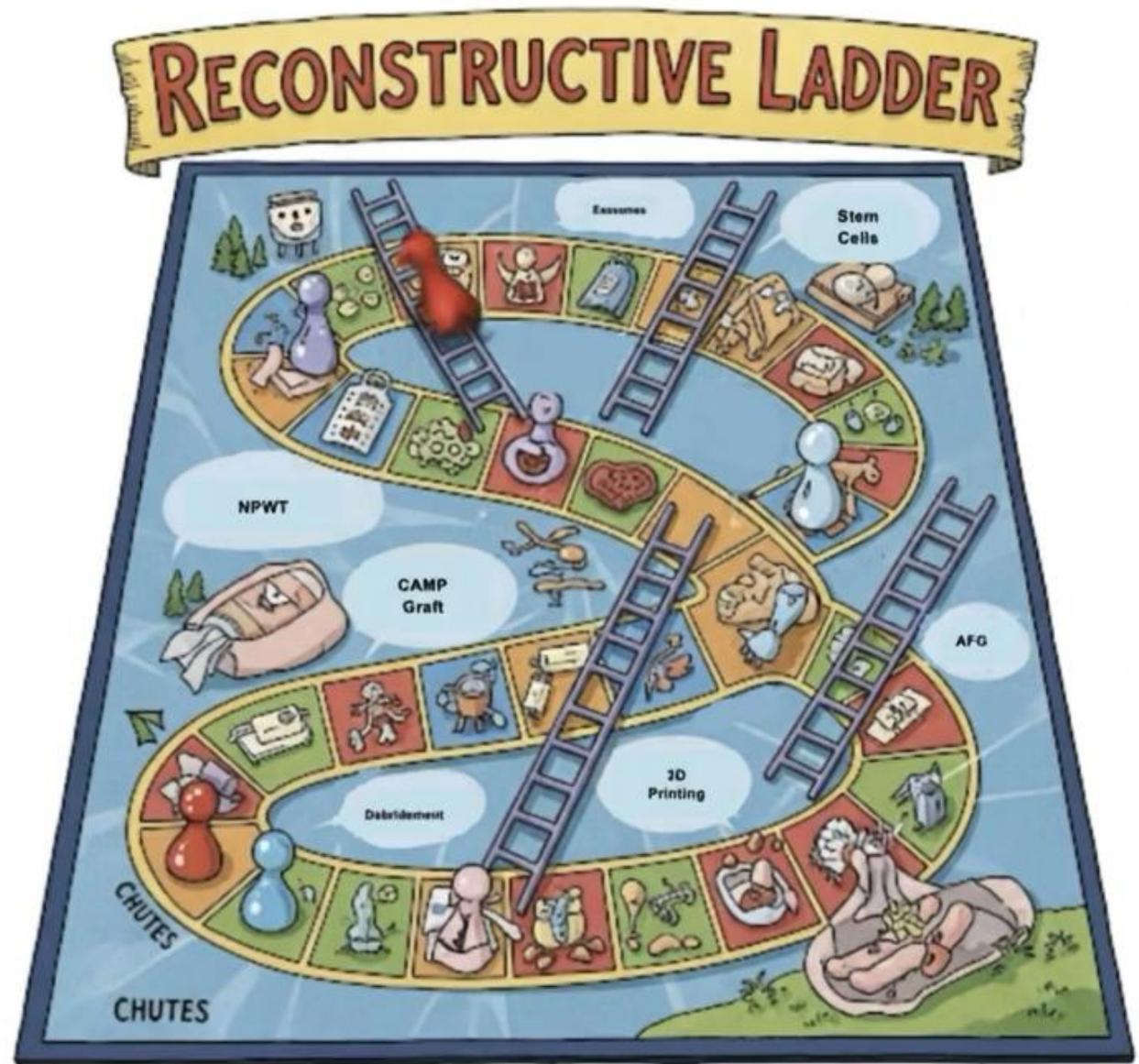
Bridging Wound Healing and The Reconstructive Ladder



Traditional Reconstructive Ladder



The Modern Reconstructive Ladder

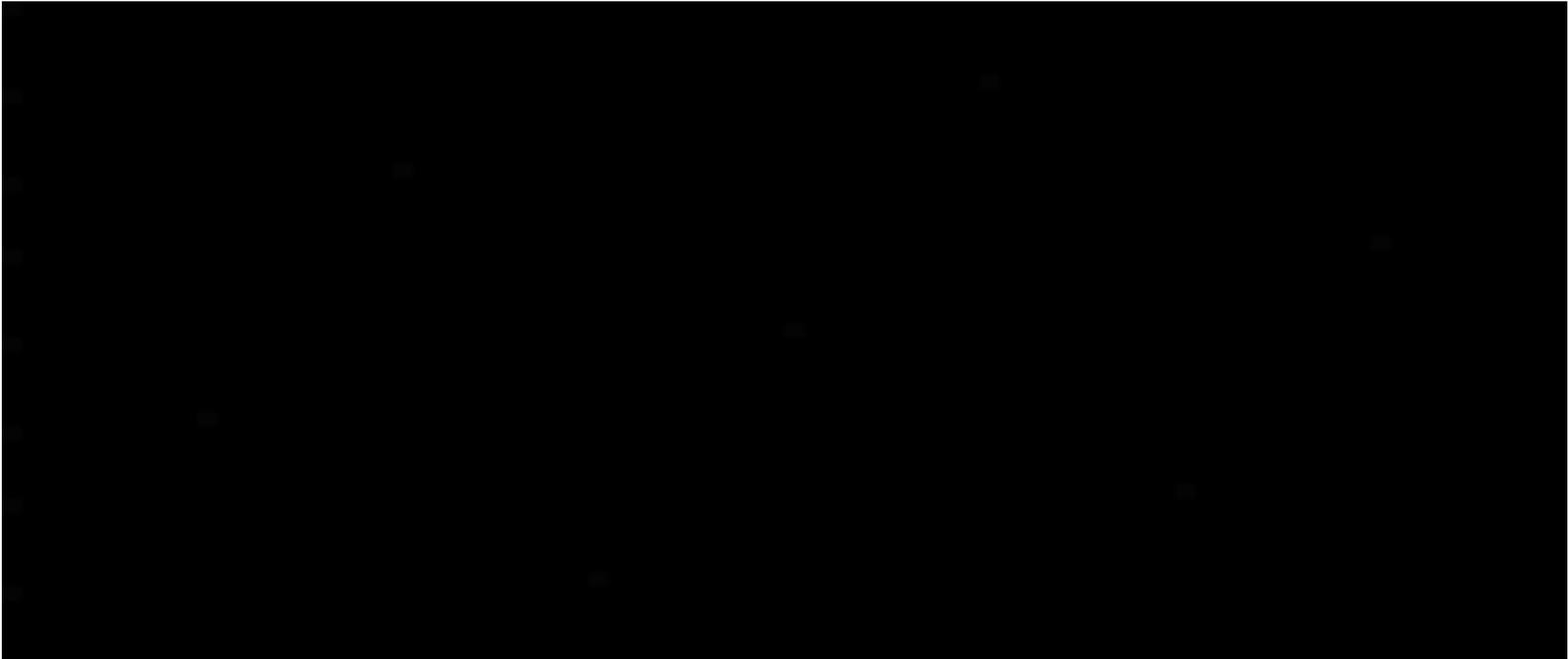


Integral Debridement: The Cornerstone of Wound Healing

- Clinical need
- Clinical experience and competency
- How quickly devitalized tissue needs to be removed
- Level of inflammation
- Local access
- Patient age and level of health
- Patient perspective
- Presence of infection
- Risk of exposing non-tissue structures
- Treatment objectives
- Treatment setting
- Wound depth and type



Debridement



REF	Size
33-52	2.0mm
33-53	3.0mm
33-54	4.0mm
33-55	5.0mm
33-57	7.0mm

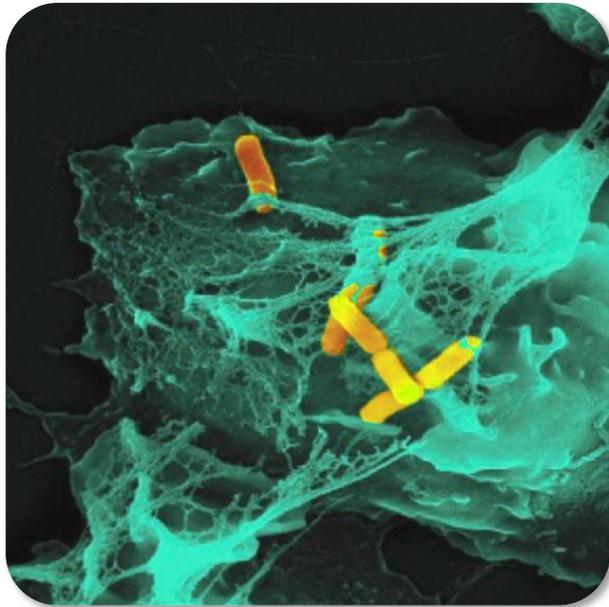
Technologies to Support Wound Healing and Wound Bed Preparation

Hypochlorous acid (HOCl) wound irrigation

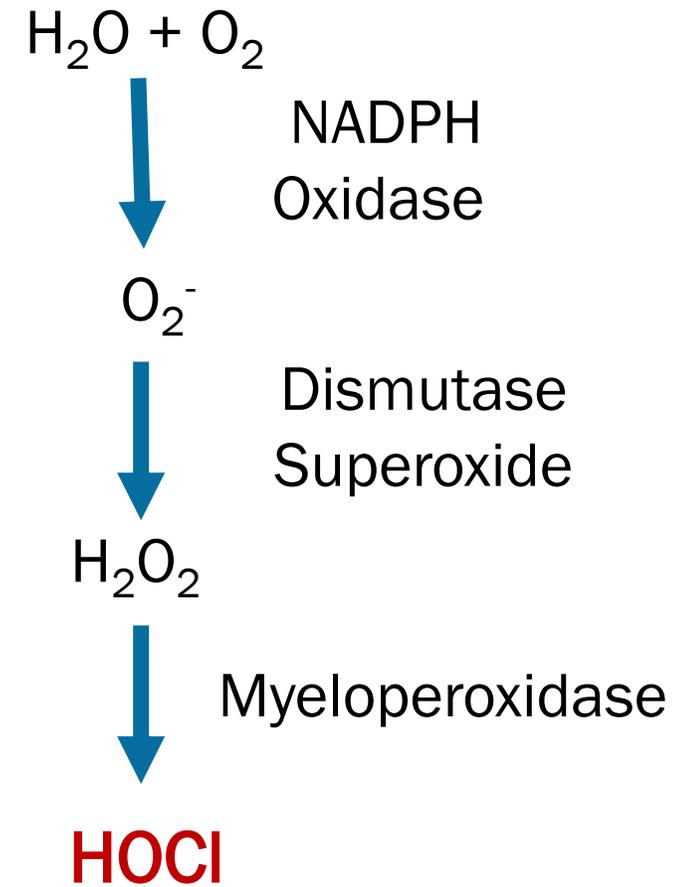
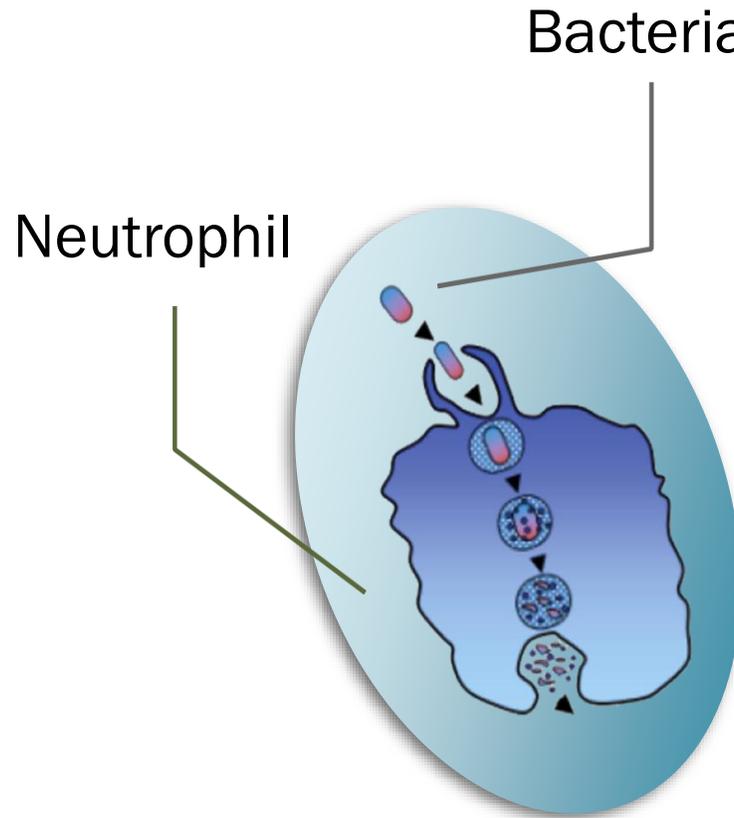
- Potent, broad-spectrum antimicrobial solution that is non-toxic to healthy cells
- Effectively reduces germs and inflammation without impeding the healing process
- Can be used pre-, intra-, and post-operatively to cleanse and prepare the wound



HOCl: The Body's Natural Microbicide

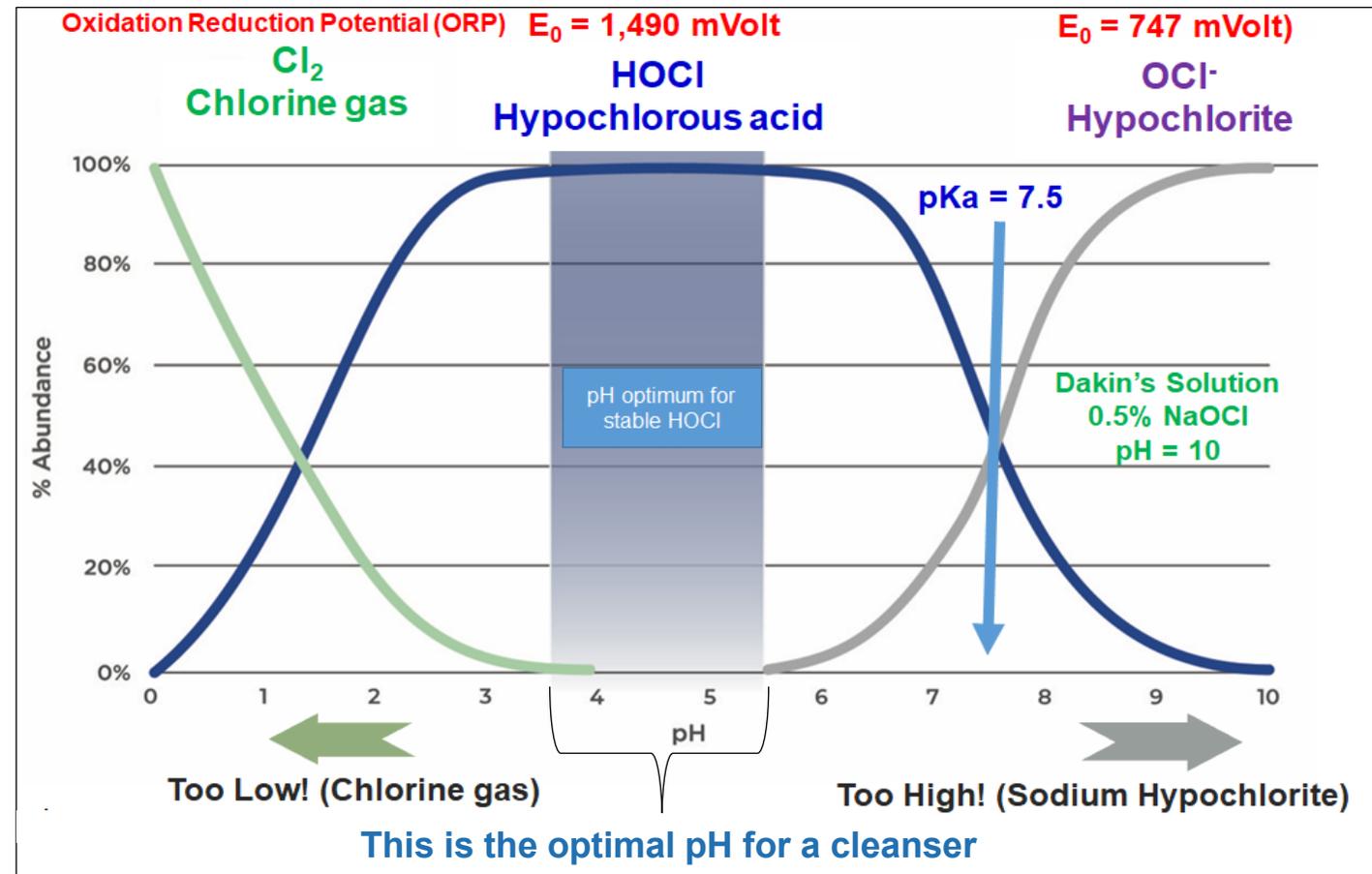


Oxidative Burst
Pathway



HOCl Dissociation Curve

- Stabilized HOCl solution has the highest concentration of HOCl at $\approx 300\text{ppm}$
- Mimics normal pH of healthy human skin
- Electrochemical manufacturing process allows for shelf stability in PET plastic



Technologies to Support Wound Healing and Wound Bed Preparation

Ultrasonic wound debridement with pHA solution

- Uses low-frequency ultrasound to selectively fragment and remove non-viable tissue with minimal damage to healthy structures
- The concurrent use of pHA provides antimicrobial irrigation during the debridement process



Technologies To Support Wound Healing and Wound Bed Preparation

Negative Pressure Wound Therapy (NPWT)

NPWT with Instillation and Dwell (NPWTi-d)

- Combines benefits of negative pressure with automated instillation of a topical solution (eg, pHA, saline)
- Actively dissolves and removes infectious material, promoting robust granulation tissue formation



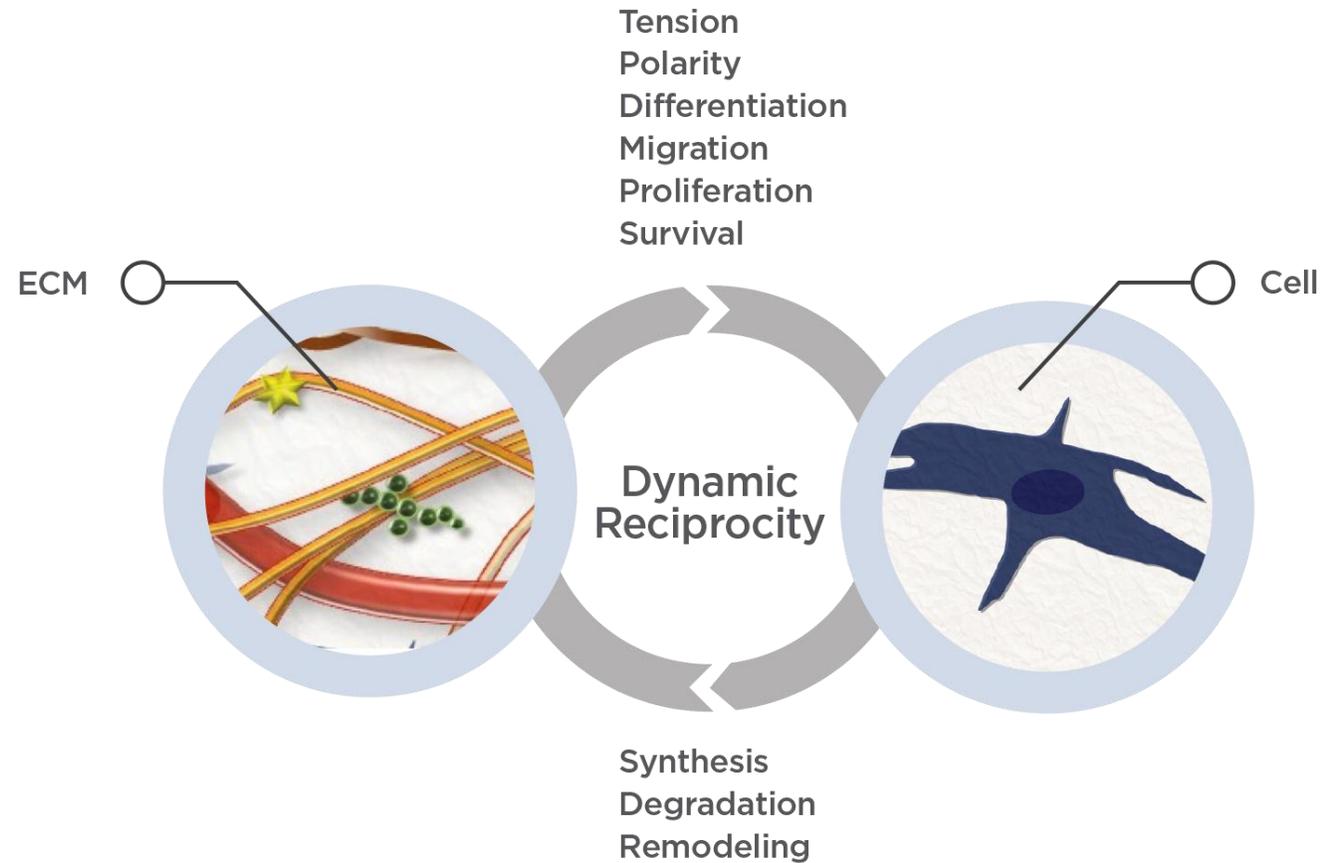
Technologies To Support Wound Healing and Wound Bed Preparation

- CAMPs/Skin Substitute Grafts



Dynamic Reciprocity

- ECM is not a silent bystander during the healing process
- ECM directs incoming cells to grow, divide, move, and attach, thus facilitating repair
- Dynamic reciprocity occurs during all phases of wound healing



Skin Substitute Grafts/CAMPs

- Factors that can lead to flap loss
 - Highly inflamed wound bed
 - Contaminated wounds
 - Hematoma/seroma
 - Shear force
 - Irregular wound bed



- Consider addition of advanced bioscaffold
 - OFM matrix
 - SIS matrix
 - Human reticular dermis

Avoiding the Leap: Skin Substitutes and Advanced Grafts

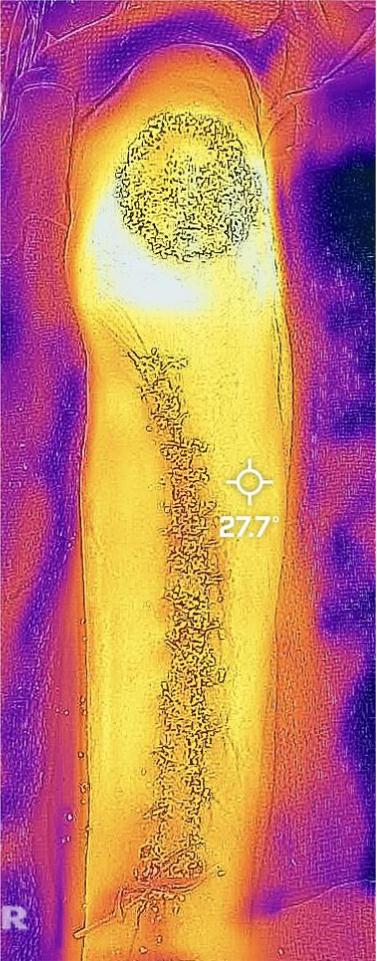
When a wound is too large for primary closure but not severe enough to warrant a flap, skin substitutes can bridge the gap.

- These grafts provide a scaffold for the patient's own cells to grow and regenerate new tissue
- Types: Autografts/ allografts/ xenografts/ synthetic grafts

Impact: A well-prepared wound bed, often achieved with the technologies discussed, can successfully support a skin substitute, thereby potentially avoiding a more complex and higher risk autologous graft or flap procedure



LLE Reconstruction



LLE Reconstruction

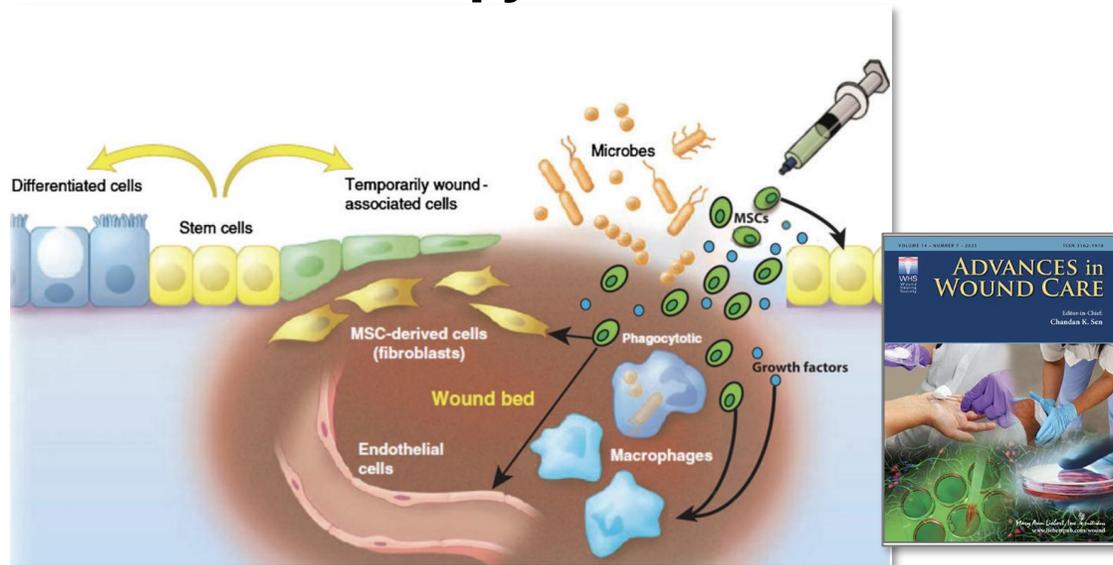


LLE Reconstruction

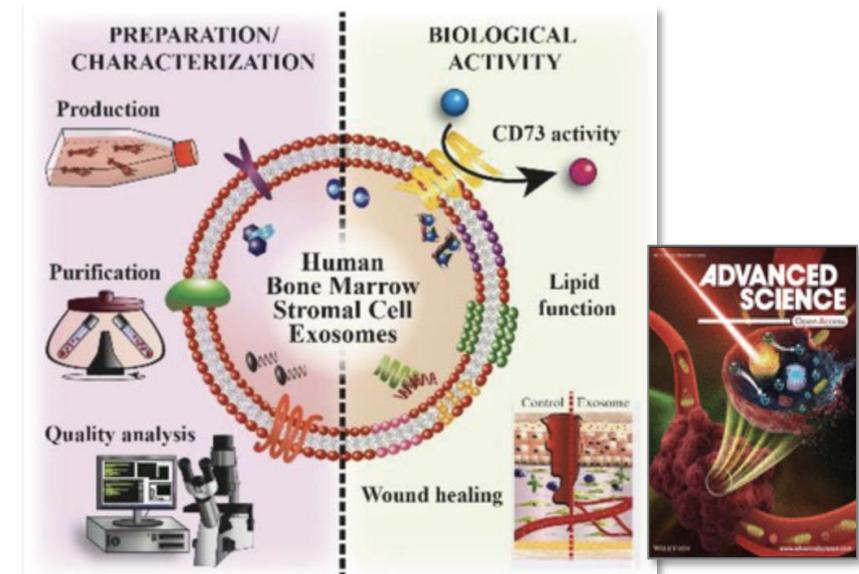


Technologies to Support Wound Healing and Wound Bed Preparation

Regenerative Medicine/ Stem Cell Therapy



Exosomes



Optimizing the Postoperative Period: The Work Isn't Done when the Wound Is Closed

Incisional Negative Pressure Wound Therapy (iNPWT)

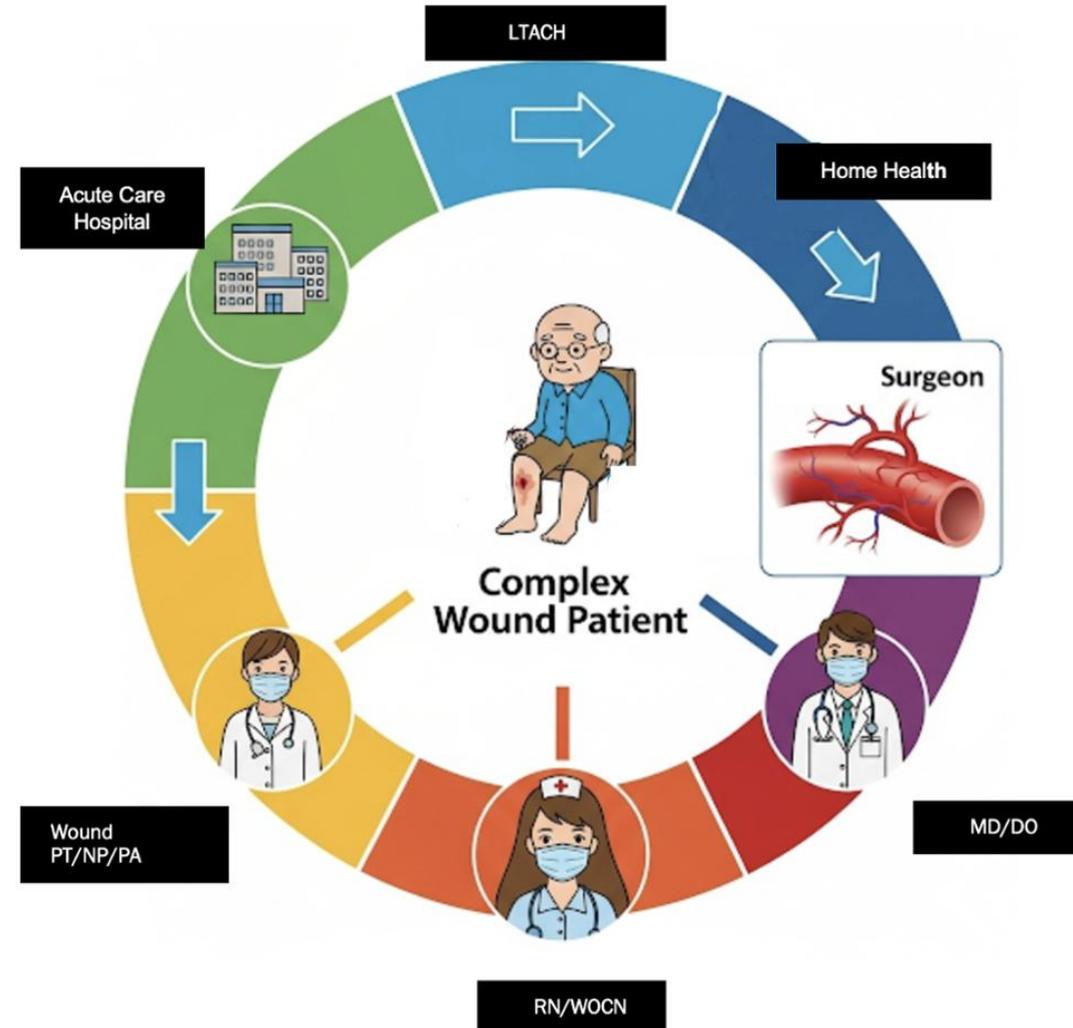
- Reduces risk of seroma, hematoma, and surgical site infections (SSIs)
- Stabilizes incision and helps ensure healing of our reconstructions



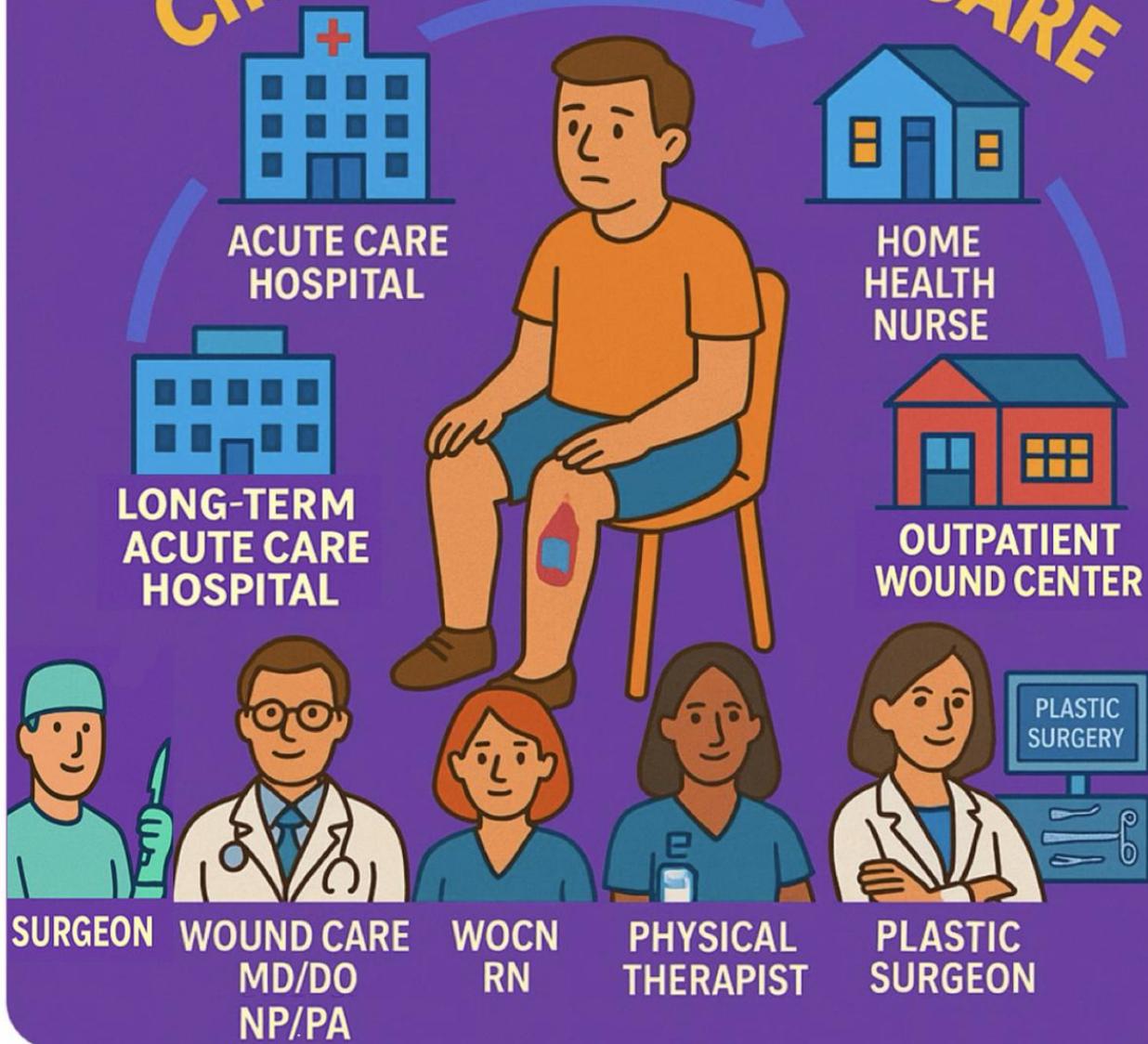
Postoperative Graft and Flap Site Management with pHA Soaks

- Helps keep graft/flap clean and prevent infection
- Maintain moist wound healing environment and support the viability of the reconstruction

The Unbroken Circle of Care: A Multidisciplinary Effort



CIRCLE OF WOUND CARE



Conclusion: When Appropriate — Staying Lower On the Ladder for Higher Quality Outcomes

- The traditional reconstructive ladder remains a valuable concept, but it has been amended by modern technologies
- These adjunctive therapies empower all wound care clinicians to proactively manage wounds, improve the wound bed, and facilitate healing with less invasive procedures

Traditional Reconstructive Ladder



- A collaborative, multidisciplinary team approach that spans the entire continuum of care is the new standard
- By working together and embracing innovation, we can avoid the highest rungs of the reconstructive ladder, leading to faster healing, reduced morbidity, and improved quality of life for our complex wound patients

Cases

**Multidisciplinary Application of
Wound Bed Preparation across
Diverse Clinical Settings**

RLE Crush Injury

- 68y Female
- Forgot to put car in park before getting out
- Accidentally ran over her own right leg
- ER admission: Soft tissue crush injury
- Initial OR washout/debridement and partial closure by orthopedics
- Fibular fracture conservative management by orthopedics



RLE Crush Injury

- Orthopedic clinic follow-up visit 2 wks later
- Significant leg edema
- New areas of soft tissue necrosis



RLE Crush Injury

- Skin progresses to frank necrosis over next 2 wks
- Presents to ED from outpatient wound clinic



RLE Crush Injury

- OR surgical debridement
- Viable deep adipose and muscle tissue
- No exposure of bone or tendon
- NPWTi-d with pHA applied
- Compression wraps for edema control



RLE Crush Injury

- NPWTi-d with pHA applied
- 22cc pHA instilled q2hrs
- 10-min dwell time



RLE Crush Injury

- POD 7: NPWT dressing change
- Excellent granulation tissue is seen



- POD 9: STSG application, NPWT



RLE Crush Injury

- POD 14: Excellent healing of STSG
- Edema control with compression wraps
- Patient is now at long-term acute care hospital (LTACH) and ambulating
- No infectious complications



RLE Crush Injury

- 6 wks postop: Excellent healing of STSG
- Edema control with compression stockings



RLE Chronic Burn Injury

- 80y Male
- Sustained 70% TBSA burns 50 yrs ago in boating accident
- Contracted Hepatitis C from blood transfusion in hospital
- Developed end-stage liver disease and underwent liver transplant
- Has severe burn scarring and STSG of BLE
- Developed venous HTN in legs leading to RLE chronic wounds
- RLE shin wound with adherent slough, dense fibrosis, and hypergranulation



RLE Chronic Burn Injury

- pHA gel initiated prior to surgery to help amplify sharp debridement
- Daily dressings with pHA gel, ABD gauze, rolled gauze, elastic tubular bandage
- Patient developed atrial fibrillation and needed therapeutic anticoagulation for 1 month prior to being optimized for surgery



RLE Chronic Burn Injury

- OR: surgical sharp debridement, ultrasonic debridement with pHA
- OR cultures
 - MRSA
 - *Pseudomonas aeruginosa*



RLE Chronic Burn Injury

- Return to OR at postop day 10
- Autologous STSG at 3:1 mesh ratio
 - Severe limitation of donor sites
- Autologous skin cell suspension sprayed over top
- NPWT applied



RLE Chronic Burn Injury

- Postop day 4: NPWT change in hospital
- pHA gel applied over STSG prior to replacement of NPWT



RLE Chronic Burn Injury

- Postop day 7: 95% STSG take
- Continue with pHA gel application at NPWT changes
 - No slough development seen at graft interstices
 - No evidence of graft infection seen



RLE Chronic Burn Injury

- 30 days postop
- 90% STSG healing
- Continue pHA gel and compression



Axillary Hidradenitis Suppurativa (HS) and Scar Contracture

- 28y Female
- 15-yr history of advanced hidradenitis suppurativa (HS)
- Prior axillary HS resection
- Disease extends onto arm and breast
- Axillary scar contracture
 - Cannot elevate her arm above 120°
- Chronic pain and drainage



Axillary HS and Scar Contracture

- OR Stage 1: Surgical resection of all disease, release of scar contracture
- Verify ROM of arm is restored
- Skin shortage
- Exposure of axillary vein
- Adipofascial rotation flap coverage over axillary vein
- NPWT application

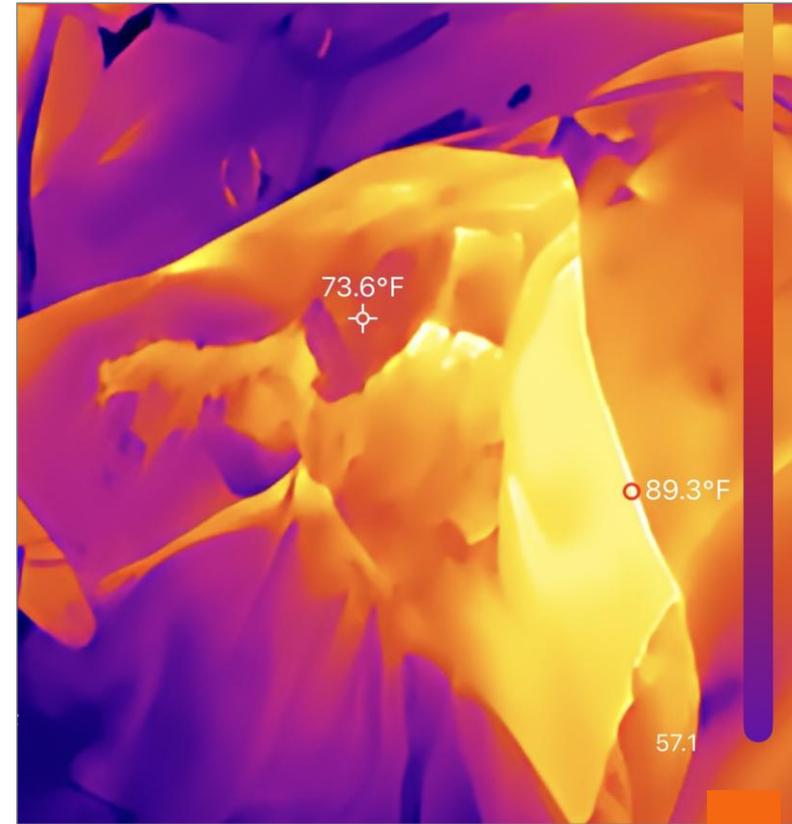


Axillary HS and Scar Contracture

Adipofascial rotation flap coverage over axillary vein



Forward looking infrared imaging to assess adipofascial flap viability



Axillary HS and Scar Contracture

- NPWT dressing change postop day 4
- Adipofascial flap viable and bleeding
- pHA wound soak
- Bedside sharp debridement

- Continue IV antibiotics and NPWT



Axillary HS and Scar Contracture

Postop day 7: Good granulation bed



STSG applied



Axillary HS and Scar Contracture

Postop day 10: Excellent initial STSG take



pHA gel applied, continue NPWT



Axillary HS and Scar Contracture



Postop day 20

- 85% graft healed
- Hypergranular areas treated with pHA soak and ultrasonic debridement in clinic
- ROM exercises

Axillary HS and Scar Contracture

- Wk 10: Healed, good ROM



Thigh Degloving Injury



- 62y Female with DM
- Hurricane
- Tree fell on her car as she was driving
- Thigh soft tissue degloving injury
- Hip fracture – ORIF by orthopedics

Thigh Degloving Injury



- OR sharp debridement
- Continue NPWTi-d with pHA

Thigh Degloving Injury



- Postop day 4
- STSG
- NPWT to bolster NPWT

Thigh Degloving Injury



- 2 months postop
- STSG fully healed
- Ambulating well

Necrotizing Soft-Tissue Infection (NSTI)/Venous Leg Ulcer (VLU)

- 65y Male with DM
- History of chronic VLU
- Catfish spine to leg
- Necrotizing soft-tissue infection (NSTI)
- Cultures: *Aeromonas*
- OR debridement with pHA irrigation



NSTI/VLU



Ovine forestomach matrix (OFM) grafts over exposed tendons at same operative stage



NSTI/VLU



NSTI/VLU



Infected Calciphylaxis

- 71y Female
- ESRD and spontaneous calciphylaxis



> **SURGICAL CULTURE** Final

Organism 1

QUANTITATION

| ESCHERICHIA COLI

| MODERATE

ANAEROBIC CULTURE Final

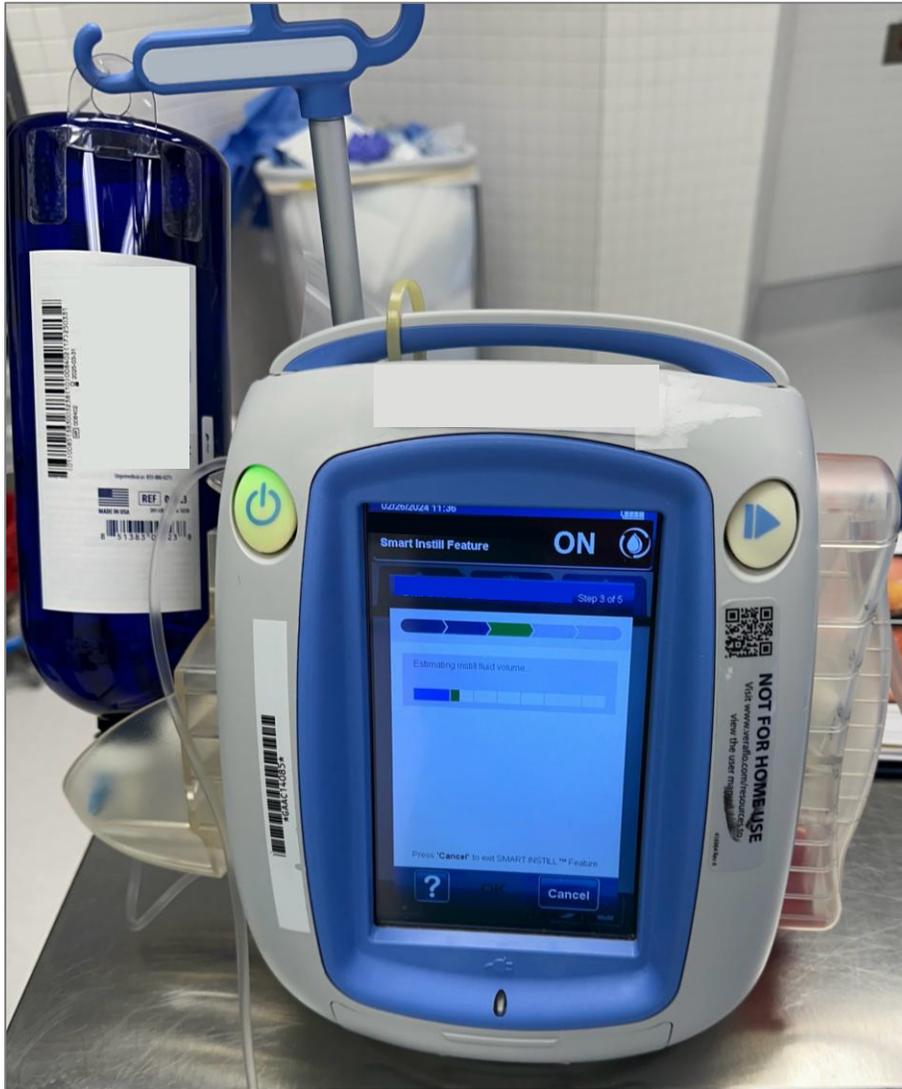
Organism 1

QUANTITATION

| BACTEROIDES FRAGILIS

| MODERATE

Infected Calciphylaxis



Infected Calciphylaxis: Staged STSG



Infected Calciphylaxis

- Proximal leg wounds healed
- Distal leg wound: Continue care in outpatient wound center



Pyoderma Gangrenosum (PG) Wound

- 68y Female
- Dermatology: Biopsied proven pyoderma gangrenosum (PG) to LLE
- Adherent slough
- Concern to avoid sharp debridement to not risk pathergy



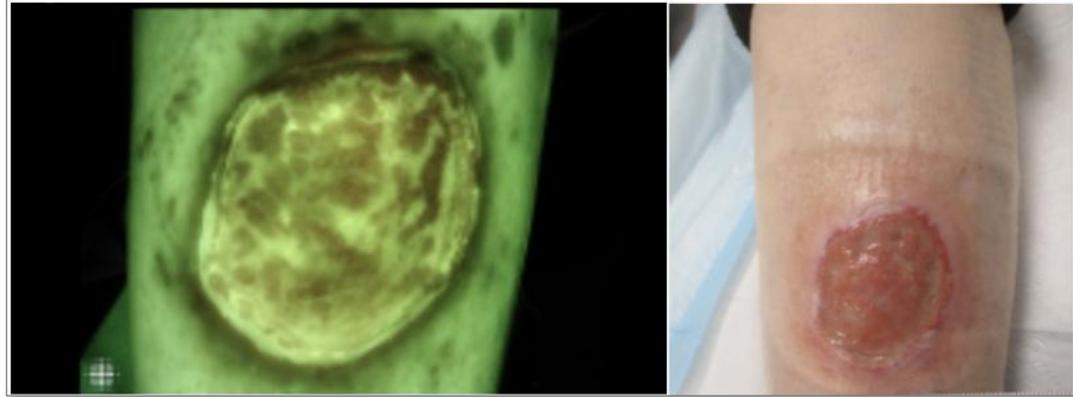
Pyoderma Wound: Integral Debridement

- pHA soaks
- Highly-charged fiber dressing



PG Wound

- 4 wks
- Bacterial fluorescence
- Epithelialization at edges

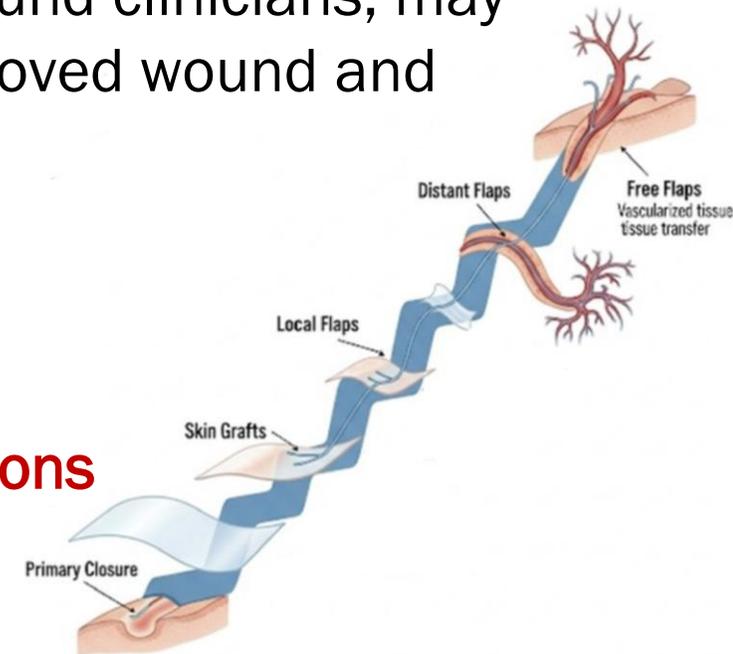


- 5 months
- Healed



Clinical Pearls

- Application and mechanical disturbance with a pHA solution to wounds with slough — prior to application of an autolytic debridement supported by highly charged fiber dressing — may help accomplish improved slough removal and wound healing. **SYNERGY**
- Utilization of the concept of integral debridement, by all wound clinicians, may allow for **better wound preparation prior to surgery** for improved wound and surgical site healing outcomes
- May allow **healing lower on the reconstructive ladder**
- Integral debridement applied postoperatively may **improve wound outcomes and decrease healing complications**



Use of pHA and Negatively Charged Fibers for Integral Debridement to Optimize the Reconstructive Ladder

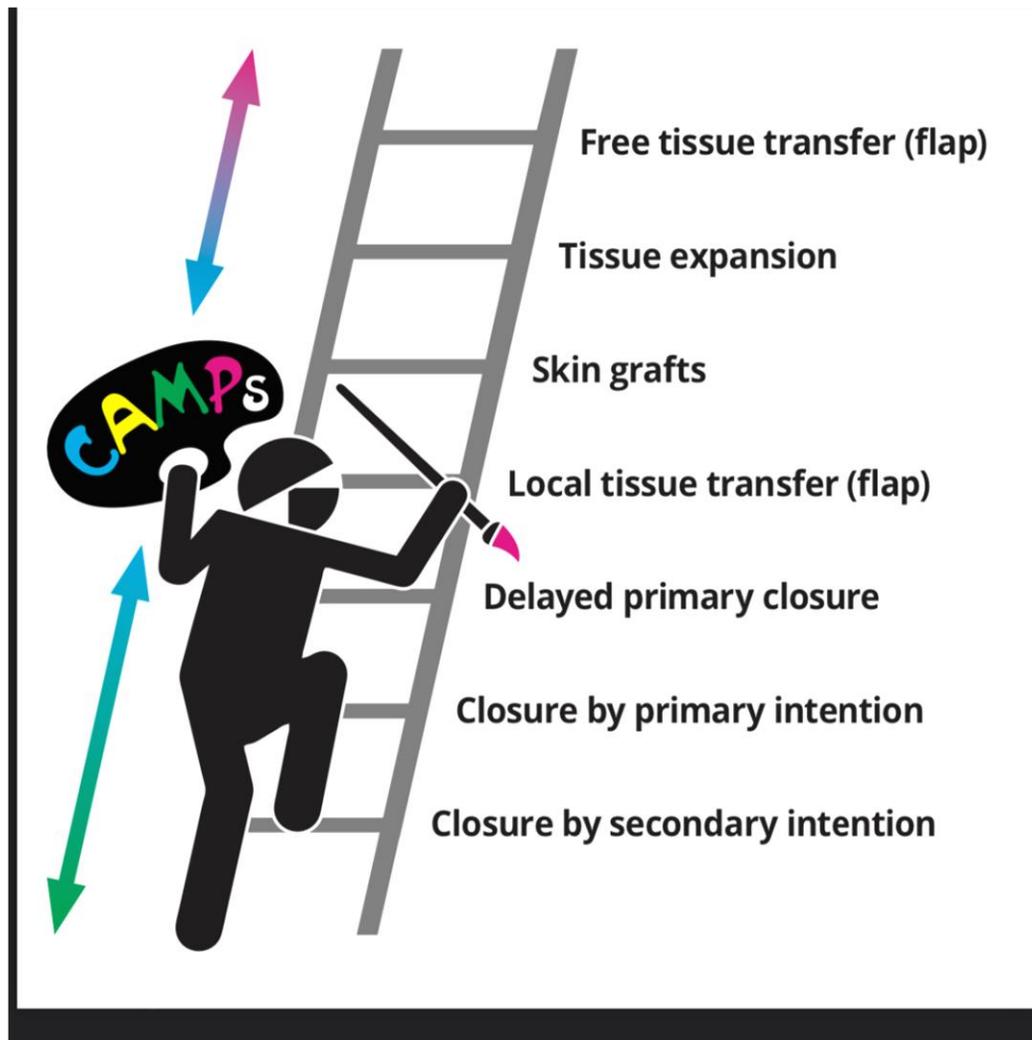
Michael N. Desvigne, MD, FACS, CWS, FACCS, MAPWCA

Plastic and Reconstructive Surgery, Wound Care and Hyperbaric Medicine

Abrazo Arrowhead Hospital and Wound Clinic

Glendale, AZ

Reconstructive Ladder vs Elevator

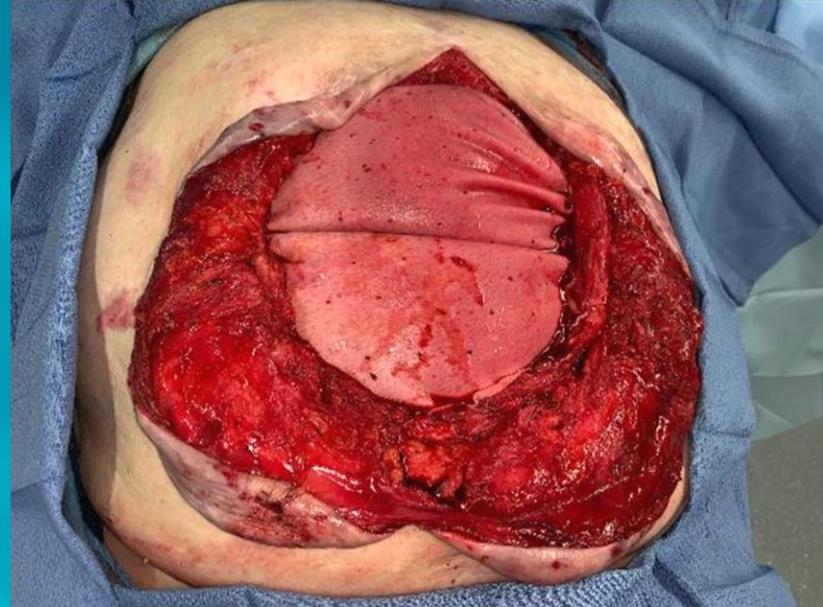


Less Is More!

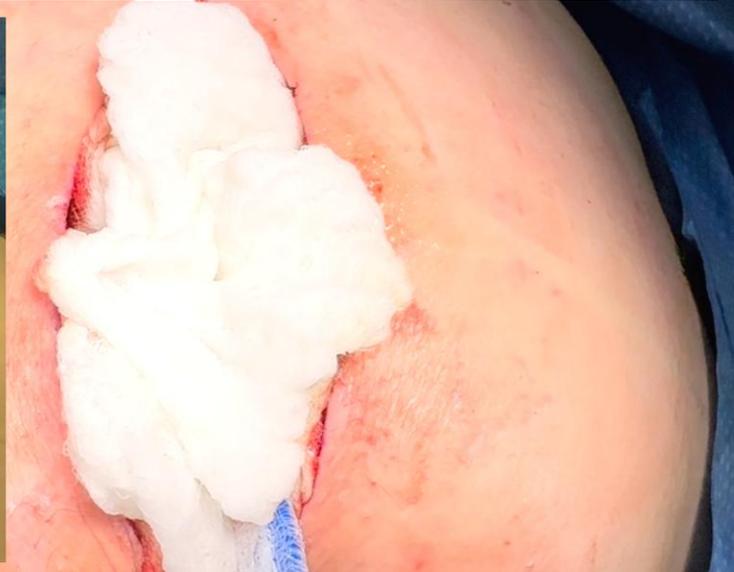
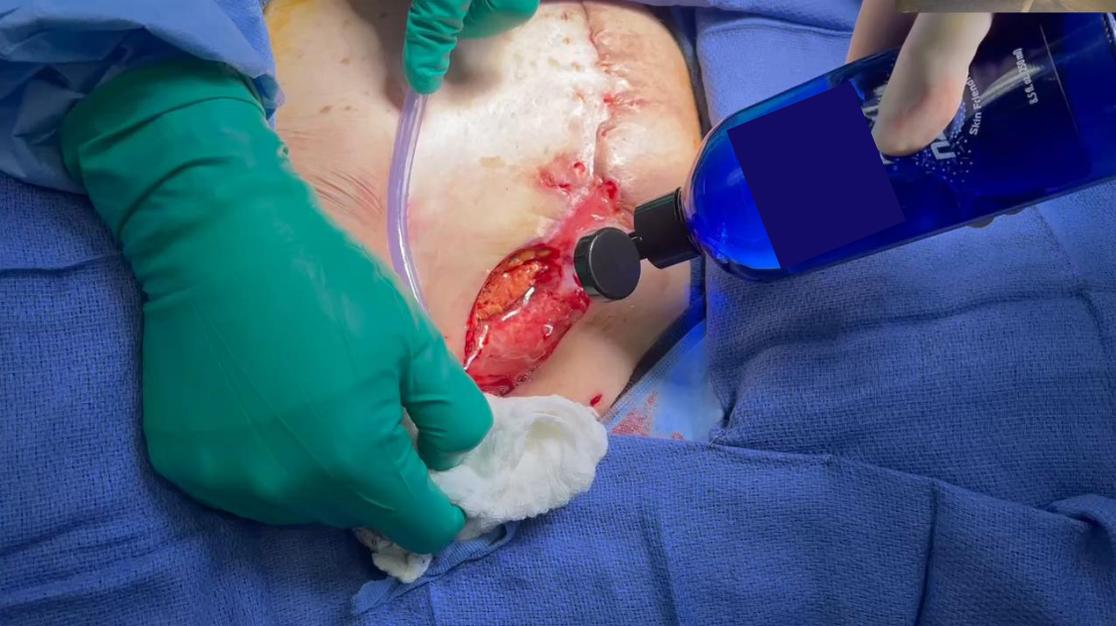
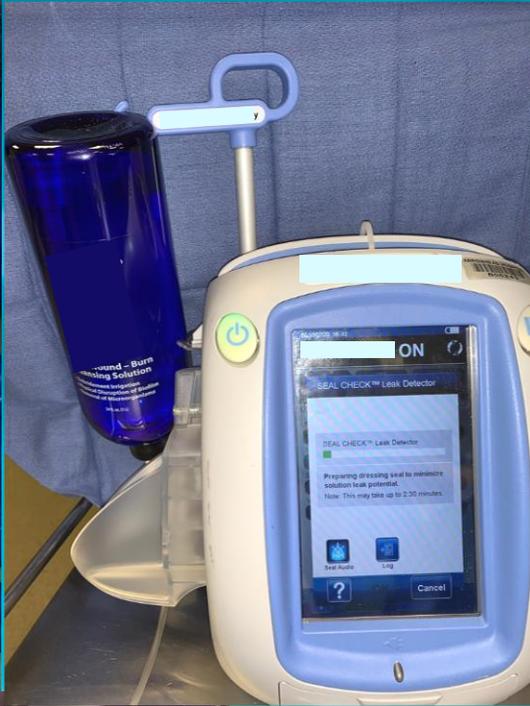


Safety First!





How I Use pHA



Why I Use pHA

Surgical reconstruction of chronic wounds using soft tissue flaps is a routine approach to achieve closure. Due to the poor tissue quality, longstanding inflammation, bioburden, and impaired blood supply, the success of flap closure is marred by reported **complication rates of 25%-58%**.

Pure hypochlorous acid (pHA*) preserved cleanser has been studied extensively for its ability to disrupt microbial colonies. Laboratory studies have shown that hypochlorous acid has the ability to mechanically disrupt 90% of microbial aggregates and colonies after just a short order of exposure.

My Data

- 93 surgical procedures were performed and treated with pHA to assist bacterial burden (20-month review)
- All patients received pHA soak and or irrigation intraoperatively. The HOCl was placed in a sterile container on the operative table. Following excisional debridement and pulse vac irrigation in those cases with significant debris, pHA was poured onto a lap sponge or 4x4 gauze with the pHA soak intraoperatively for 10 min. We report no postoperative infections in all cases presented here.
- Complications: 20% (Reported as high as 50% for pressure ulcer)
 - Incisional dehiscence: 15 (13 pressure ulcers: 1 HA, 1 abdominal wall)
 - Seroma: 2
 - Partial graft loss: 2
 - **Postop infection: 0**

Pure Hypochlorous Acid (pHA*) Preserved Cleanser

- pH range **3.5-5.5** is conducive to healing
 - Average skin pH is **5.5**
- **Combine with sharp debridement** for wounds with mature microbial colonies
- 5-8 min of pHA* solution contact with wound
 - Treats 90%-95% of microbial colony organisms
- Reacts with organic matter in wound and dissipates in seconds
 - **Safe to use with skin substitute grafts in same operative setting**
- Rapid rate of bacterial removal with pHA* solution is seen (*in vitro*)

*pure hypochlorous acid preserved cleanser.

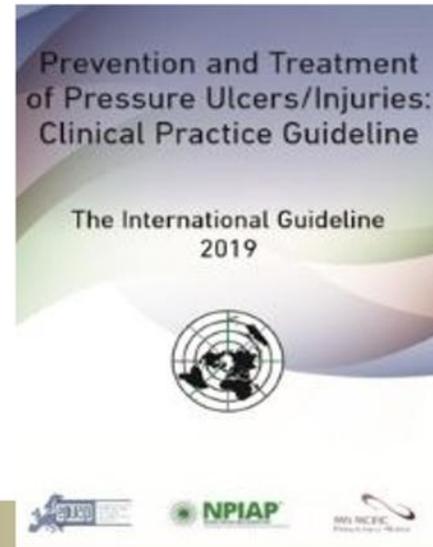
Winterbourn CC, et al. *J Biol Chem*. 2006;281(52):39860-39869. Robson, MC. *Wound Manage Prev*. 2020;66(5):9-10. Nagoba B, et al. *Wounds*. 2015;27(1):5-11. Hidalgo E, et al. *Chem Biol Interact*. 2002;139(3):265-282.

pHA* Cleanser

- Chronic wounds and plastic surgical wound reconstruction are complicated by
 - **Microbial contamination, complex colony formation, pH disturbance from a mildly acidic range**
- Basic science research has demonstrated efficacy of pure hypochlorous acid (pHA*) cleanser against **microbes and complex colonies**, as well as favorable effects on keratinocyte and fibroblast migration
- HOCl is a component of the innate immune response
 - Aids pathogen killing via the **neutrophil oxidative burst**

Clinical Practice and Consensus Guidelines

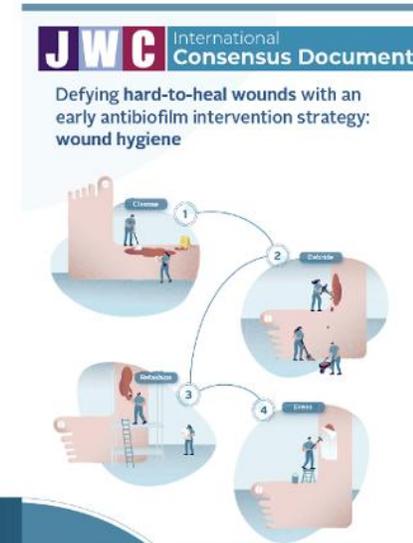
November 2019



National Pressure Injury
Advisory Panel
International Guidelines

“HOCl is accepted with
Level 1 evidence”

March 2020

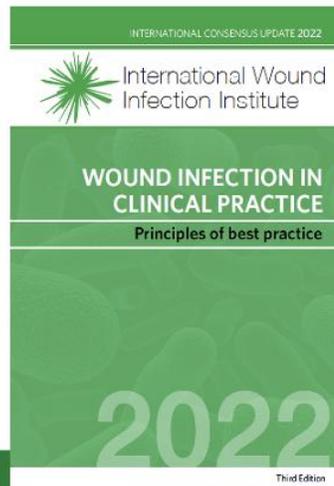


JWC International
Consensus Guidelines:
Hard-to-heal wounds

Wound cleansing as an
anti-microbe strategy

Clinical Practice and Consensus Guidelines

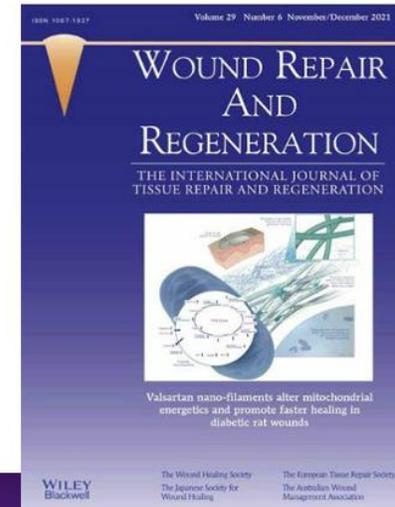
March 2022



International Wound Infection Institute:
Wound Infection in Clinical Practice

“Many older antiseptics, including [hydrogen peroxide](#), [traditional sodium hypochlorite](#) (eg, EUSOL and Dakin’s solution), and [chlorhexidine](#) are no longer recommended for use in open wounds due to the risk of tissue damage associated with their use.”

April 2022



Wound Repair and Regeneration:
Treatment Guidelines

Microbicidal agents that have a high therapeutic index (TI) against typical wound pathogens should be more effective in reducing bacterial bioburden while not killing wound cells. For example, the TI for hypochlorous acid is typically much higher than hypochlorite or for hydrogen peroxide for key bacterial pathogens.

Case Summary: Sacral Ulcer, Stage 4

- 36y Female with incomplete paraplegia from MVA presents with sacral ulcer, stage 4
- Medical history: Urostomy, lupus anticoagulant
- Social history: Lives with family
- Treatment:
 - Taken to OR for surgical closure
 - Excision ulcer with partial osteotomy performed
 - **Intraoperatively, pHA utilized as 10-min soak performed prior to flap closure**
 - Placental allograft placed to optimize healing
 - NPT initiated for incisional management immediately following closure

Sacral Ulcer, Stage 4 (Day 1)



Sacral Ulcer, Stage 4 (Day 1)



Sacral Ulcer, Stage 4 (Day 1)



Sacral Ulcer, Stage 4 (Day 1)



Sacral Ulcer, Stage 4 (Day 1)



Sacral Ulcer, Stage 4 (3 Months)



Case Summary: Full-Thickness Necrosis Groin

- 79y Female s/p percutaneous **aortic valve repair** complicated by bleed and hematoma right groin resulting in full-thickness necrosis
- Medical history: Aortic valve stenosis, CHF, HTN, obesity
- Treatment:
 - **NPWTi-d initiated with pHA at bedside**
 - Taken to OR for staged debridements
 - Definitive closure performed with reticular dermal matrix placed as tissue scaffolding for soft tissue replacement
 - Placental allograft placed to optimize healing
 - Incisional NPT initiated following closure
 - **Additional pHA utilized as an irrigant prior to secondary closure**

Full-Thickness Necrosis Groin (Day 1)



Full-Thickness Necrosis Groin (Day 1)



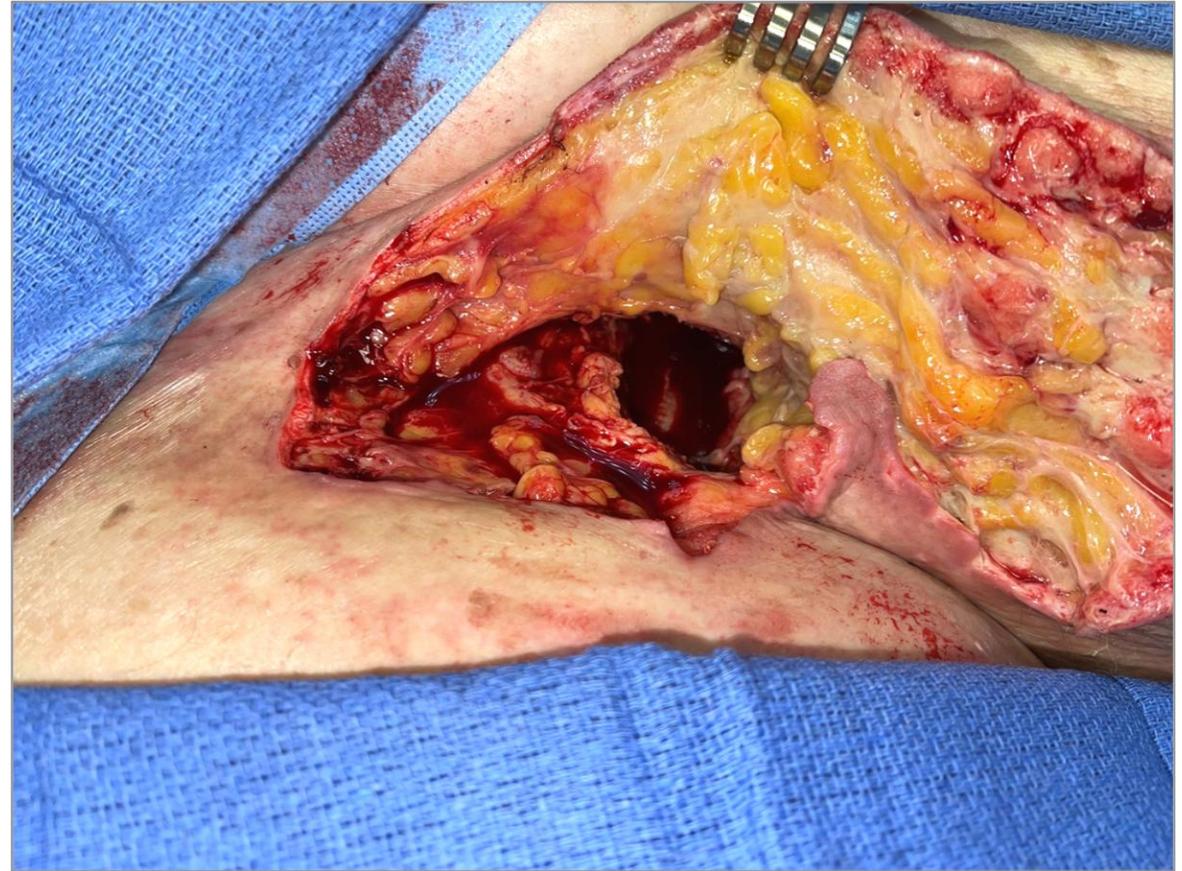
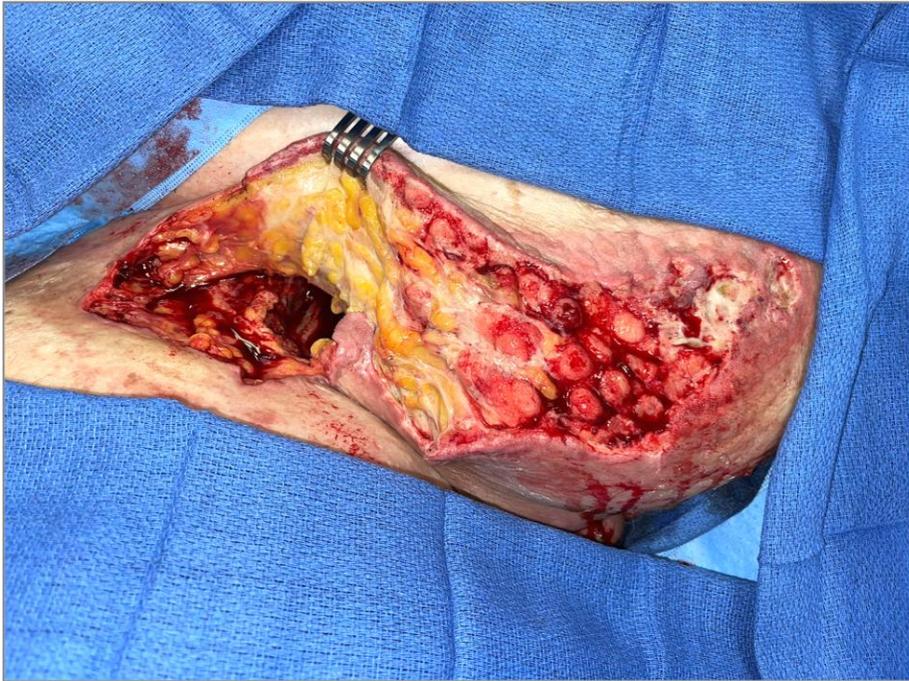
NPWTi-d initiated with pHA to loosen eschar and necrotic tissue

Full-Thickness Necrosis Groin (Day 3)



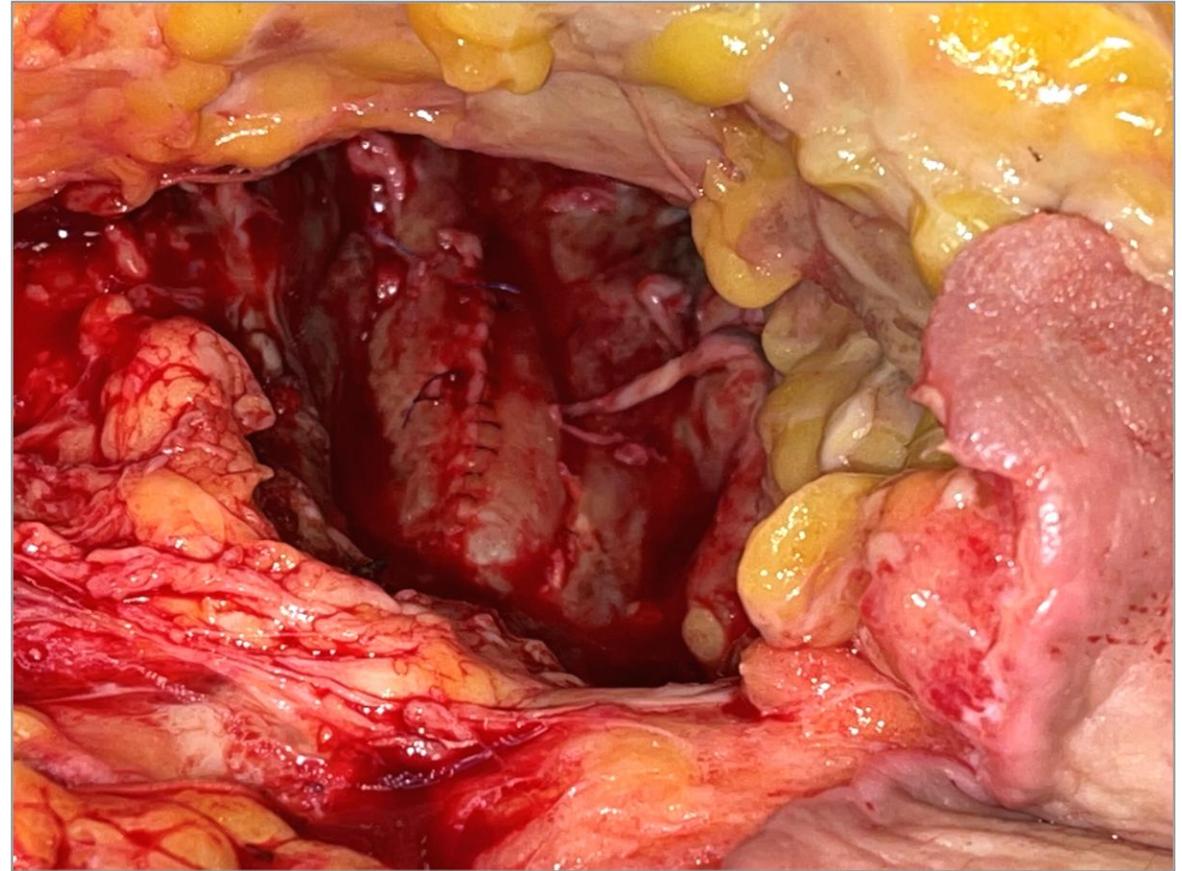
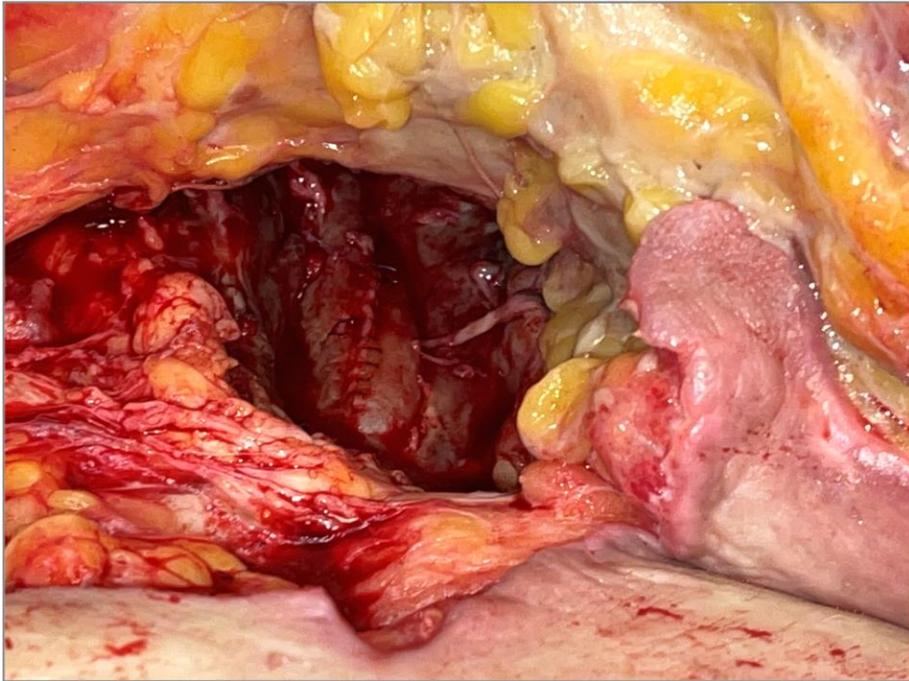
Eschar loosened; NPWTi-d with pHA continued

Full-Thickness Necrosis Groin (Day 5)



Necrotic tissue removed; soft tissue deficit present with exposed femoral vessels

Full-Thickness Necrosis Groin (Day 5)



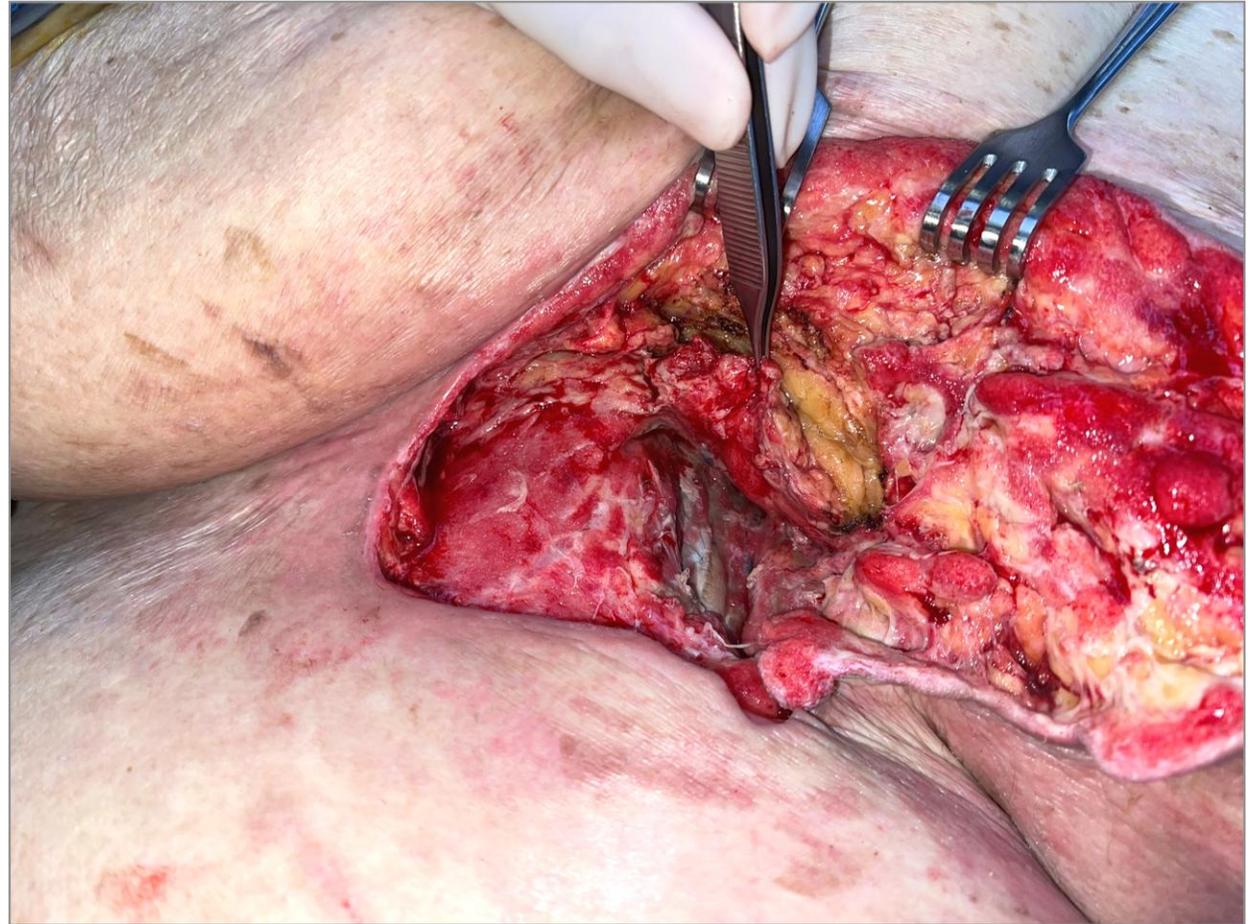
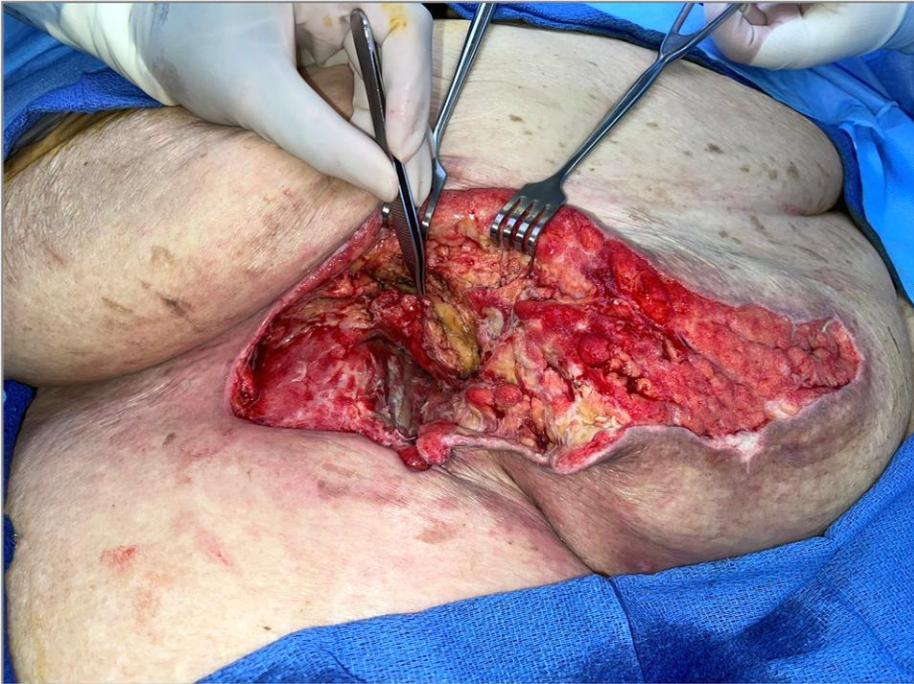
Necrotic tissue removed; soft tissue deficit present with exposed femoral vessels

Full-Thickness Necrosis Groin (Day 7)



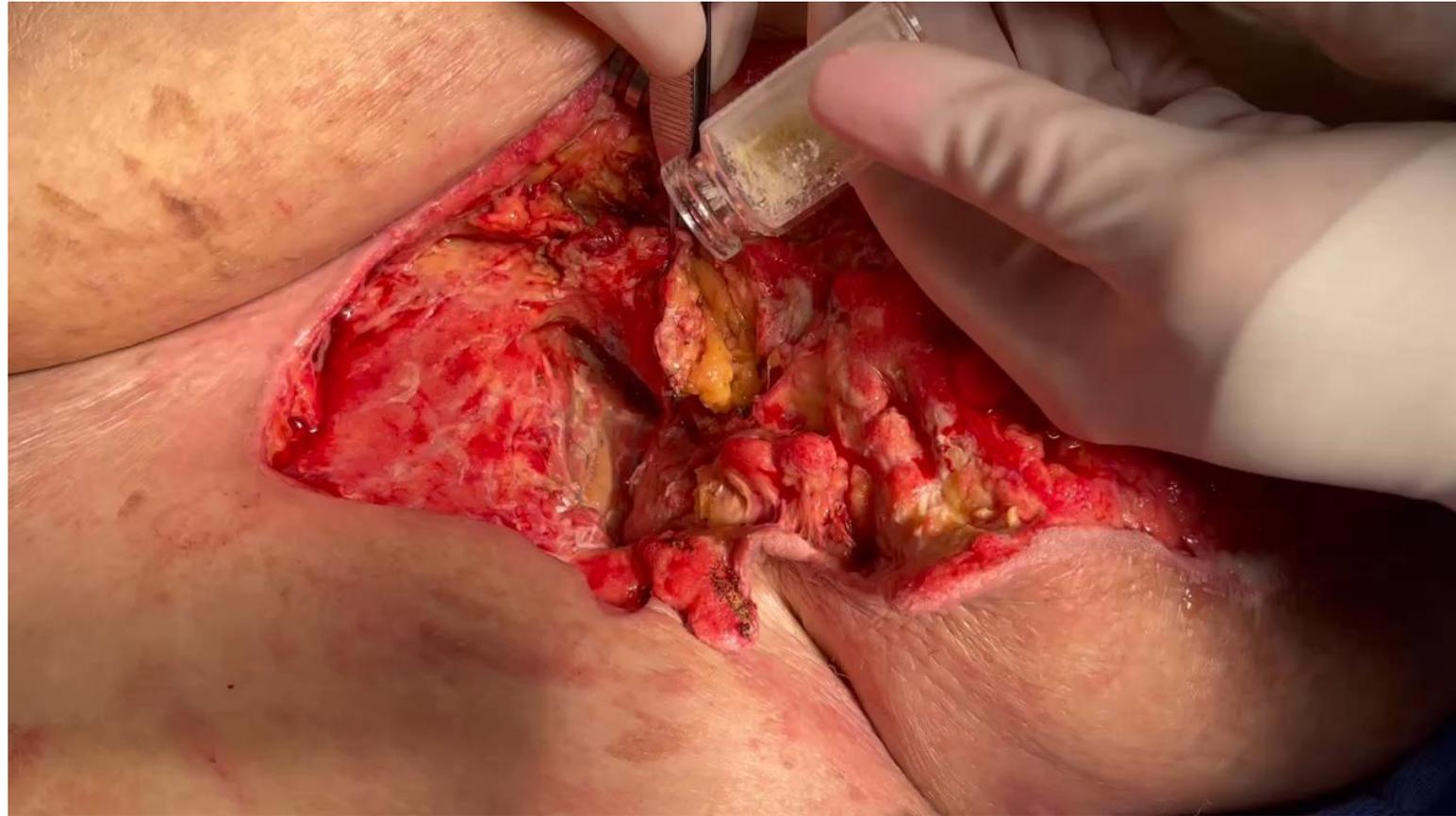
NPWTi-d with pHA continued to reduce bioburden

Full-Thickness Necrosis Groin (Day 14)



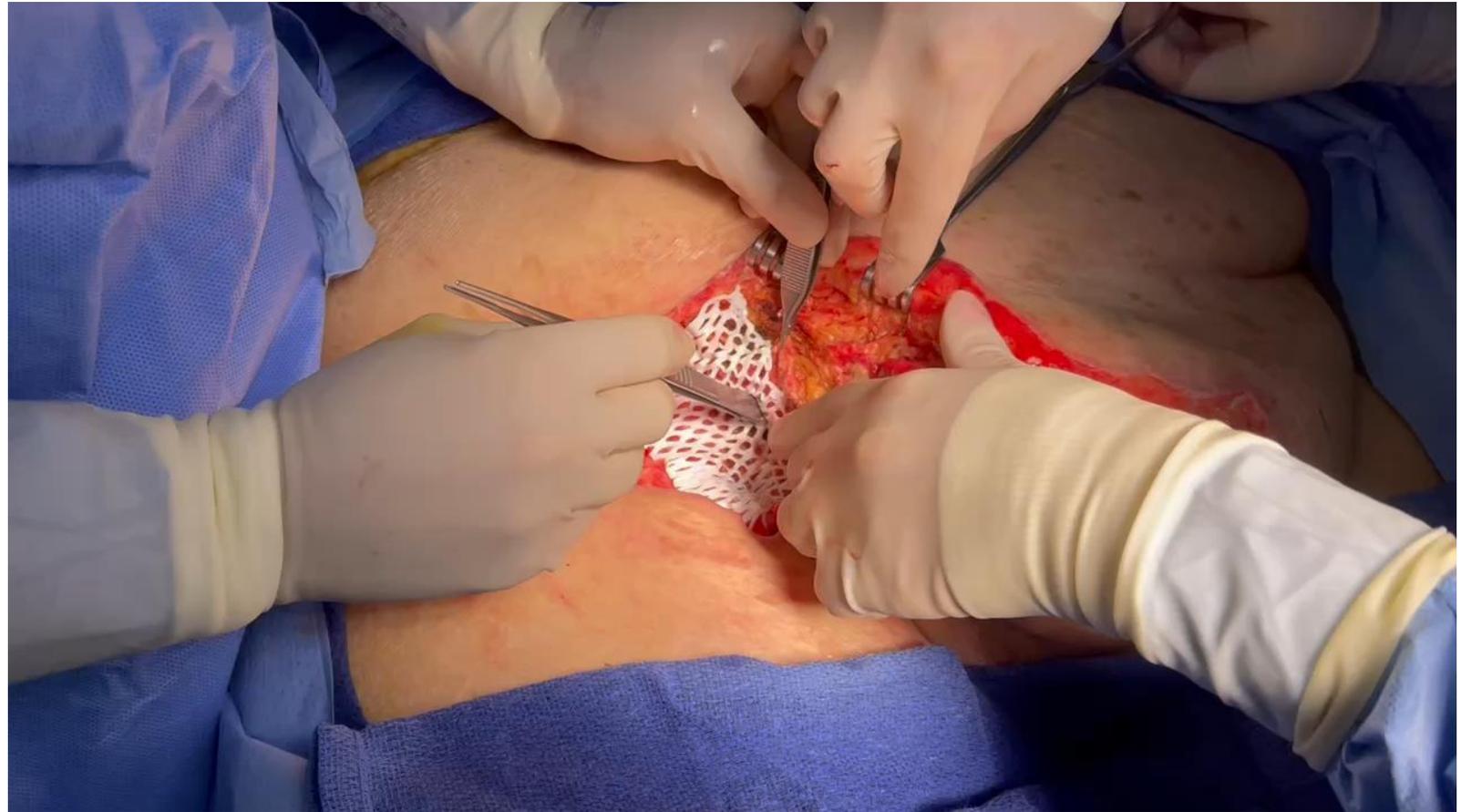
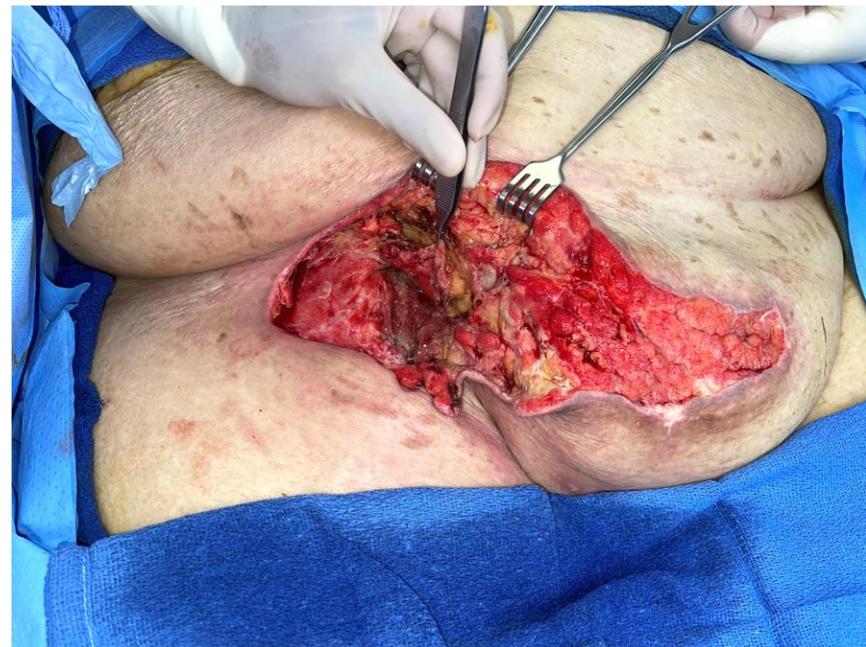
Flap mobilized for coverage of vessels

Full-Thickness Necrosis Groin (Day 14)



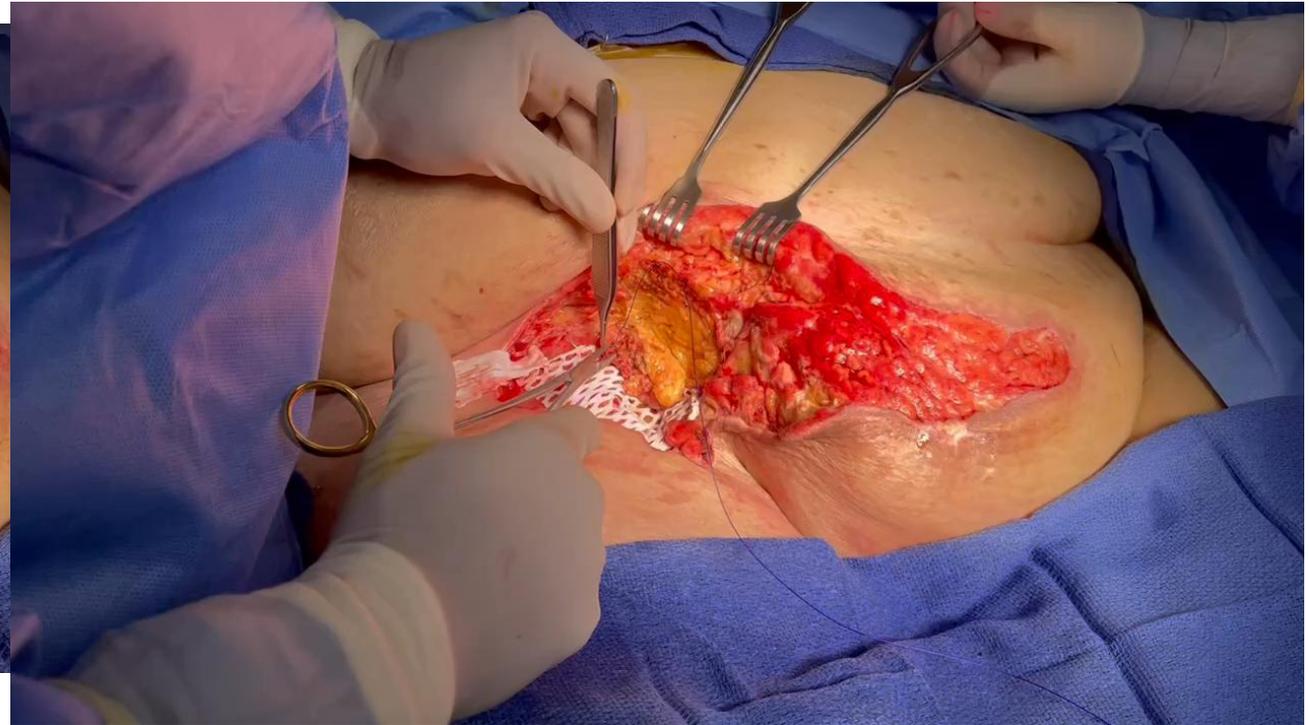
Placental allograft utilized to optimize wound bed

Full-Thickness Necrosis Groin (Day 14)



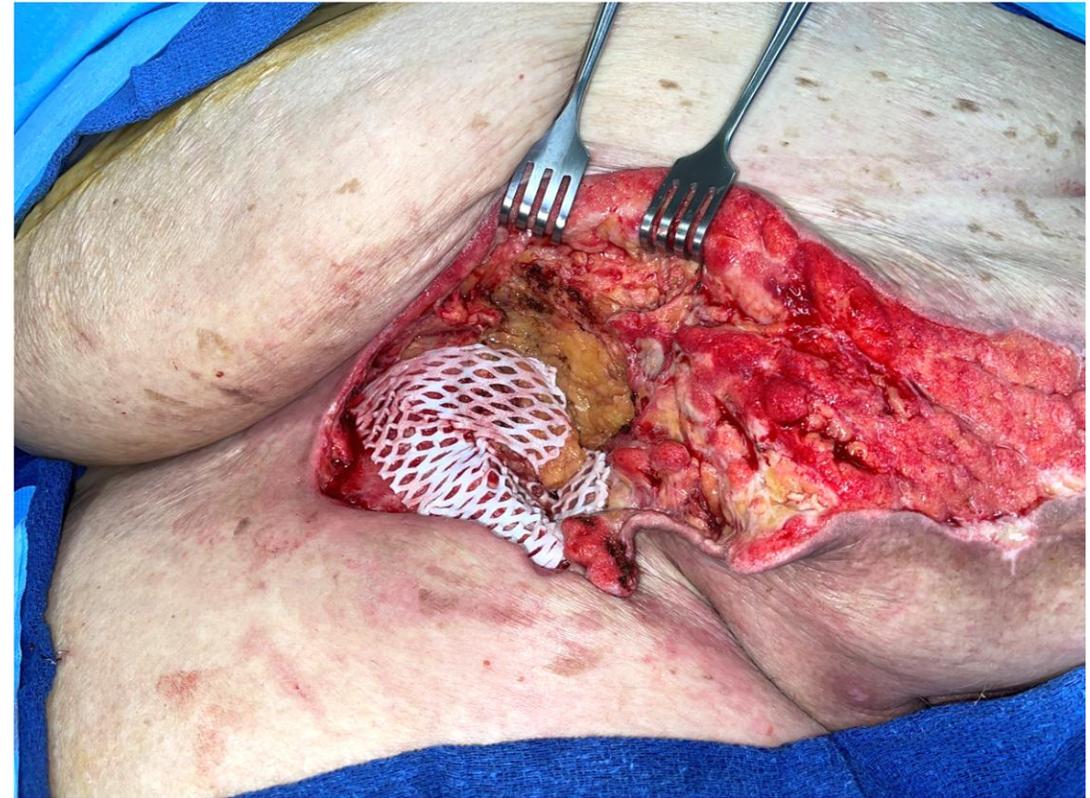
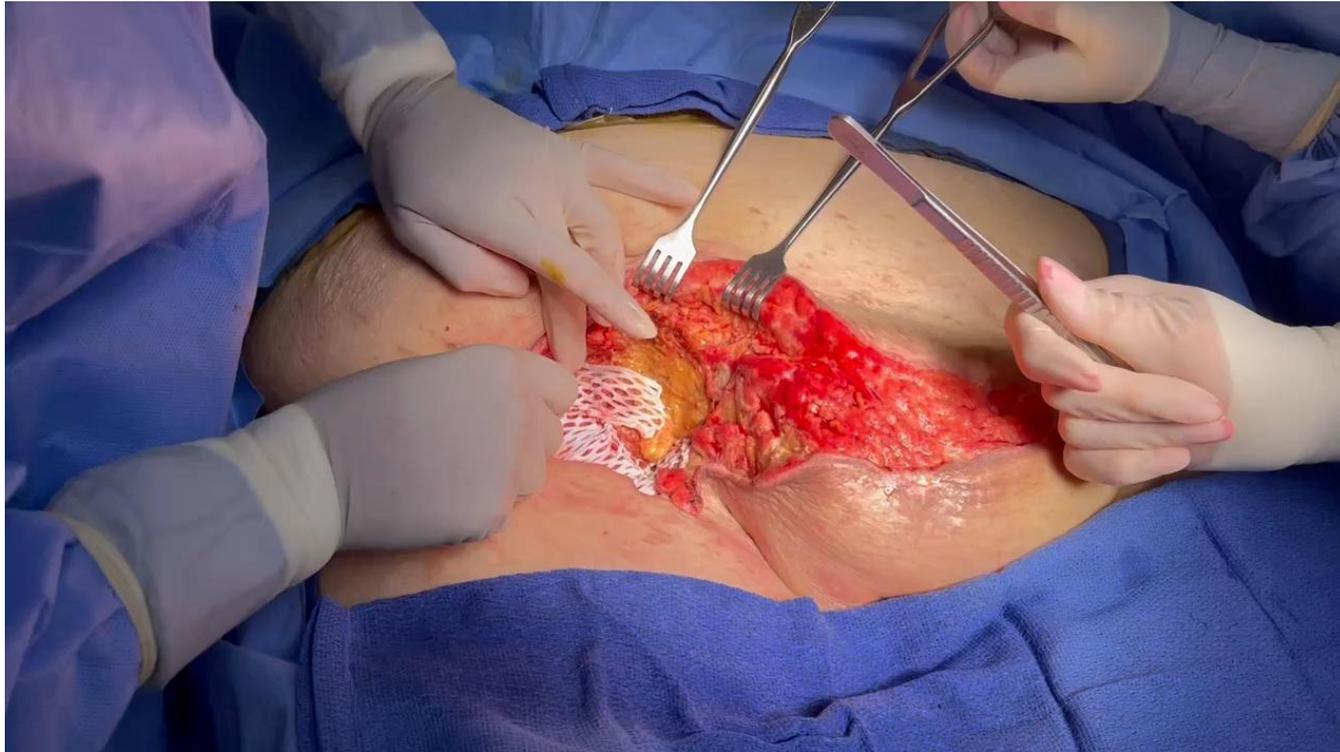
Reticular dermal matrix utilized as soft-tissue scaffolding

Full-Thickness Necrosis Groin (Day 14)



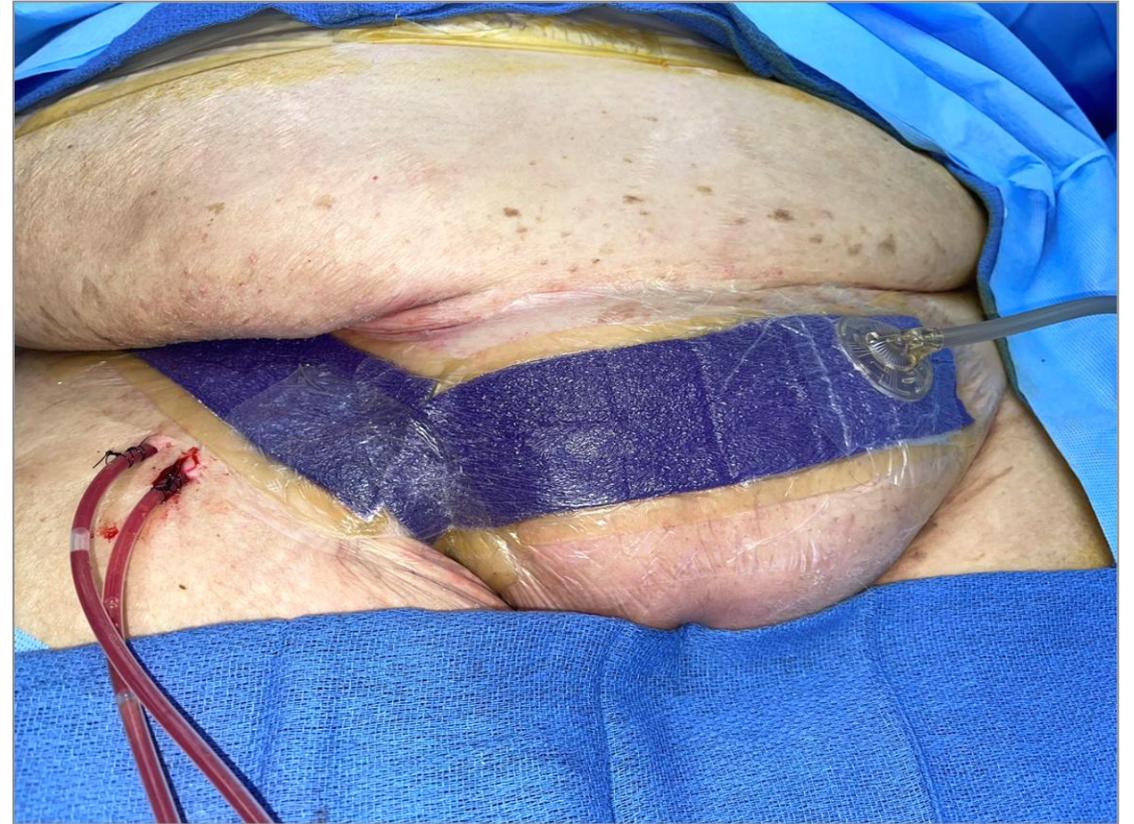
Layered support with reticular dermal matrix and native flap tissue

Full-Thickness Necrosis Groin (Day 14)



Layered support with reticular dermal matrix and native flap tissue

Full-Thickness Necrosis Groin (Day 14)



Closure performed and NPT placed

Full-Thickness Necrosis Groin (Day 24)



NPT dressing and drains removed; patient returned to care facility and started on physical therapy

Full-Thickness Necrosis Groin (Day 26)



Incision dehiscence

Full-Thickness Necrosis Groin (6 Wks)



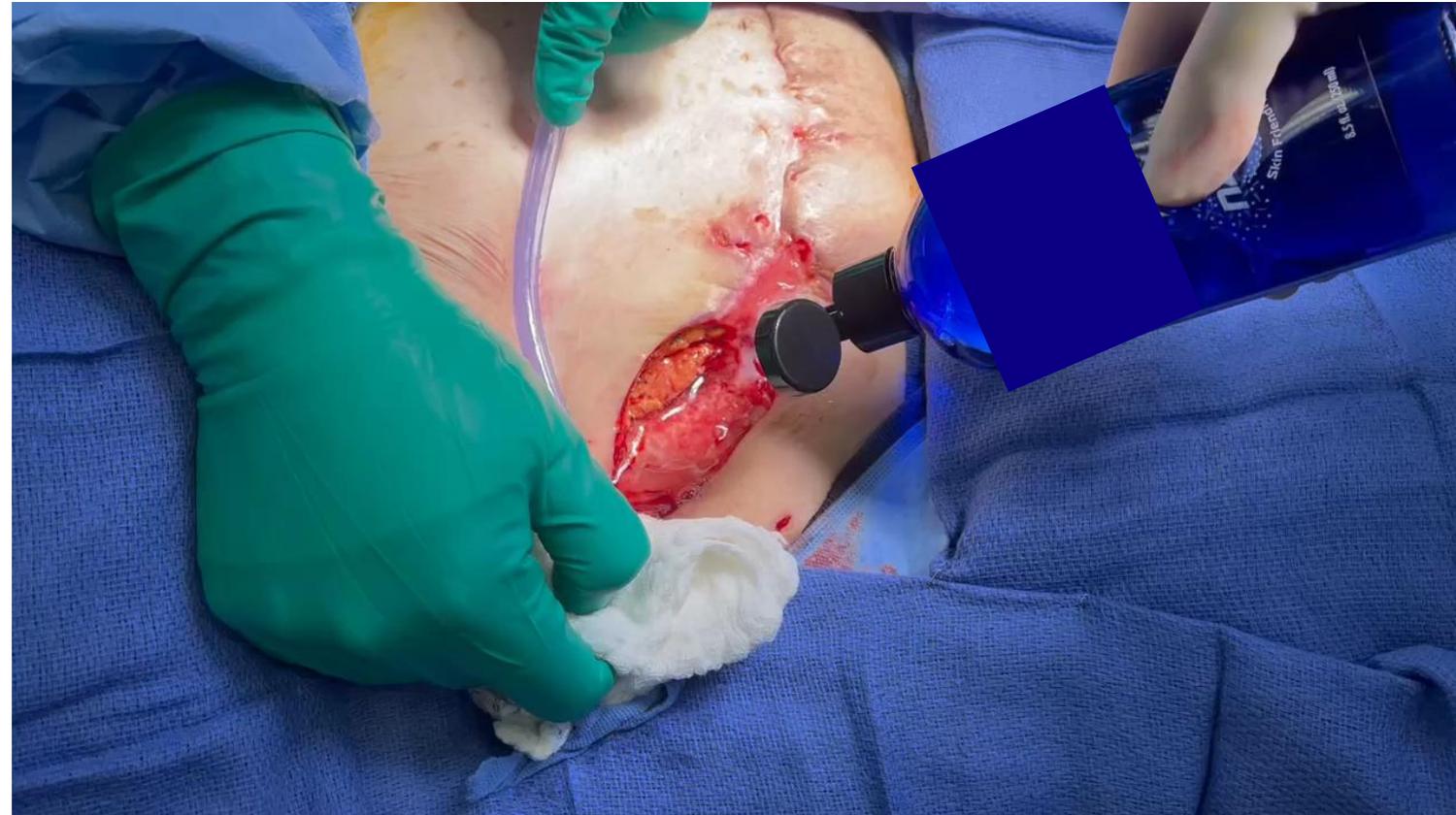
Dermal matrix completely incorporated with no vessel exposure

Full-Thickness Necrosis Groin (8 Wks)



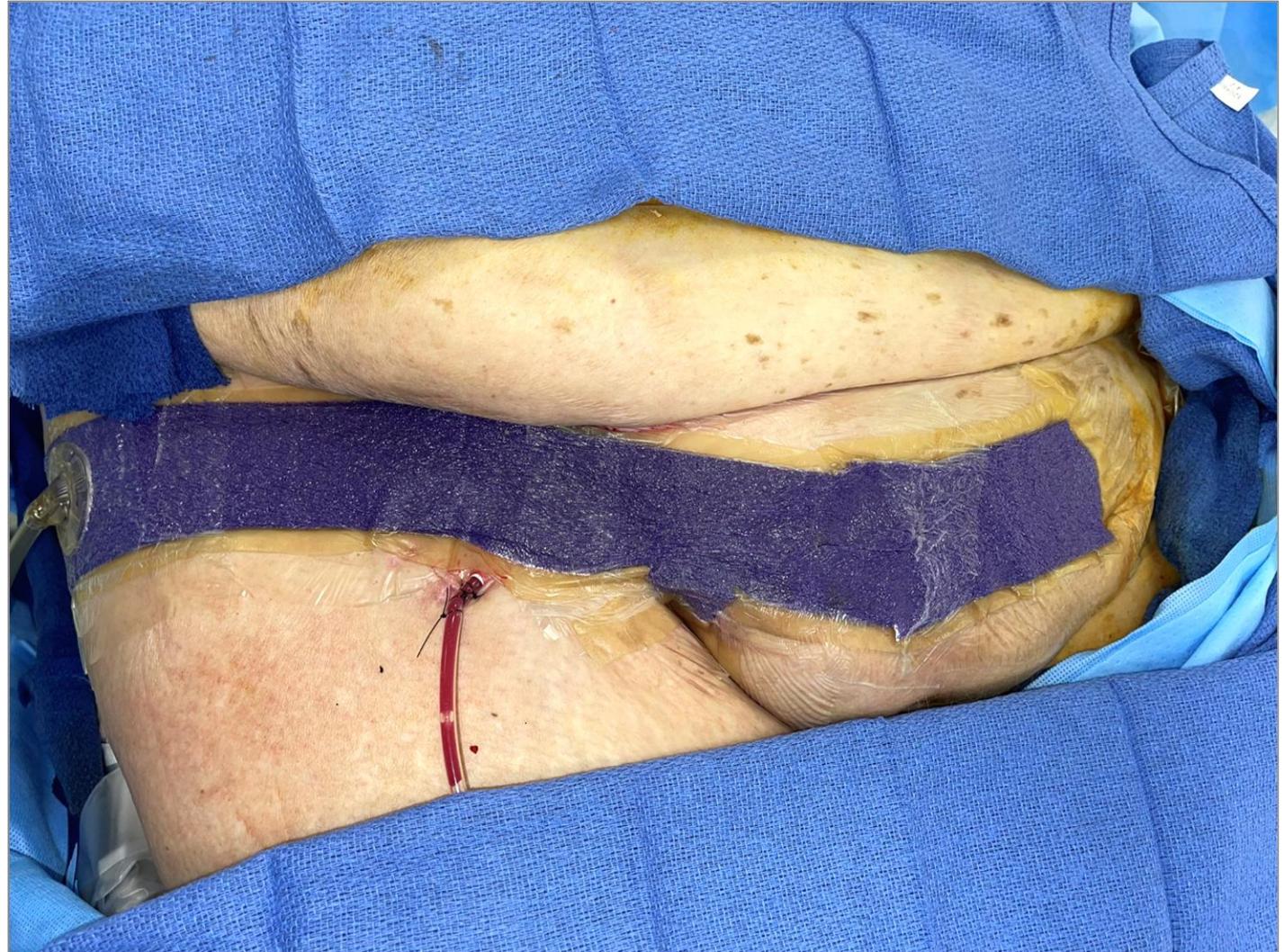
Dermal matrix completely incorporated with no vessel exposure

Full-Thickness Necrosis Groin (8 Wks)



pHA placement and soak for 10 min

Full-Thickness Necrosis Groin (8 Wks)



Closure performed and NPT placed

Full-Thickness Necrosis Groin (3 Months)



Healed; no further surgical intervention needed

Case Summary: Non-Healing Surgical Wound Lower Back

- 74y Female s/p spine surgery complicated by PE requiring anticoagulation that resulted in hematoma and secondary dehiscence
- Medical history: DVT, PE (on anticoagulants)
- Treatment:
 - Taken to OR for surgical closure with finding of deep tissue abscess
 - Underwent drainage of abscess and debridements
 - **Intraoperatively, pHA utilized as 10-min soak**
 - NPWTi-d initiated with pHA

 - Returned to OR 72 hrs for definitive surgical closure
 - **Intraoperatively, pHA utilized as 10-min soak**
 - Placental allograft placed to optimize healing
 - NPT initiated for incisional management immediately following closure

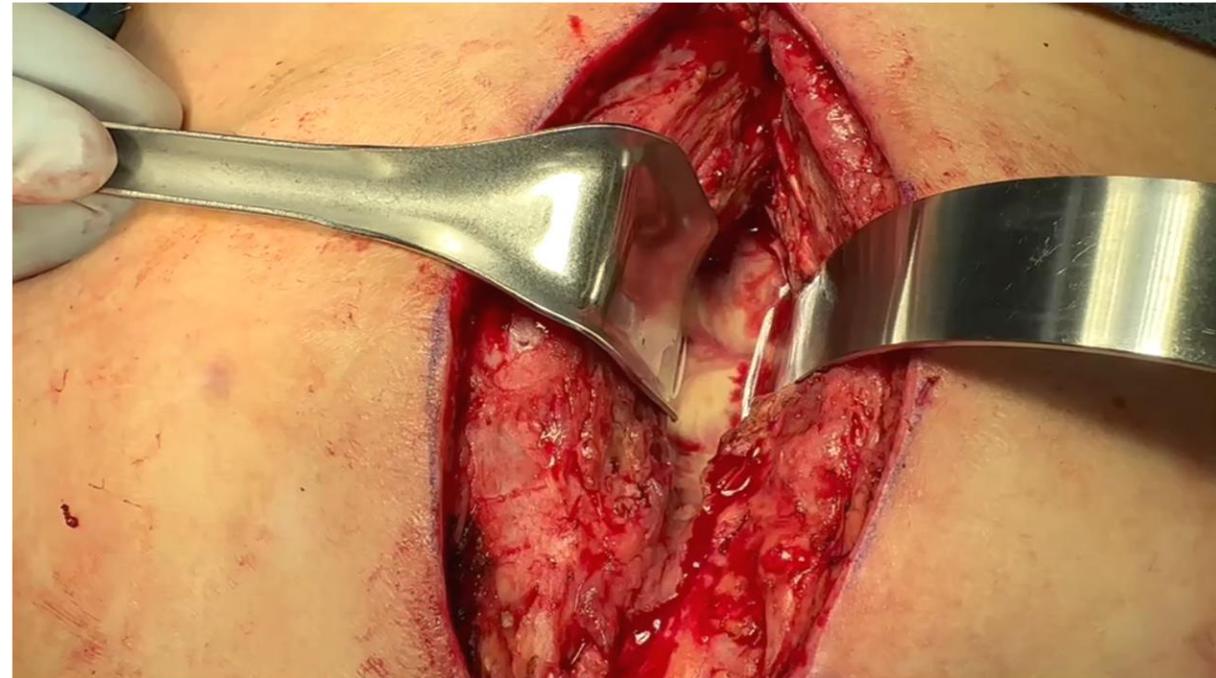
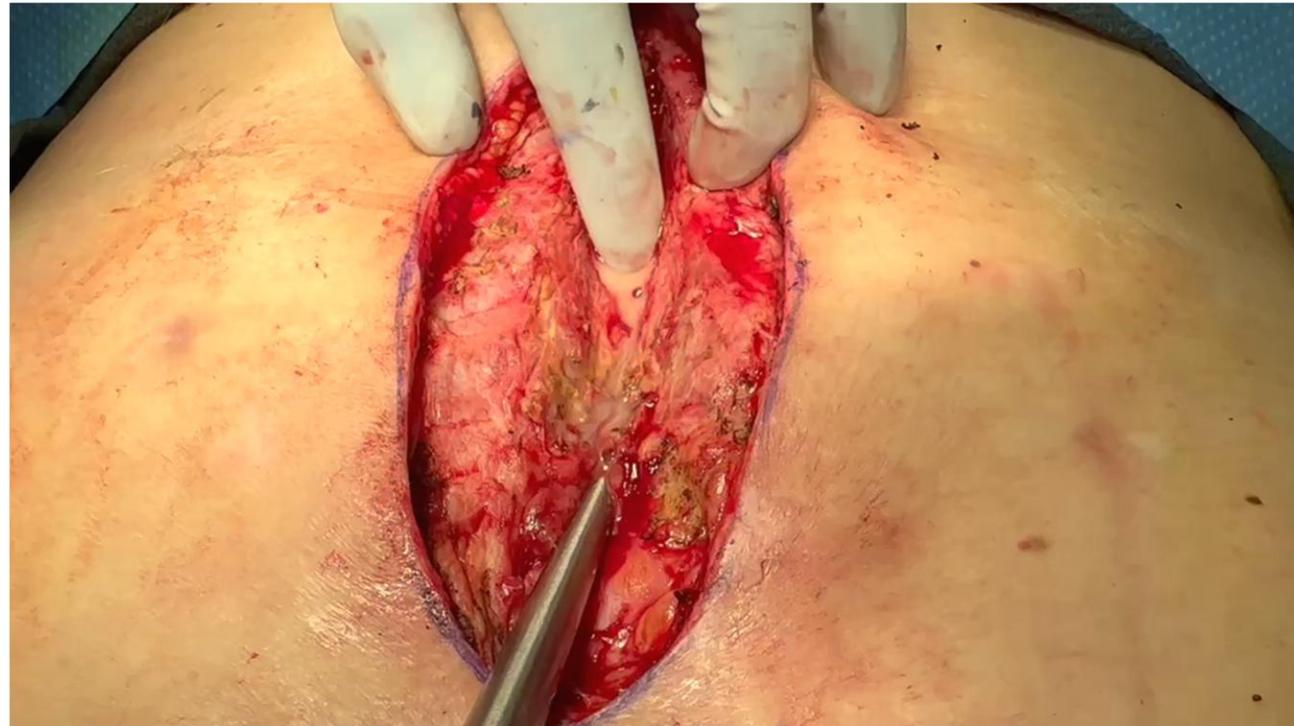
Non-Healing Surgical Wound, Back (Day 1)



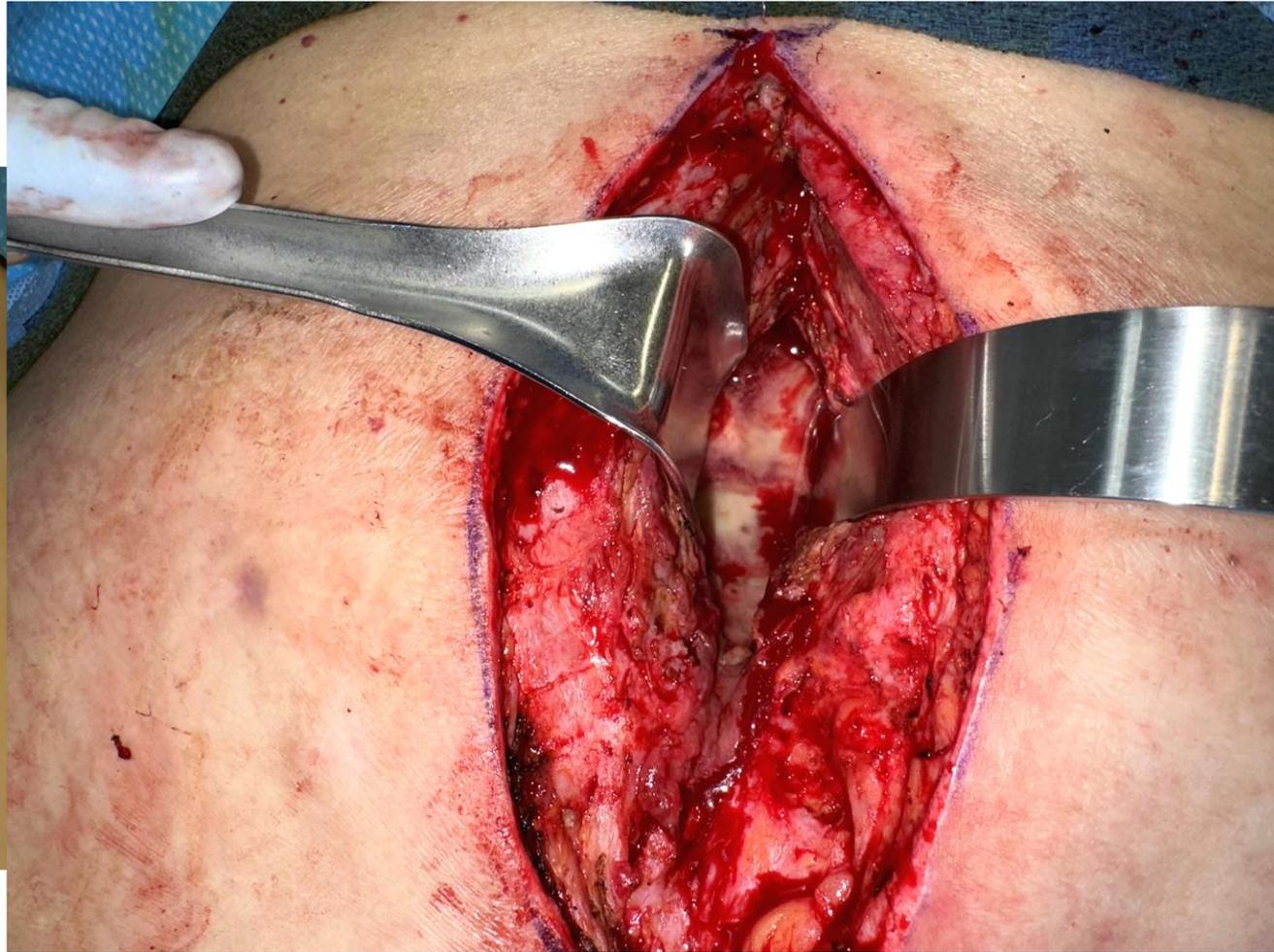
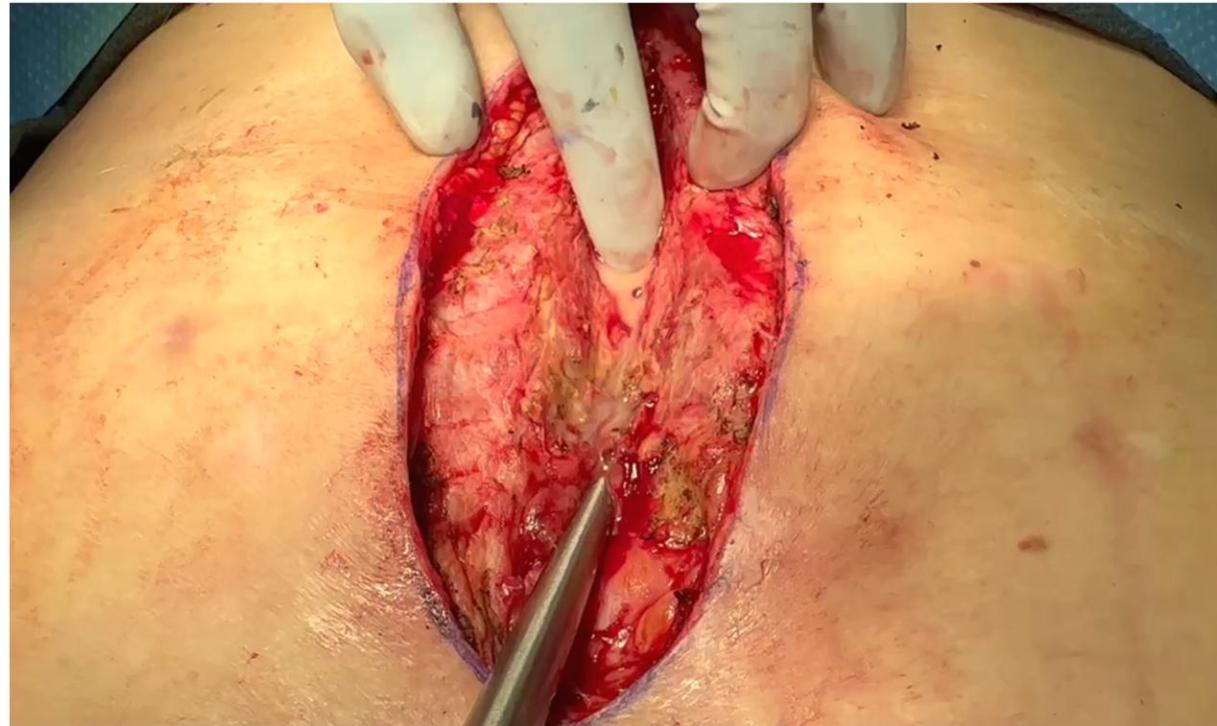
Non-Healing Surgical Wound, Back (Day 1)



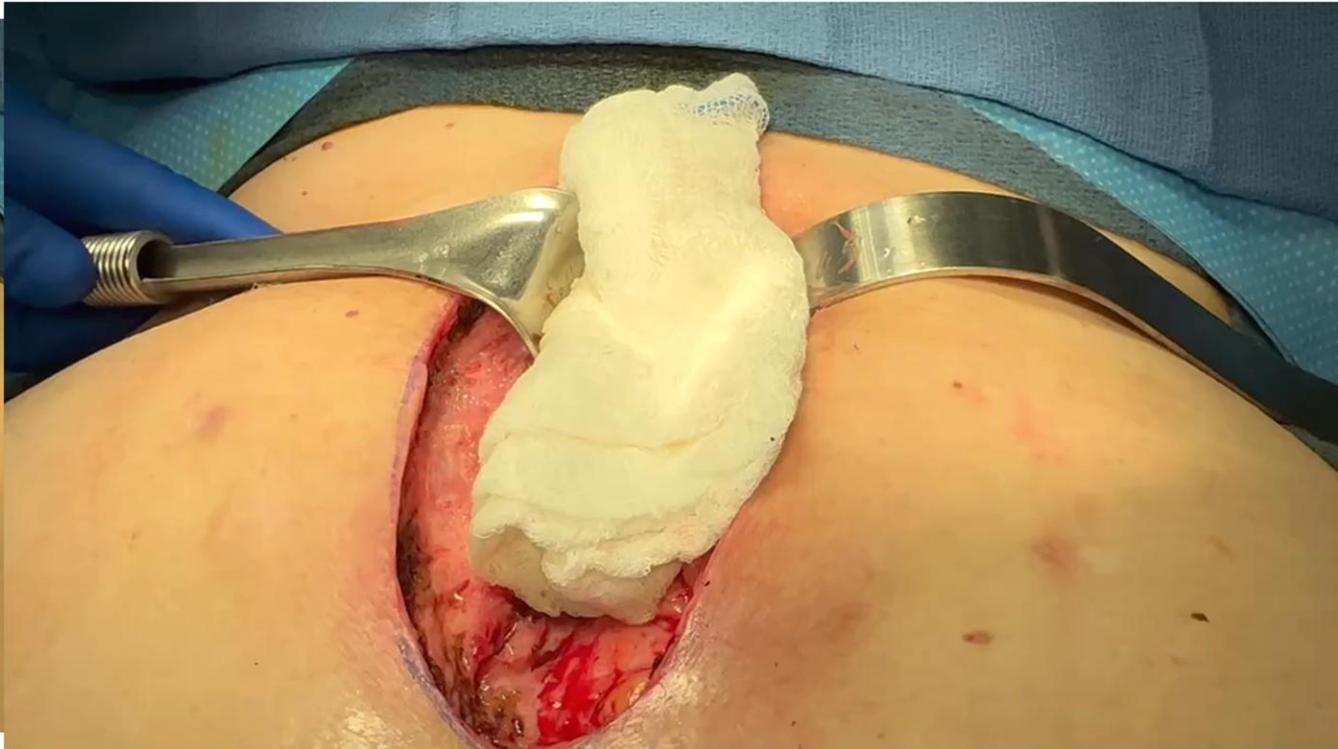
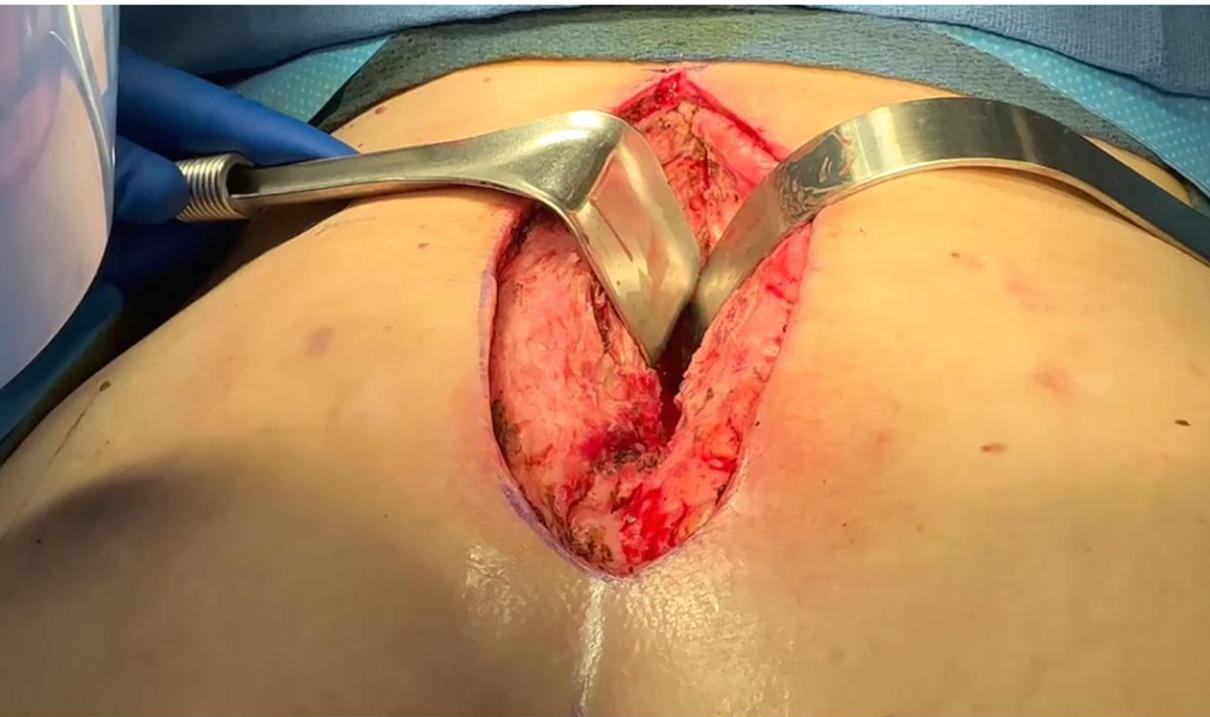
Non-Healing Surgical Wound, Back (Day 1)



Non-Healing Surgical Wound, Back (Day 1)



Non-Healing Surgical Wound, Back (Day 1)



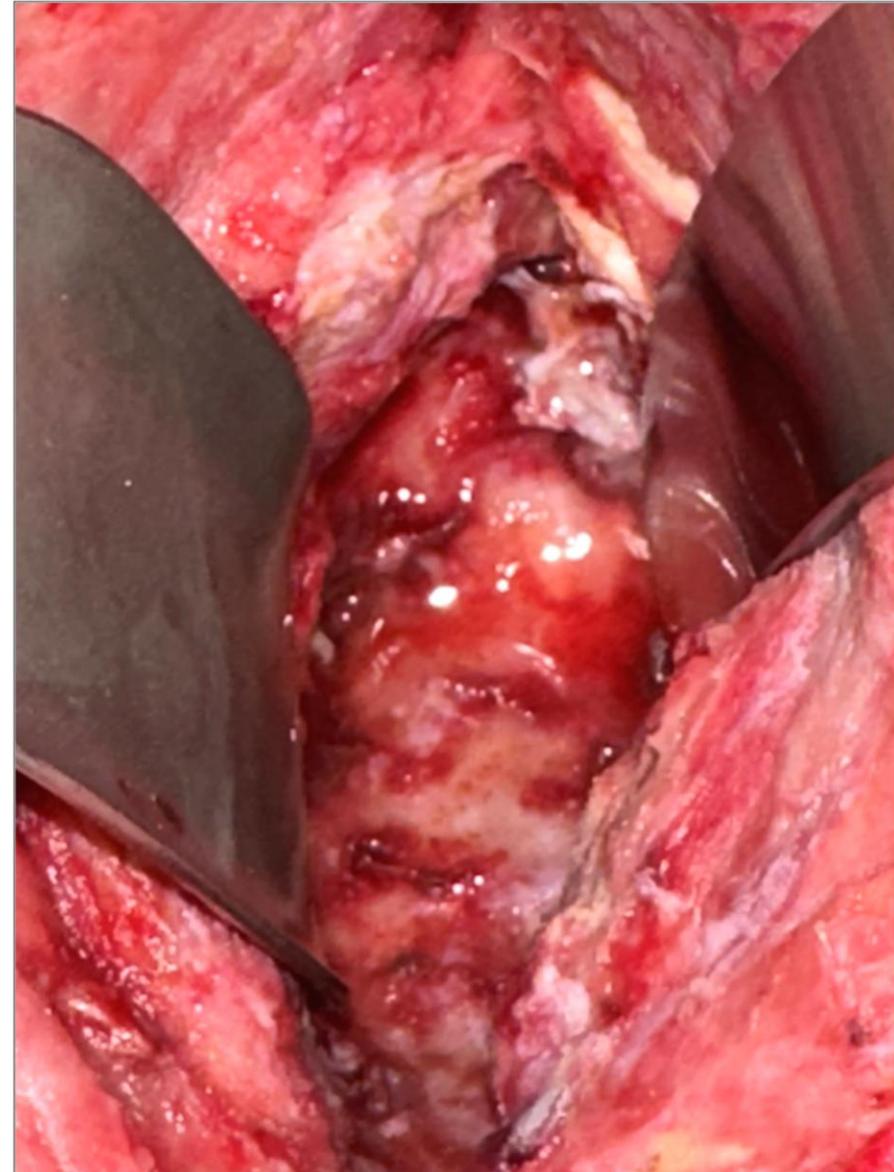
Non-Healing Surgical Wound, Back (Day 1)



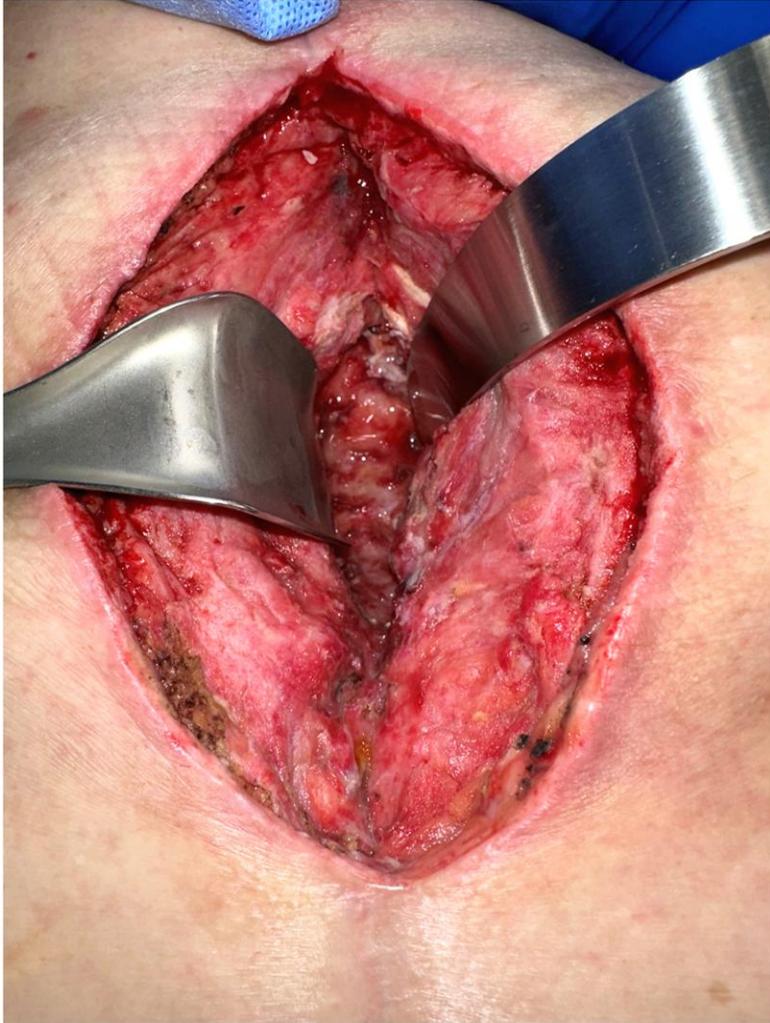
Non-Healing Surgical Wound, Back (Day 3)



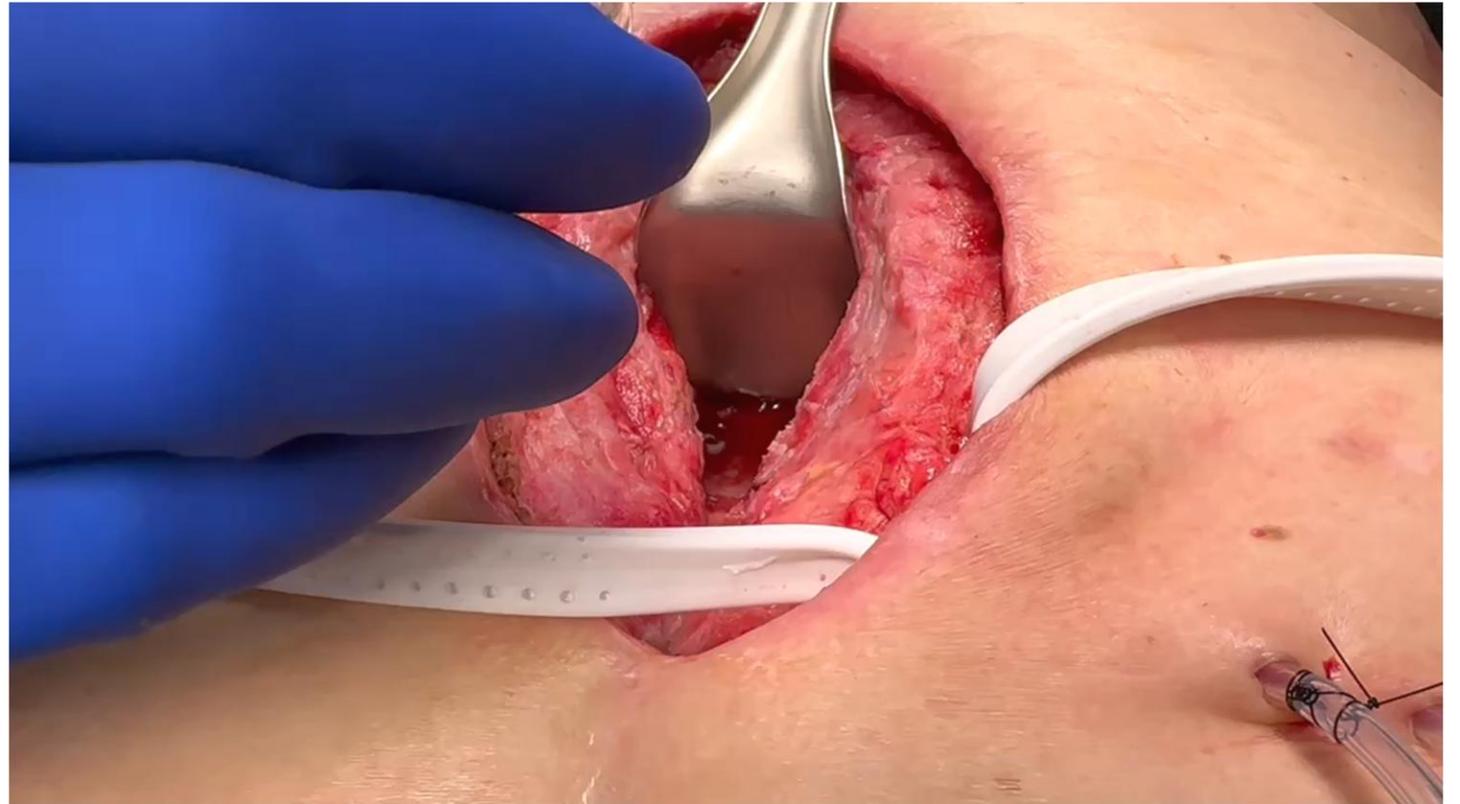
Non-Healing Surgical Wound, Back (Day 3)



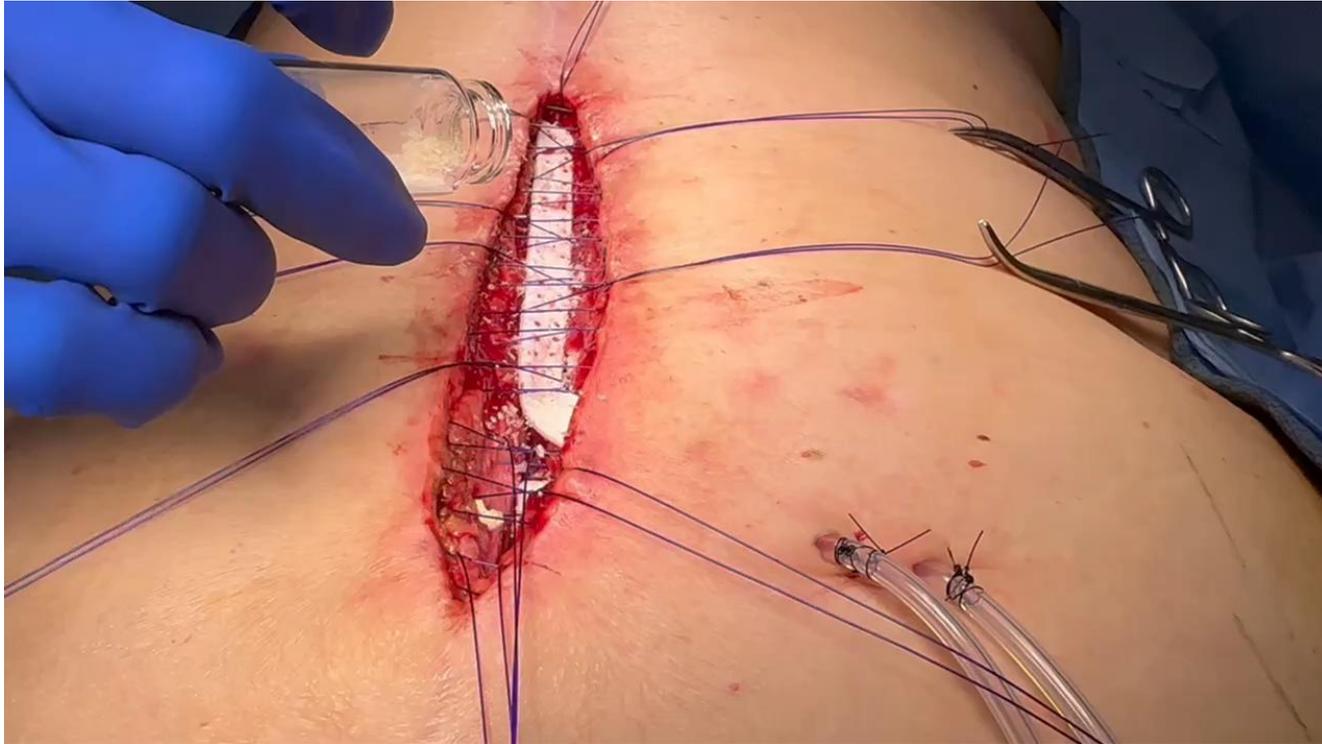
Non-Healing Surgical Wound, Back (Day 3)



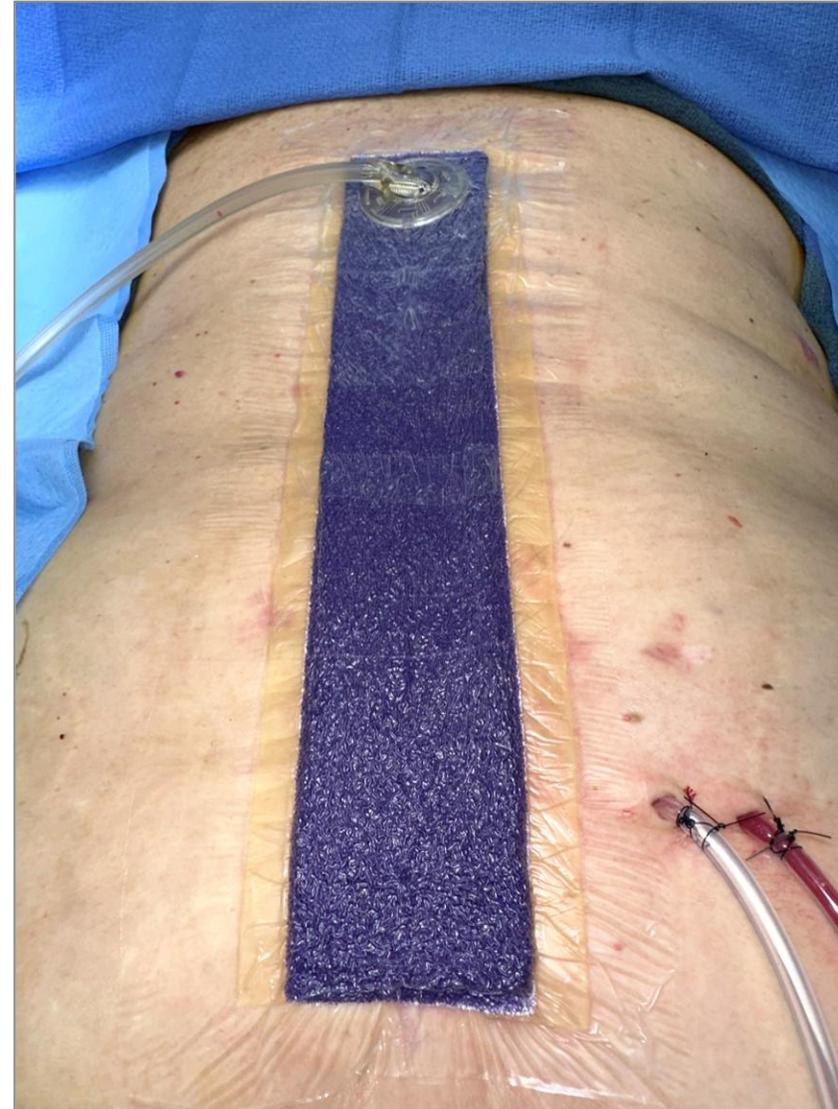
Non-Healing Surgical Wound, Back (Day 3)



Non-Healing Surgical Wound, Back (Day 3)



Non-Healing Surgical Wound, Back (Day 3)



Non-Healing Surgical Wound, Back (2 Wks)



Non-Healing Surgical Wound, Back (4 Wks)



Non-Healing Surgical Wound, Back (6 Wks)



Non-Healing Surgical Wound, Back (3 Months)



Integral Debridement: To Optimize the Reconstructive Ladder

Prior Planning Prevents Piss Poor Performance

~ U.S. Army

WISEFAMOUSQUOTES.COM

Types of Debridement



The Need for Debridement Options

Current State:

- Feeling stuck in a pigeonhole of 5 ways to prepare a wound bed

Clinician Wants:

- To safely clean a wound and “do no harm” to healthy tissue
- Something with diverse use cases and safe with other modalities

Market:

Evolutionary
vs
Revolutionary

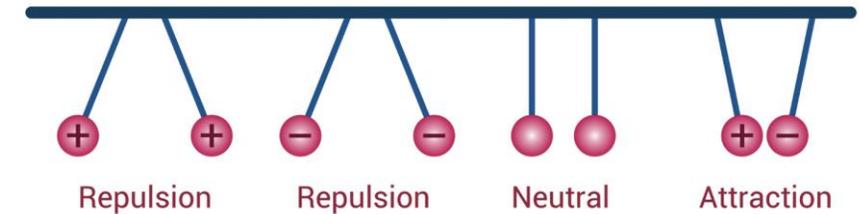
New Concept: Charged Fiber Technology

- Absorbent fiber dressing with TLC-Ag matrix
- Lipido-colloid technology with silver salts
- Cleaning action plus antimicrobial barrier protection

- Opposites attract
- Works by electrostatic interactions



Laws of attraction and repulsion



Venous Leg Ulcer



Day 0: Application of new dressing



Day 7: Tissue softer



Day 14: Slough thinner



Day 28: Reduction of slough



Day 35



Day 42: Wound smaller

Case Summary: Right Ischial Pressure Ulcer

- 61y Male with paraplegia with h/o multiple pressure ulcers, including progressive right ischial ulcer with necrotic debris despite wound management and offloading
- Medical history: Paraplegia
- Treatment
 - Clostridial collagenase utilized following office excisional debridements
 - Negatively charged dense fibers added to clostridial collagenase to expedite debridement
 - Taken to OR for flap closure once wound bed preparation deemed adequate
 - Placental allograft placed to optimize healing
 - Incisional NPWT initiated with a customizable incision management dressing immediately following closure

Necrotic Pressure Ulcer (Day 1)



Debridement supported with negative charged fibers applied daily

Necrotic Pressure Ulcer (Days 1, 7)



Necrotic Pressure Ulcer (Day 7)



Necrotic Pressure Ulcer (Day 7)



Necrotic Pressure Ulcer (Day 7)



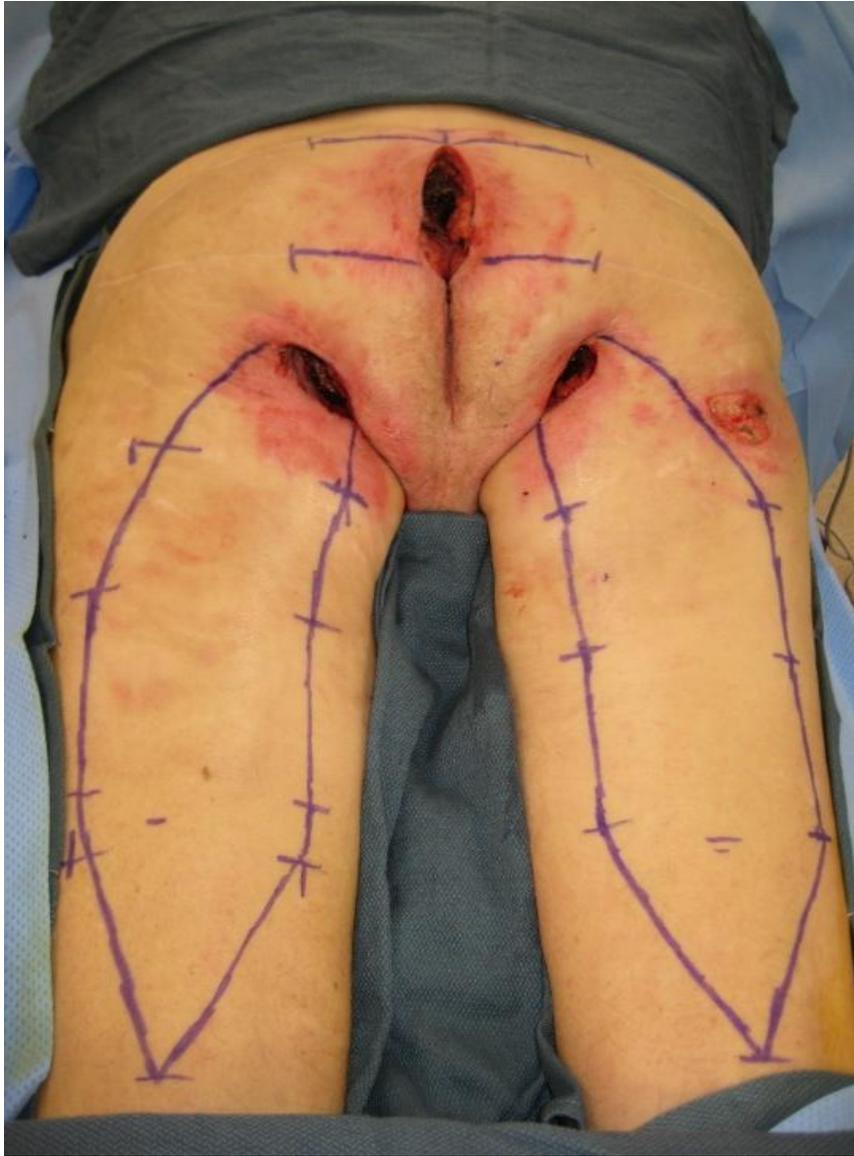
Debridement supported with negatively charged fibers applied daily until definitive surgical closure performed



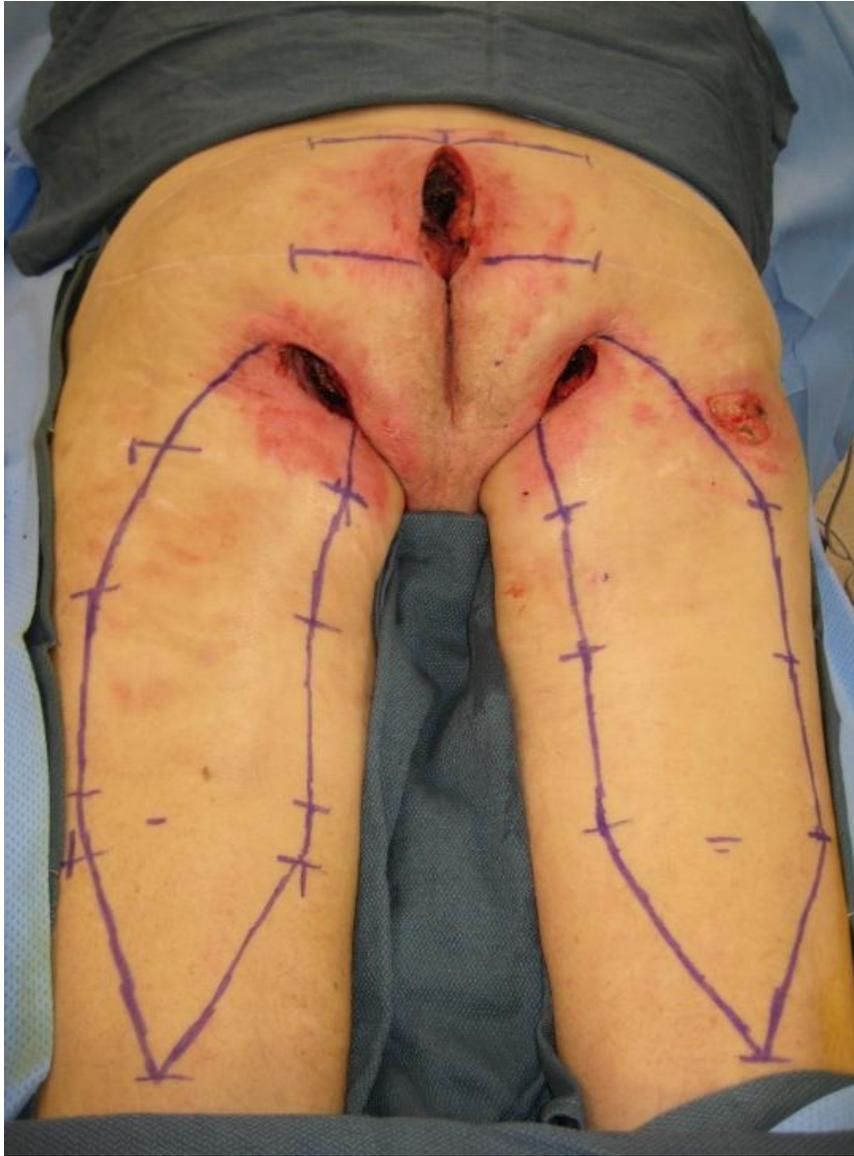
Necrotic Pressure Ulcer (6 Wks)



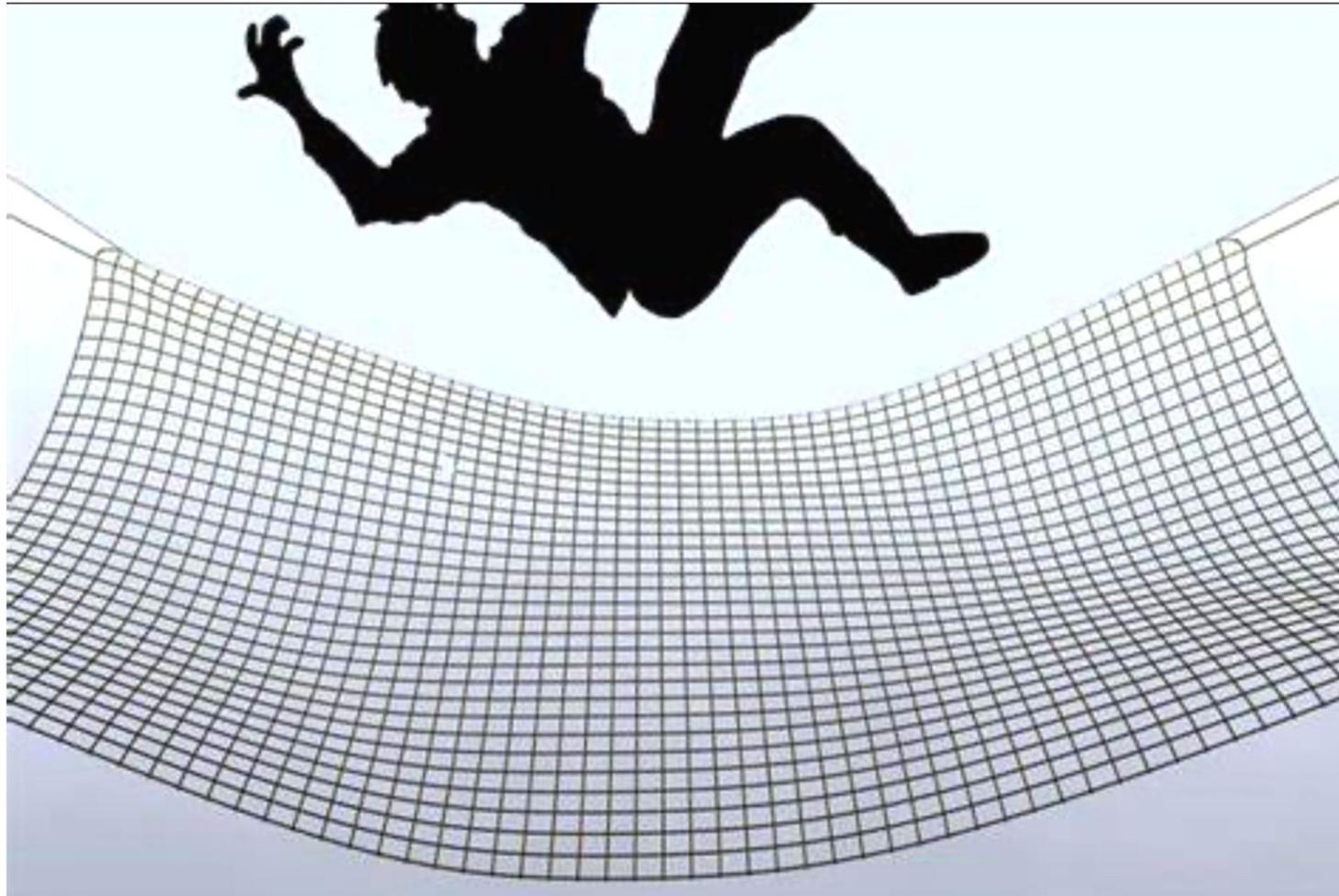
Less Is More!



Less Is More!



If you fall, have a safety net!



Sacral Ulcer, Stage 4 (Day 21)



Sacral Ulcer, Stage 4 (Day 21)



If you fall, have a team to catch you!



Summary

- **The reconstructive ladder is evolving** and now takes into consideration additional technologies to optimize surgical outcomes
- **Integral debridement is an inherent part of wound bed preparation** for surgical and non-surgical closure
- pHA preserved cleanser that has been utilized in wound cleansing may be beneficial for patients who undergo surgical wound reconstruction
- Negatively charged fibers may assist in the removal of slough, bioburden, and necrotic tissue, and associated debris that may lead to infection in highly complex wounds
- pHA seems to be compatible with the use of biological matrices, which may be used to modify the reconstructive ladder and/or be used as a “back up” plan

Thank You