Integral Debridement Day

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Faculty Disclosures

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Disclosures

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- Applicable CME staff have no relationships to disclose relating to the subject matter of this activity
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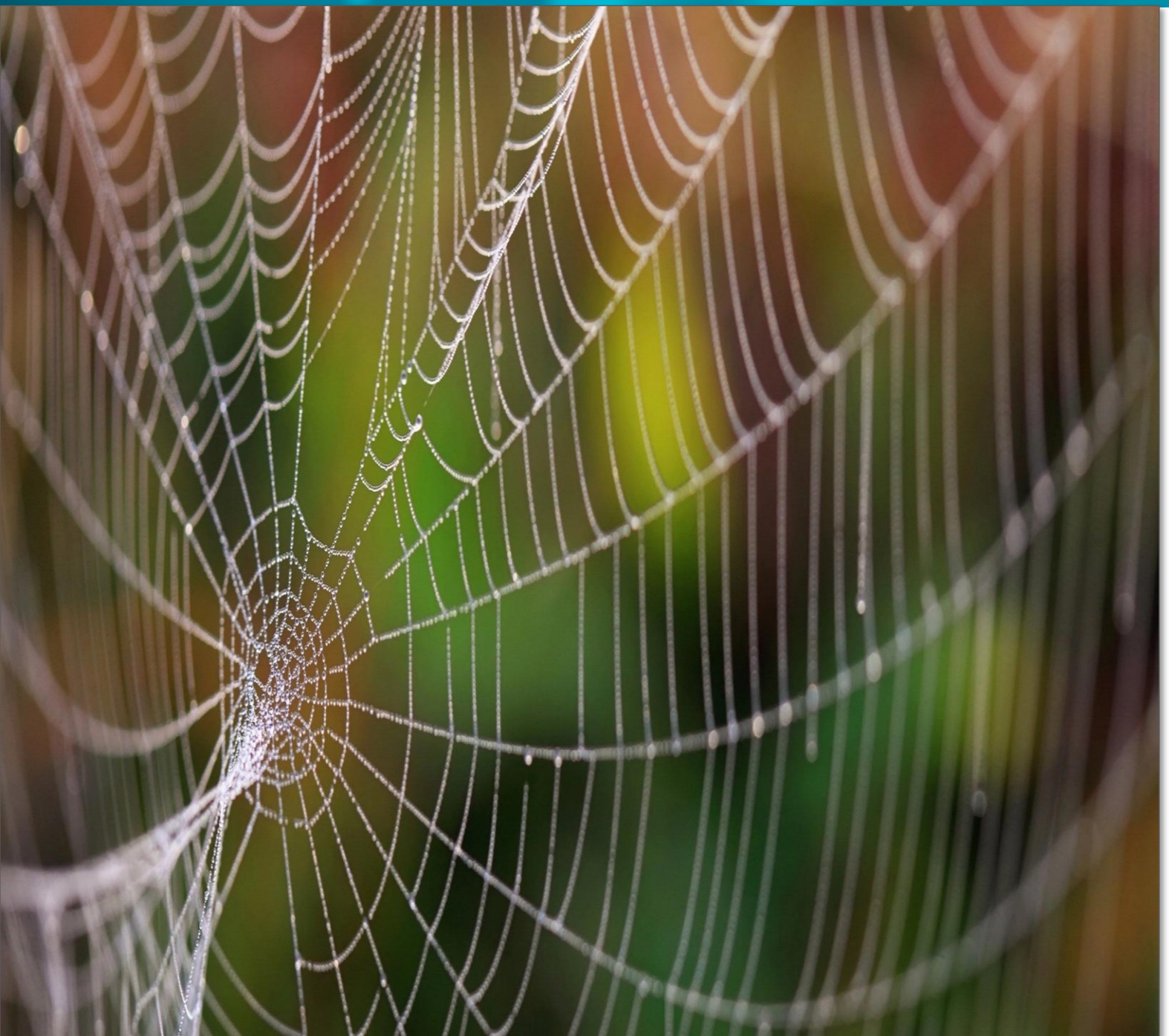
Submit questions at any time via the Question Box

We look forward to hearing from you!

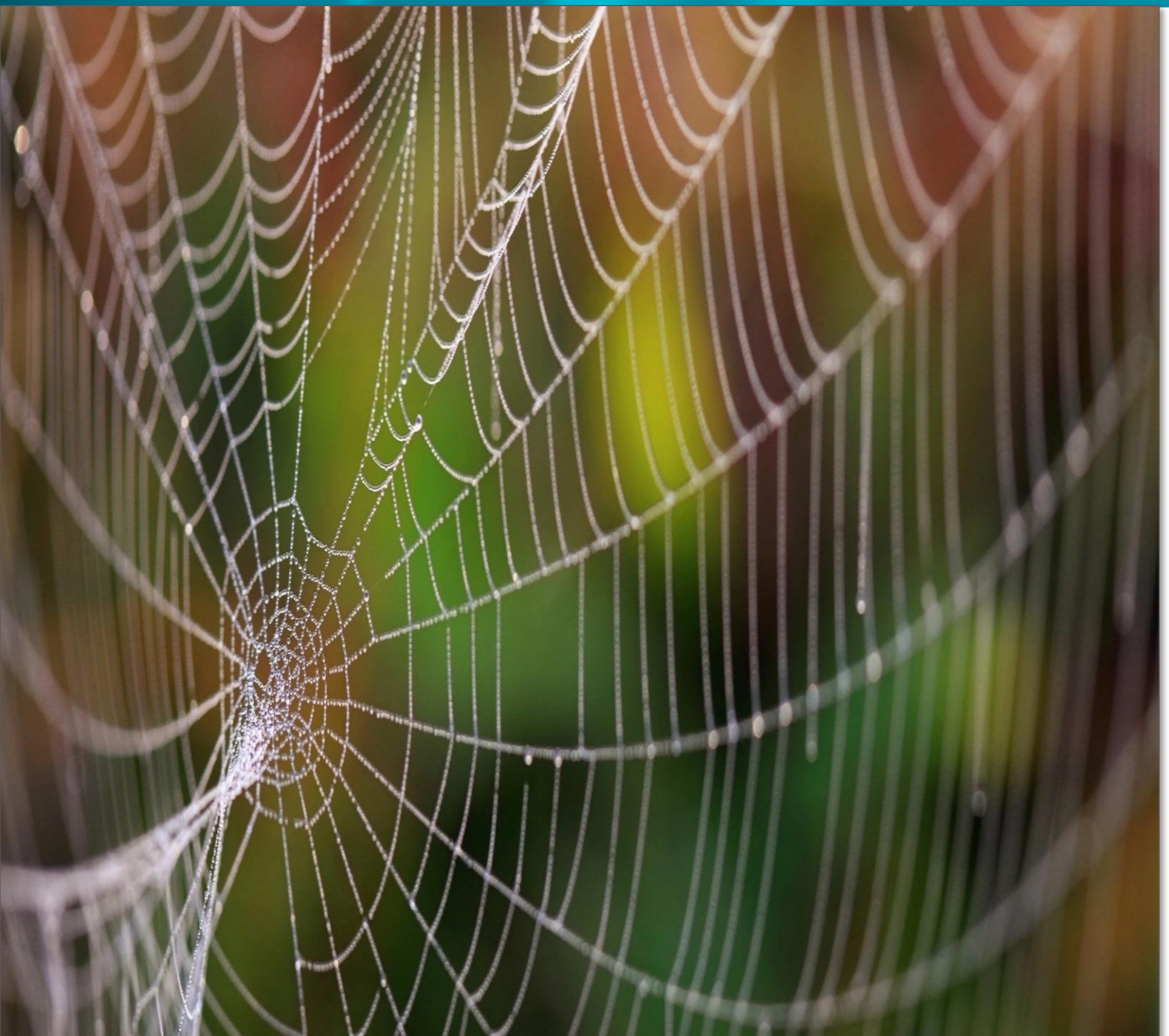
Learning Objectives

- Outline current and emerging debridement techniques and techniques that aid or support debridement
- Identify the mechanics and physical forces of attraction behind debridement technologies and their synergies
- Assess how some products may work cooperatively in the area of necrotic matter/slough removal



What is a complex wound?

- Simply put, it's a wound on a complex patient
- Other terms used
  - Chronic
  - Hard to heal



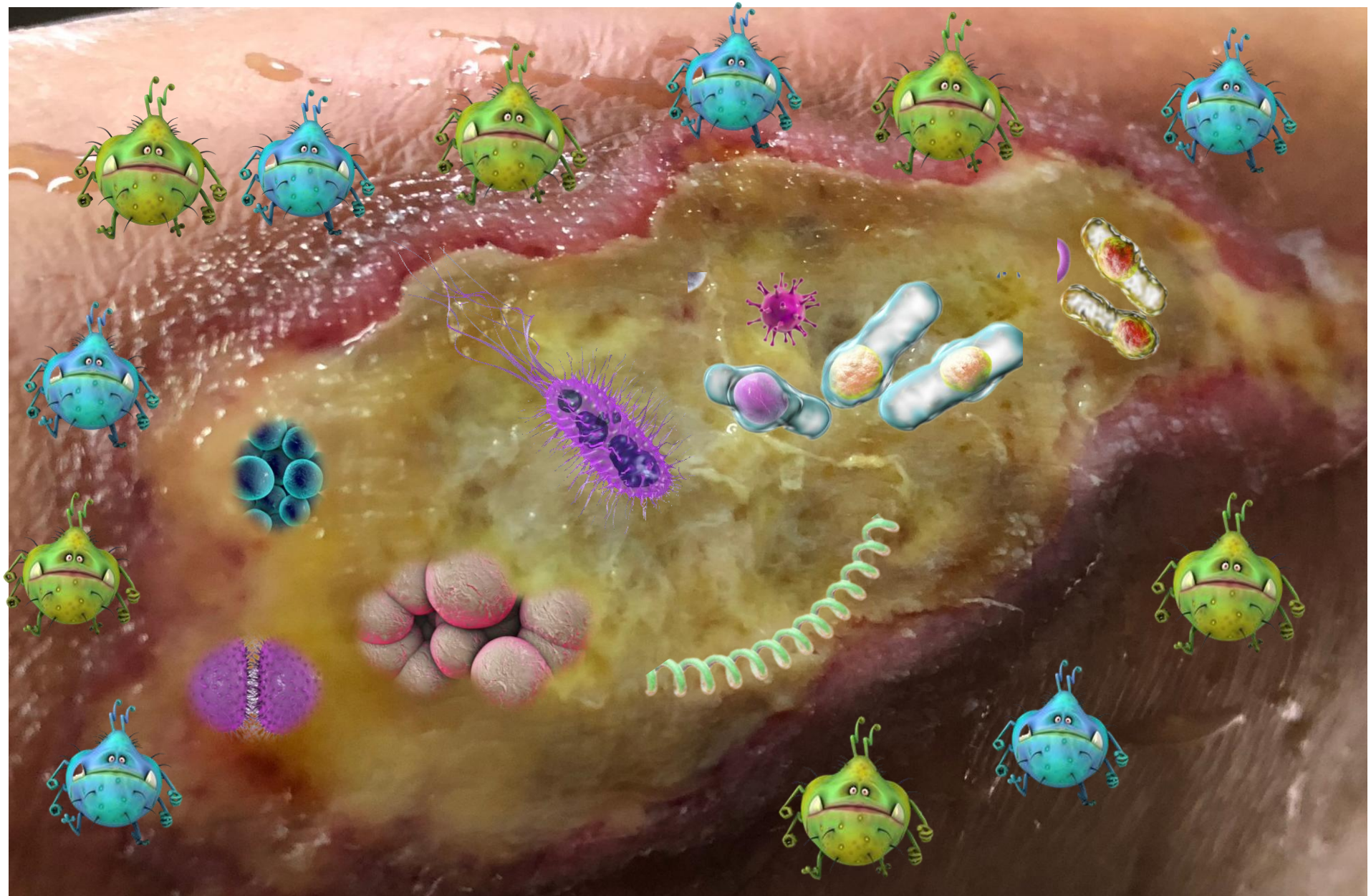
What is a complex wound?

- Simply put, it's a wound on a complex patient
- Other terms used
  - 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
  - Bacteria / biofilm
  - Proteases
  - Edema
  - pH

Necrotic Tissue Is a Buffet for Bacteria



Decision Making in Debridement

“Begin with the end in mind.”

Stephen Covey

Wound Bed Preparation / Debridement

By failing to prepare, you prepare to fail

Benjamin Franklin

Current and Emerging Techniques That Aid or Support Debridement

Abigail E. Chaffin, MD, FACS, CWSP, MAPWCA
Professor and Chief, Division of Plastic Surgery
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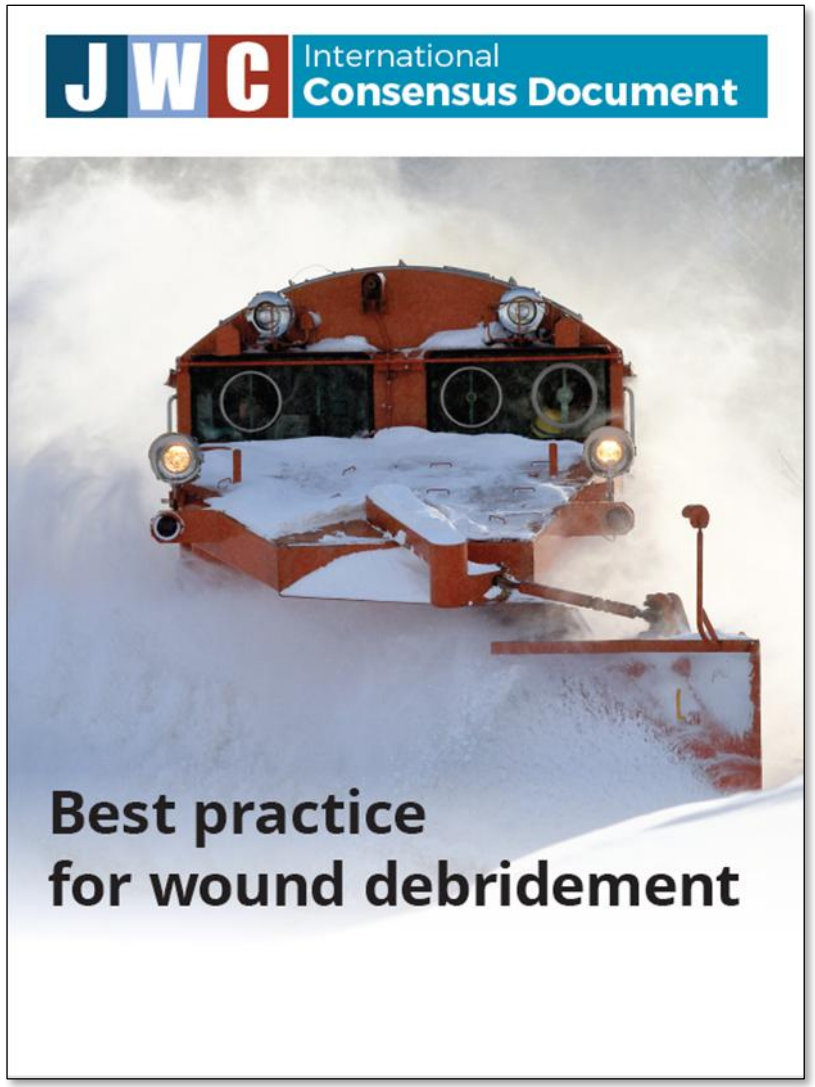
What Is Debridement, and Why Is It Important?

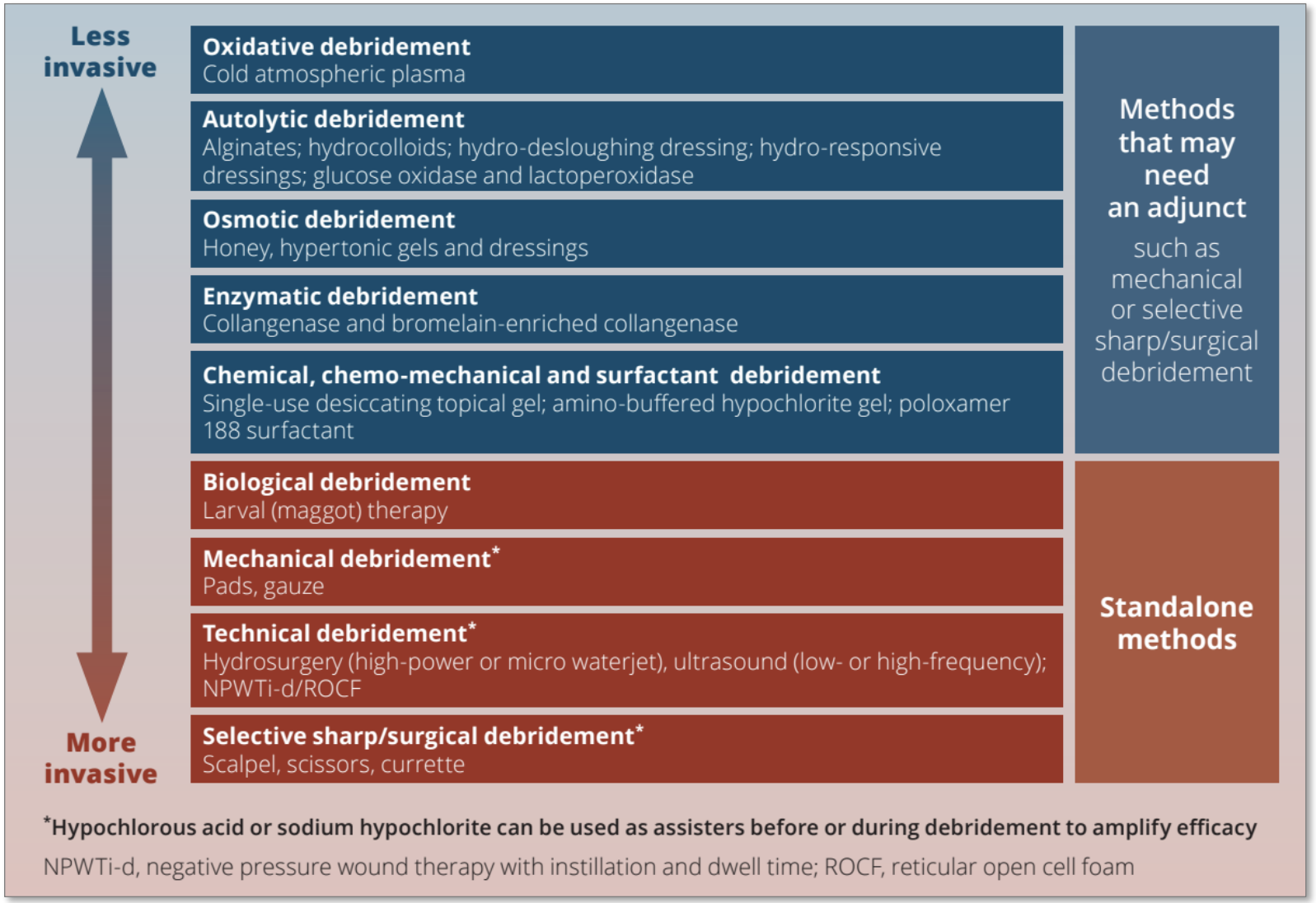
- Definition
  - The removal of viable (living) and non-viable components, including necrotic tissue, slough microorganisms, biofilm, extracellular polymeric substance (EPS), and foreign materials

- 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



Slide courtesy of Terry Swanson NP, FAWMA, FMACNP
EPS = extracellular polymeric substance.
Best Practice for Wound Debridement. *J Wound Care*. 2024;33(6):Sup C.

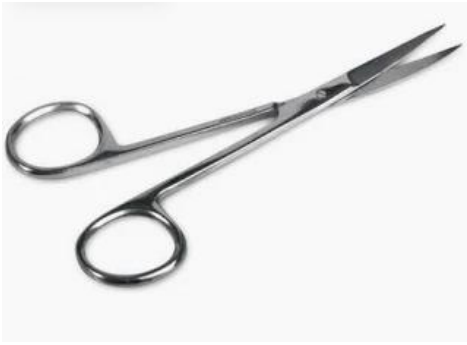
Methods of Debridement



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

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



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

Surgical vs Selective Sharp Debridement

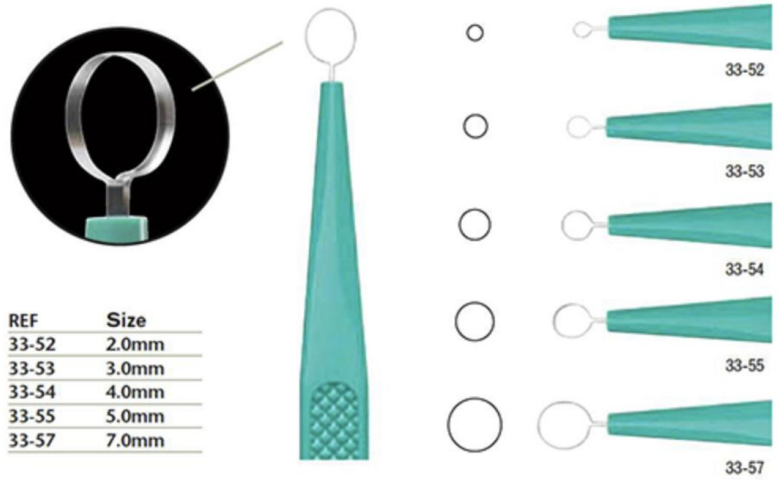
Table 2. Standalone debridement methods

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.

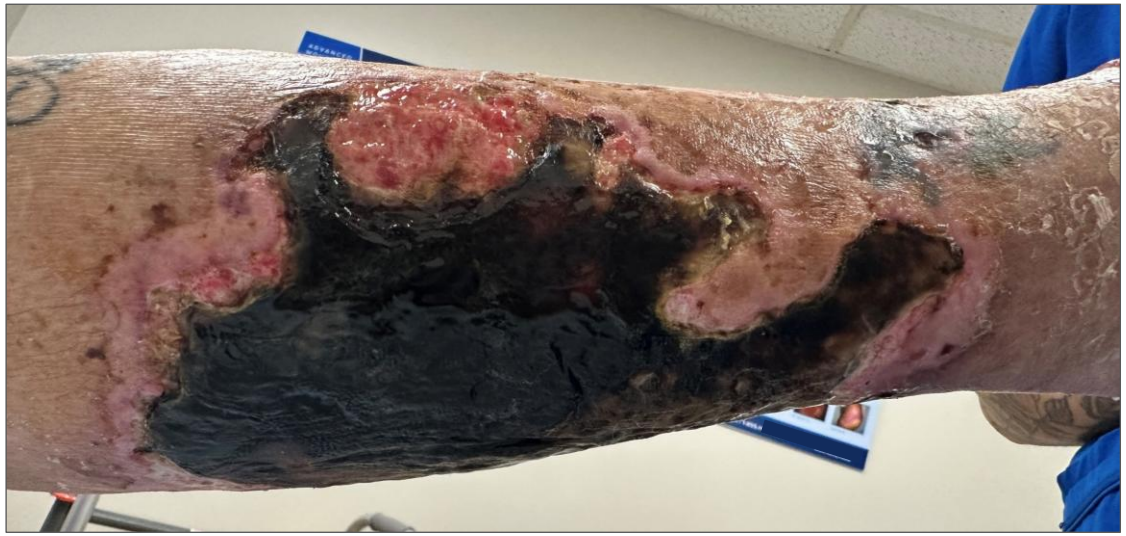
Selective Sharp Debridement

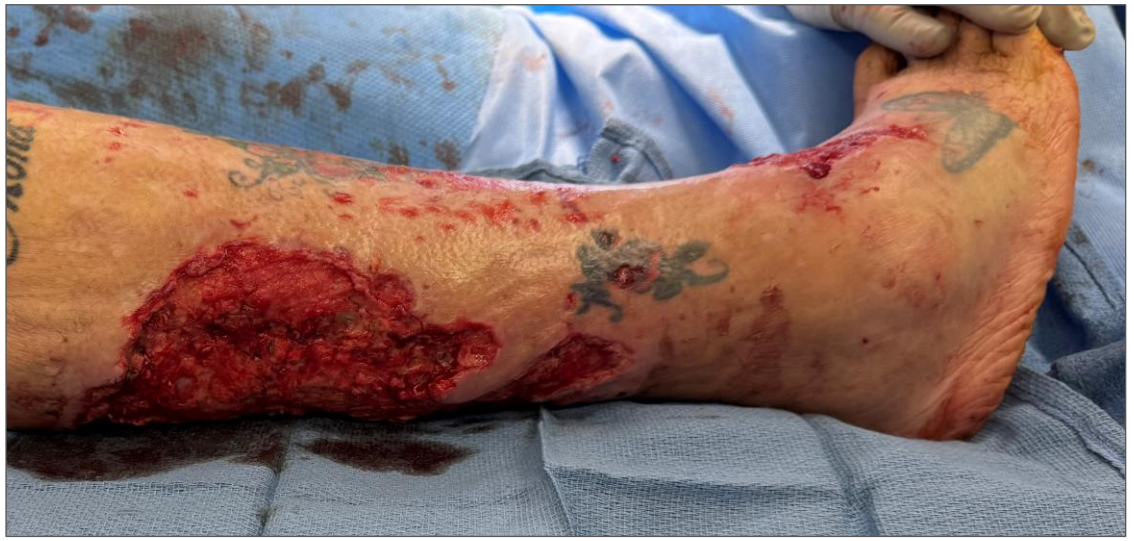
- Commonly performed in outpatient setting as part of routine wound care
- Confined to non-viable tissue, so low blood loss is anticipated
- If patient has bleeding tendencies, then appropriate precautions are taken
- Identify and manage procedural pain
- Skilled healthcare professional with necessary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



Surgical Debridement

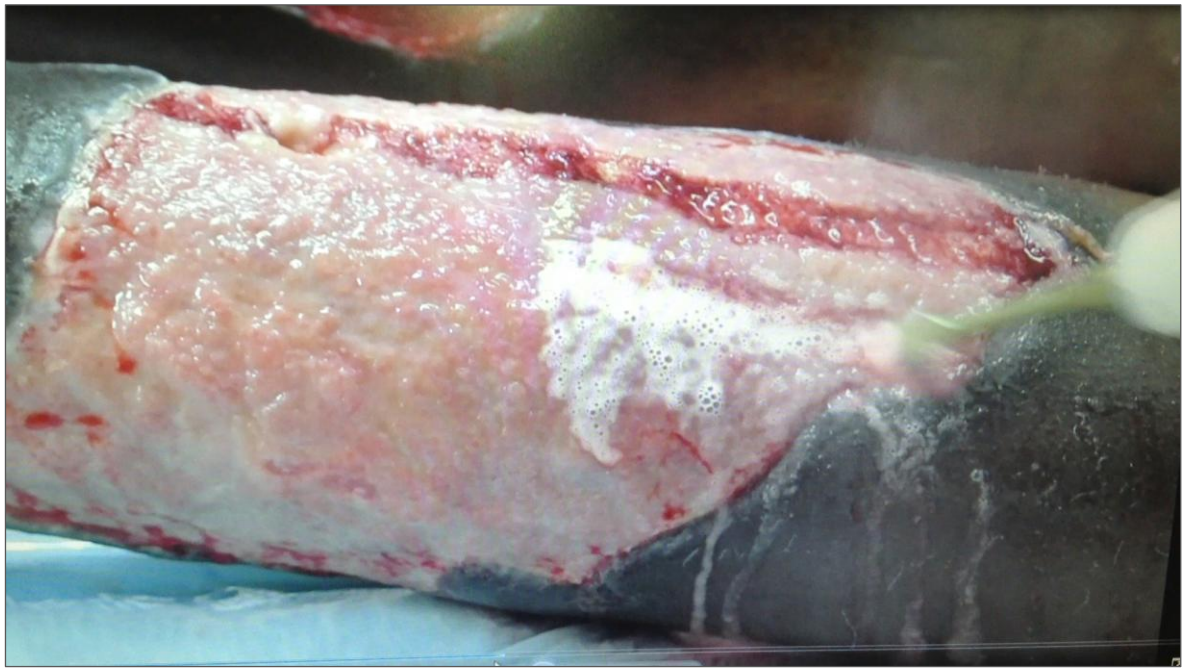
- Performed in the operating room or designated procedure room, at the bedside in post-acute settings
- Completed by a surgeon or trained wound care professional
- Excision into viable tissue
- Can include full-thickness wounds with extensive necrotic tissue, deep structures, or complex patients requiring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





Integral Debridement

- Definition
  - The combined use of different but complementary methods of debridement on the same wound
- Purpose
  - Allow healthcare professionals to make more informed decisions regarding the selection and application of debridement methods, tailoring for the individual requirements after assessing the patient, the wound, and their environment



Slide courtesy of Terry Swanson NP, FAWMA, FMACNP
Best Practice for Wound Debridement. *J Wound Care*. 2024;33(6):Sup C.

Adjunctive Therapies/Assisters (Amplifiers) for Debridement

Table 1. Summary of debridement methods needing an adjunct procedure

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.

DFU=diabetic foot ulcer; ROS=reactive oxygen species; WBP=wound bed preparation.
Best Practice for Wound Debridement. *J Wound Care*. 2024;33(6):Sup C.

Adjunctive Therapies/Assisters (Amplifiers) for 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.

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

HOCl-Based Cleanser: Assister/Amplifier of Mechanical Debridement

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

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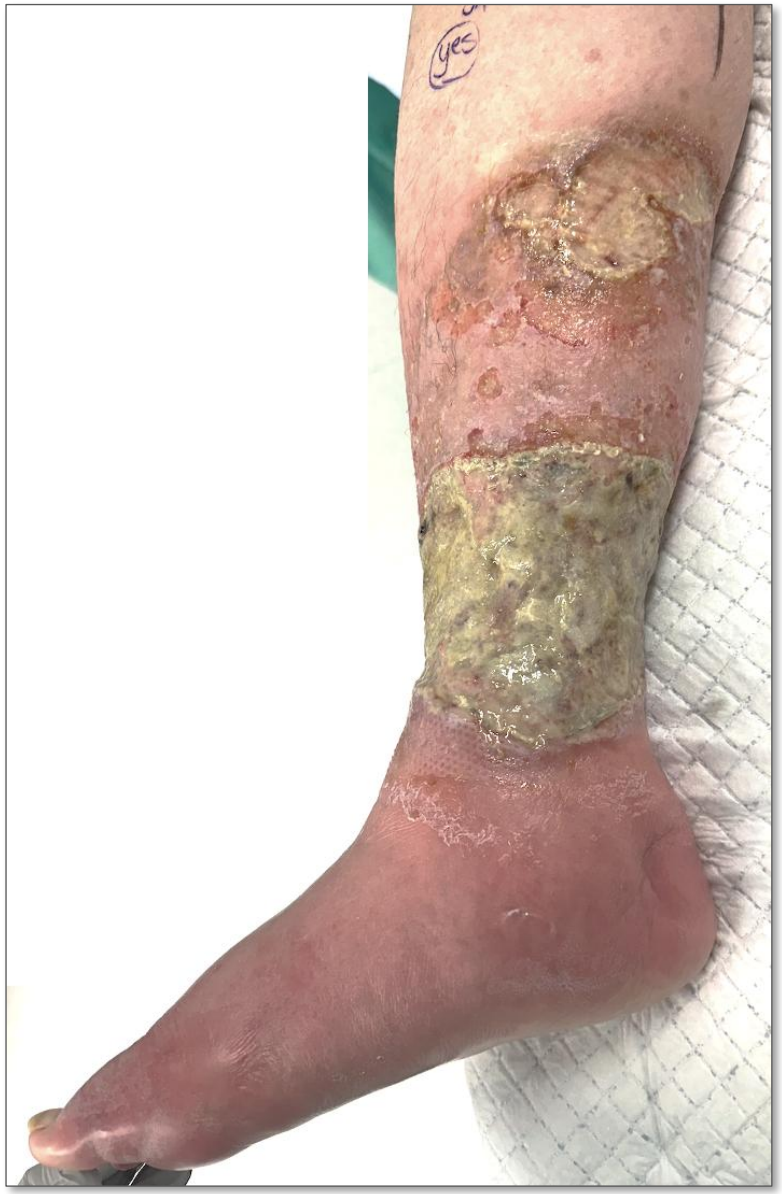
Slough

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**



ECM = extracellular matrix.

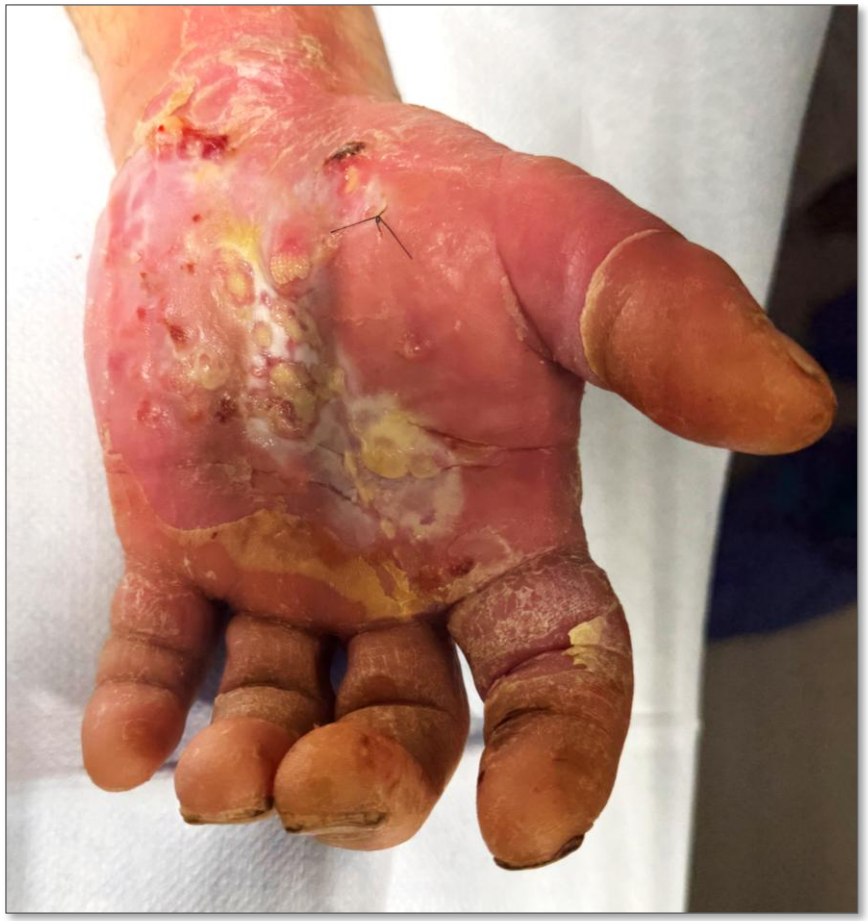
Slough

Loose Slough

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

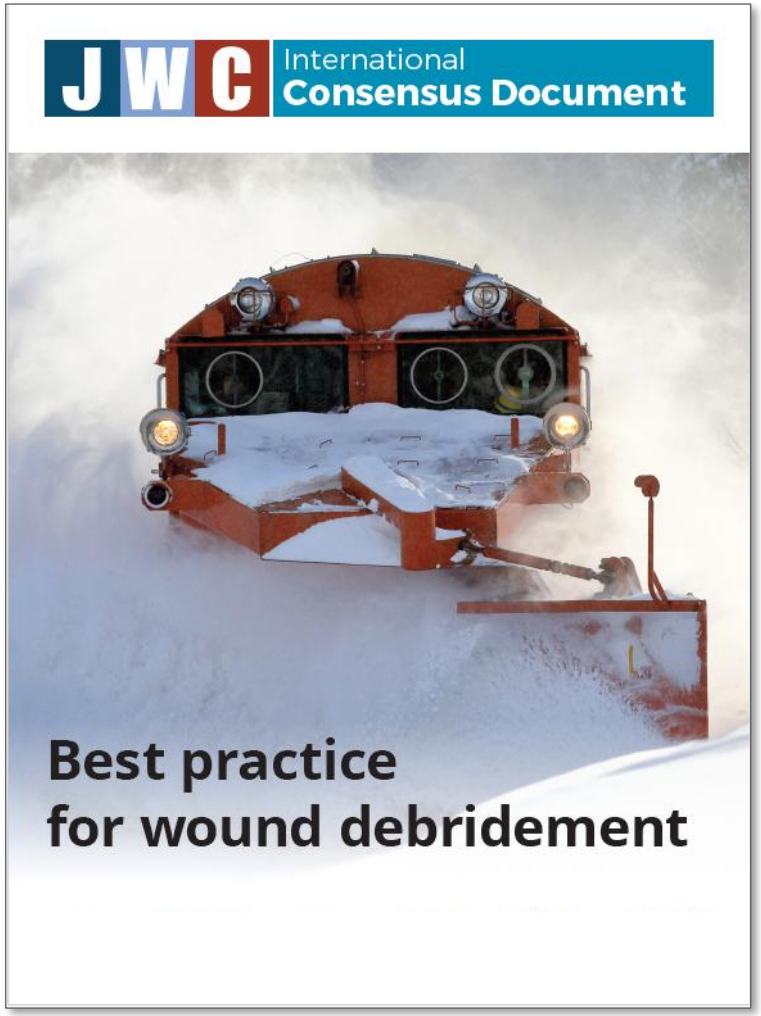
Adherent Slough: PRO-INFLAMMATORY

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



Recently Published Data

- Dieter Mayer, et al. *Journal of 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 negative pressure wound therapy with instillation and dwell (NPWTi-d) with reticulated open cell foam (ROCF)
- It has properties that enable it to remove germs and debris in a way that differentiates it from saline
- **SYNERGISTIC technology** with other forms of debridement



NPWTi-d=negative pressure wound therapy with instillation and dwell; ROCF=reticulated open cell foam.
Best Practice for Wound Debridement. *J Wound Care*. 2024;33(6):Sup C. Mayer DO, et al. *J Wound Care.* 2024;33(Supp6b):S1-S32.

Integral Debridement

- Emphasizes the 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
- Healthcare professional's level of training may limit their scope of practice

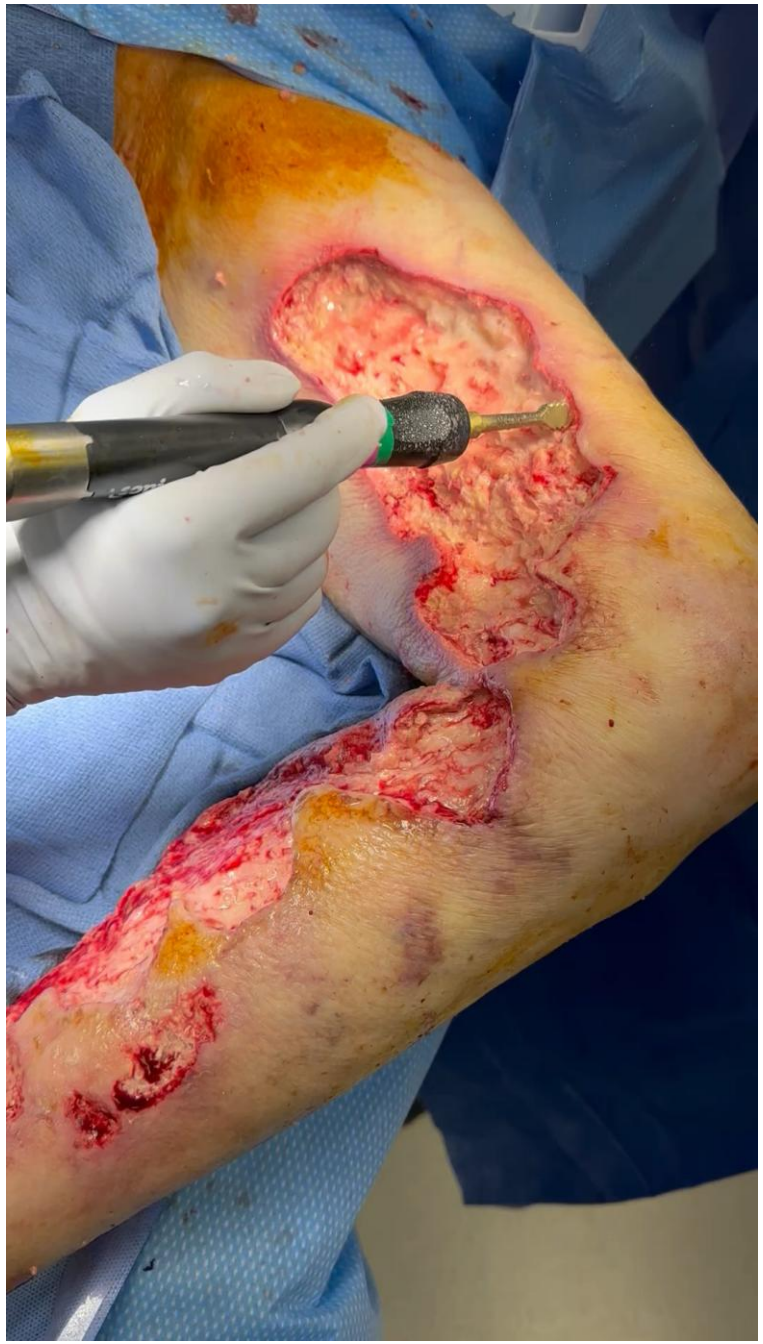
- CONSIDER the clinical context and patient perspectives when selecting the appropriate debridement method
- **Ensures that debridement care is not only effective** but also **aligned with the unique needs and goals of each patient**

Clinical Pearls

- Integral debridement enhances the debridement effort by combining types of debridement
  - Therapeutic vigorous cleansing with sharp debridement

    + post-debridement cleansing

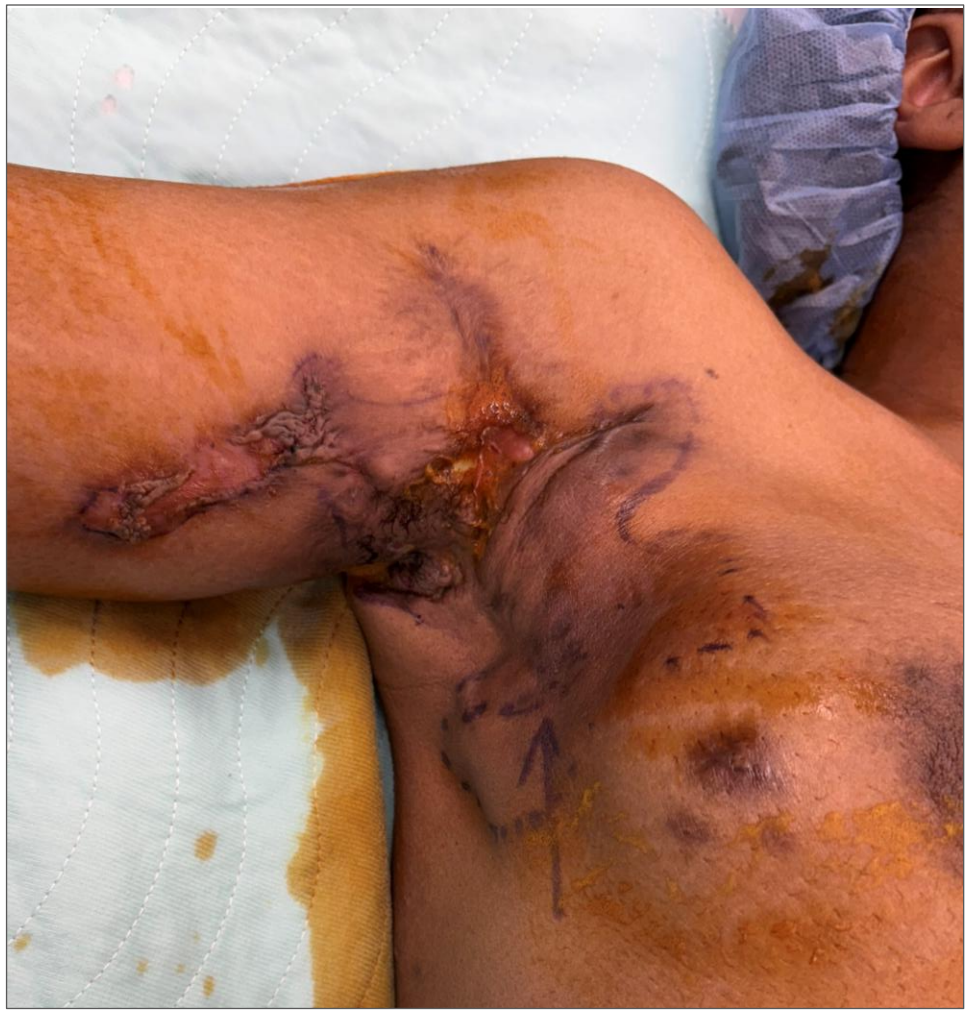
    + a topical dressing that continues to deslough/ debride while also providing moisture balance
  - If infection management is also required, add an antimicrobial
- Work smarter, not harder, and promote wound healing through effective and appropriate debridement



Cases

Axillary Hidradenitis and Scar Contracture

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

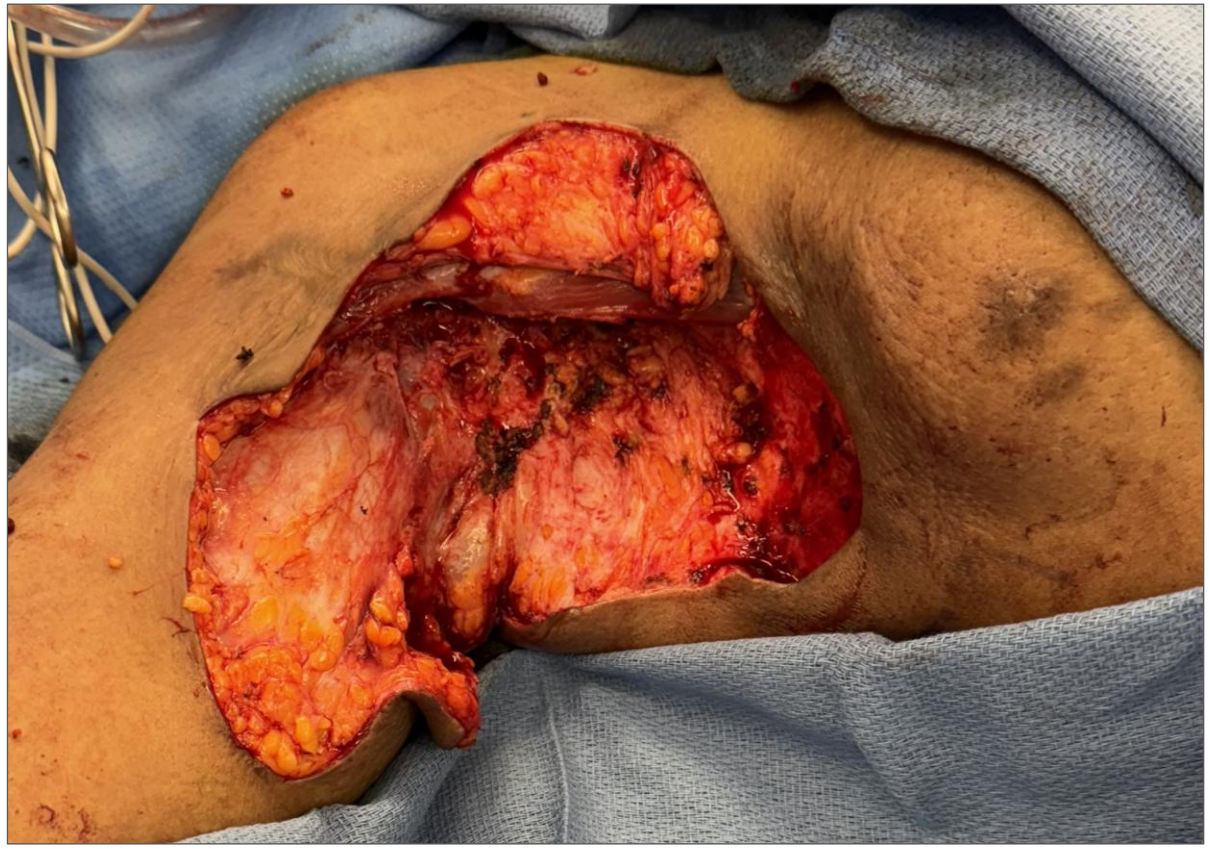


Axillary Hidradenitis and Scar Contracture

- OR Stage 1: Surgical resection of all disease and release of scar contracture
- Verify ROM of arm is restored
- Skin shortage
- Exposure of axillary vein

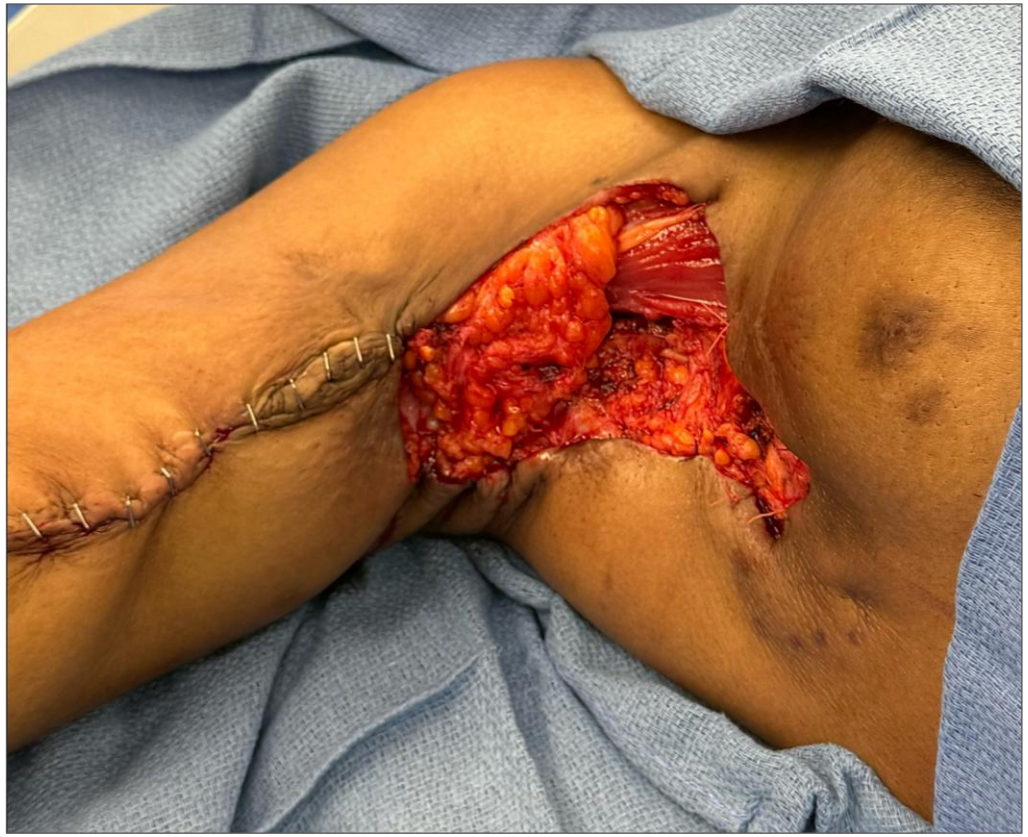
- Adipofascial rotation flap coverage over axillary vein

- NPWT application

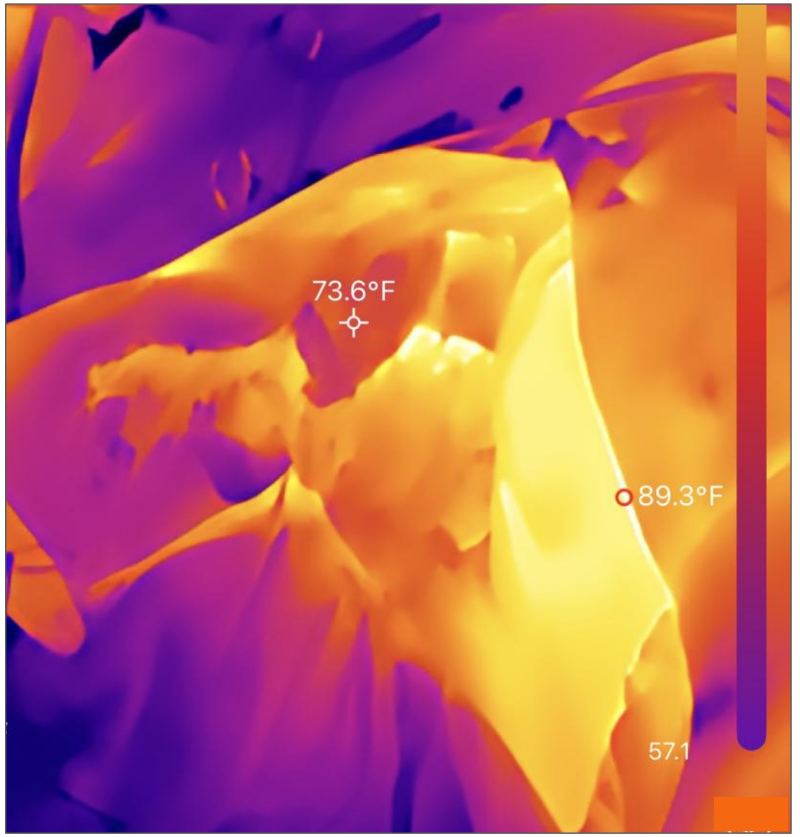


Axillary Hidradenitis and Scar Contracture

Adipofascial rotation flap coverage over axillary vein



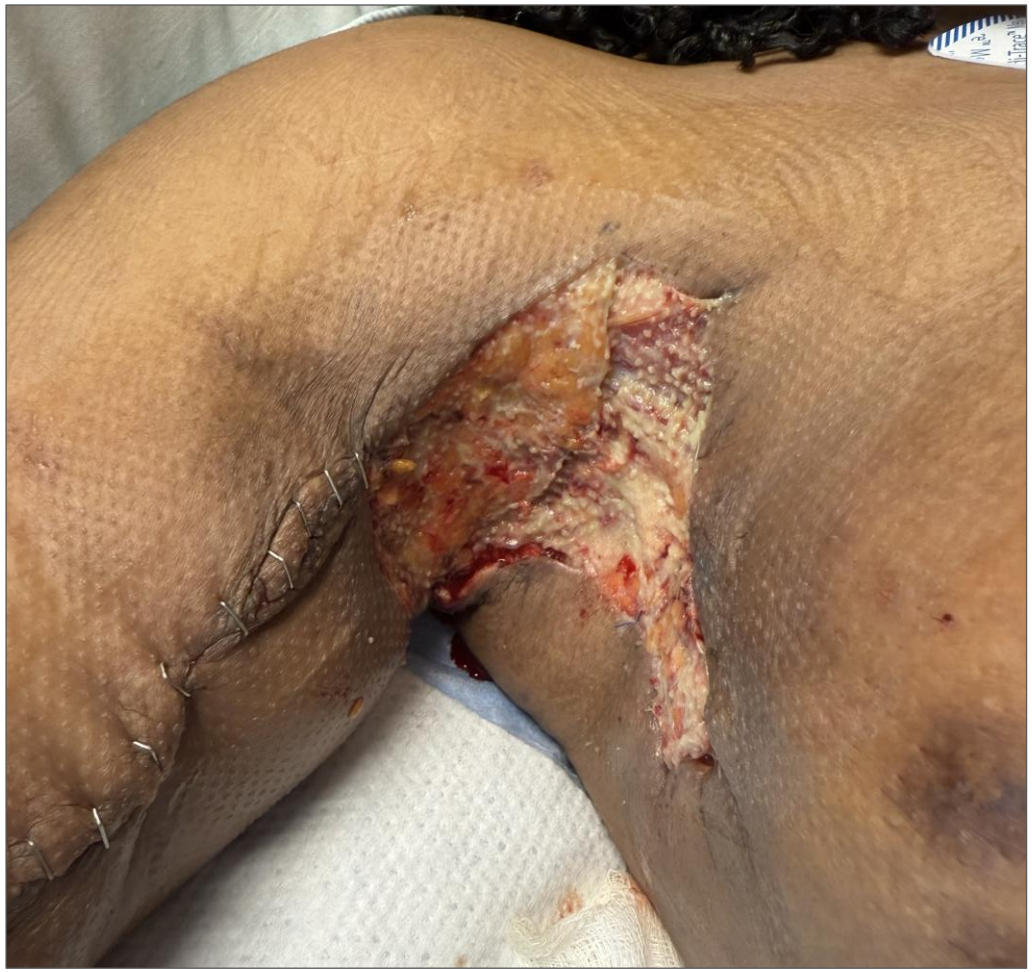
Forward looking infrared imaging to assess adipofascial flap viability



Axillary Hidradenitis and Scar Contracture

- NPWT dressing change POD4
- Adipofascial flap viable and bleeding

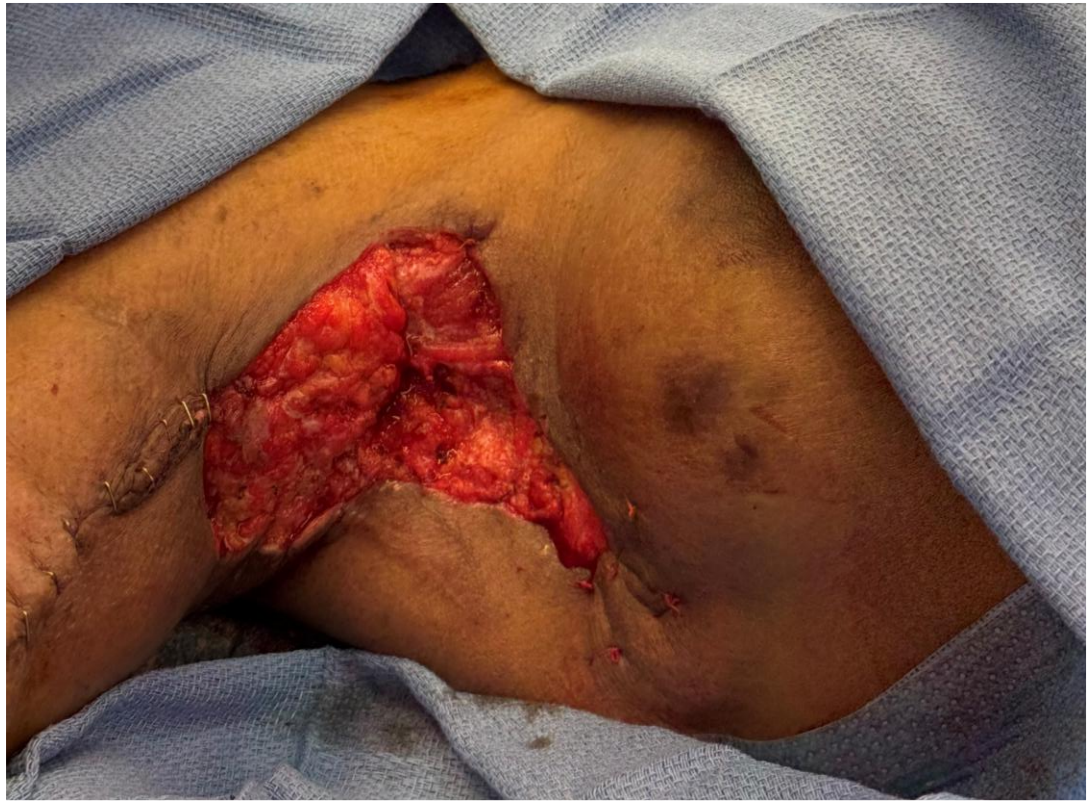
- Continue IV antibiotics and NPWT

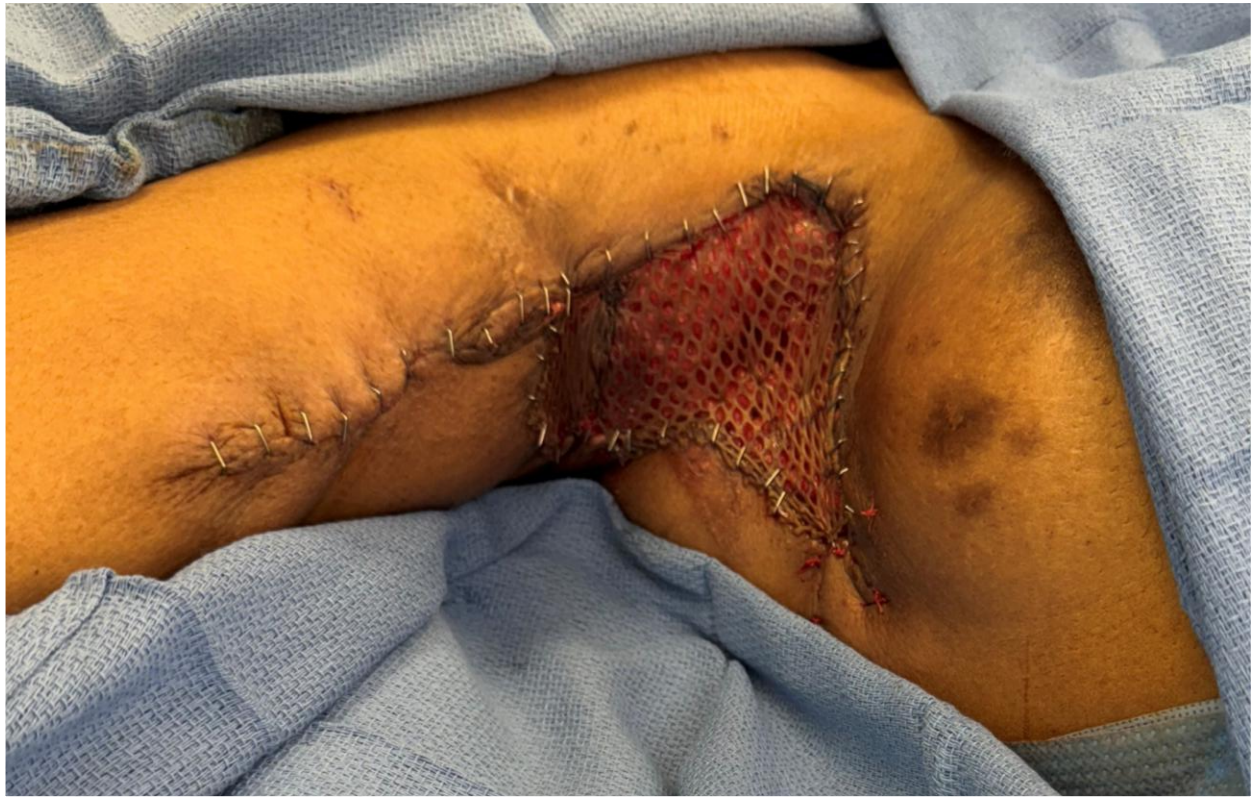


POD = postop day.

Axillary Hidradenitis and Scar Contracture

- POD7
  - Good granulation bed
  - Split-thickness skin graft (STSG) placed

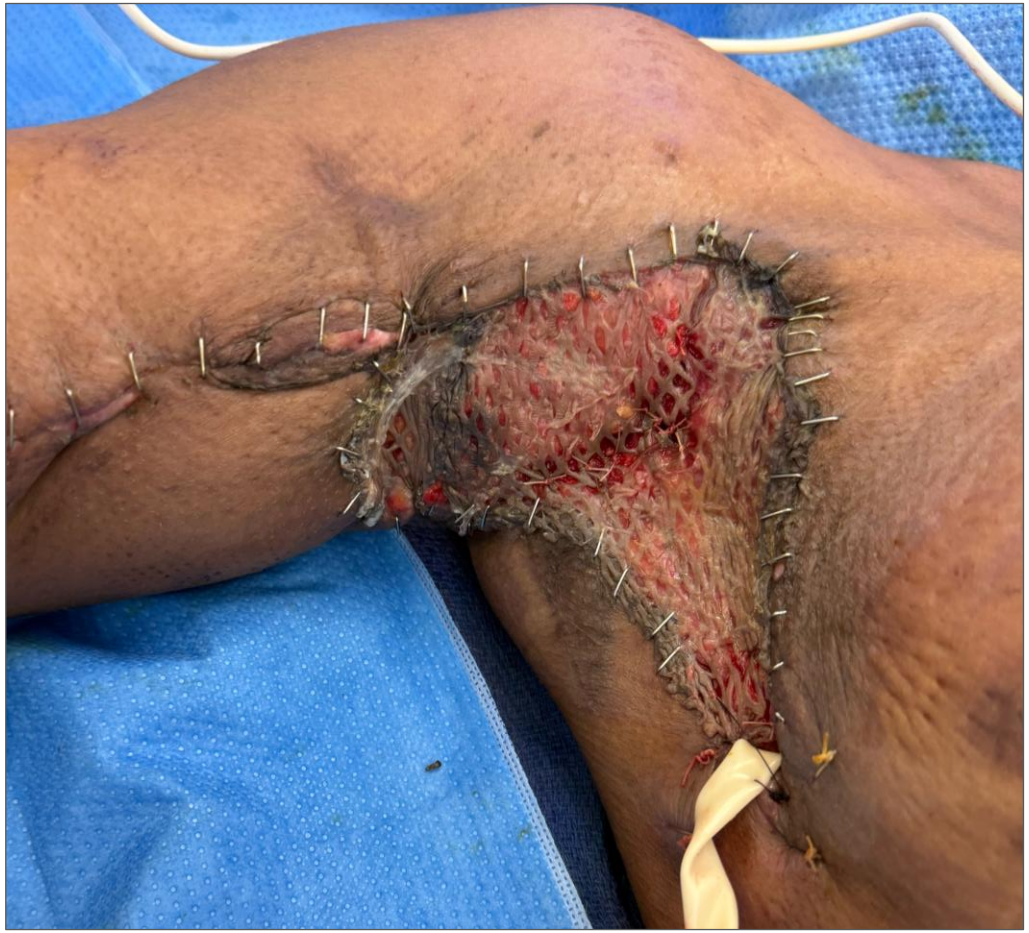




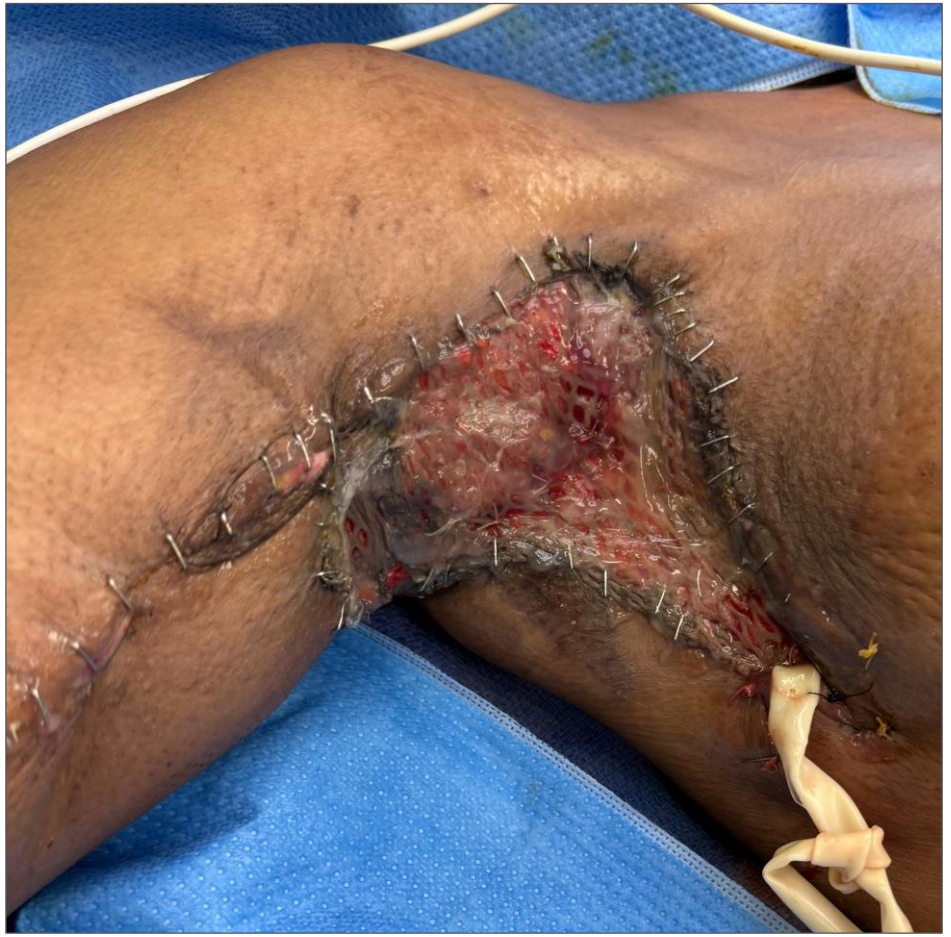
STSG = split-thickness skin graft.

Axillary Hidradenitis and Scar Contracture

- POD10: Excellent initial STSG take



- pHA gel applied, continue NPWT

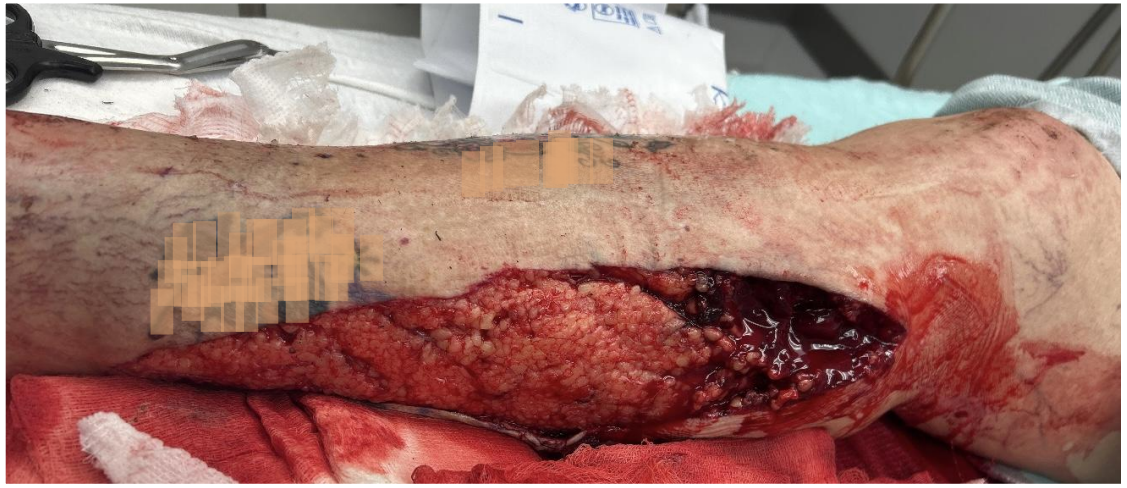


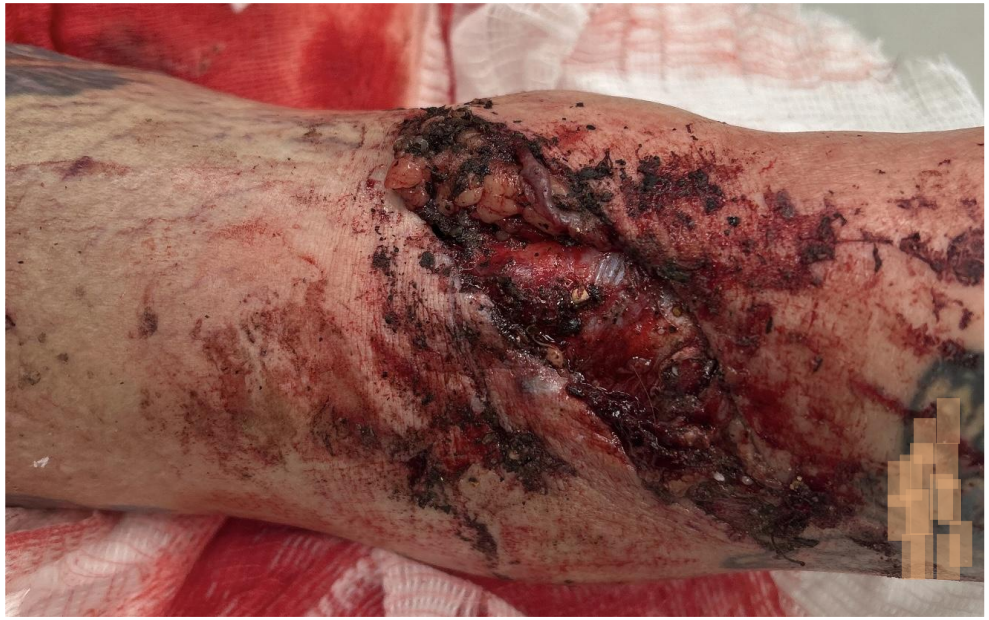
pHA = pure hypochlorous acid.

RLE Crush Injury

- 68y Female
- Forgot to put her car in park before she got out of her car

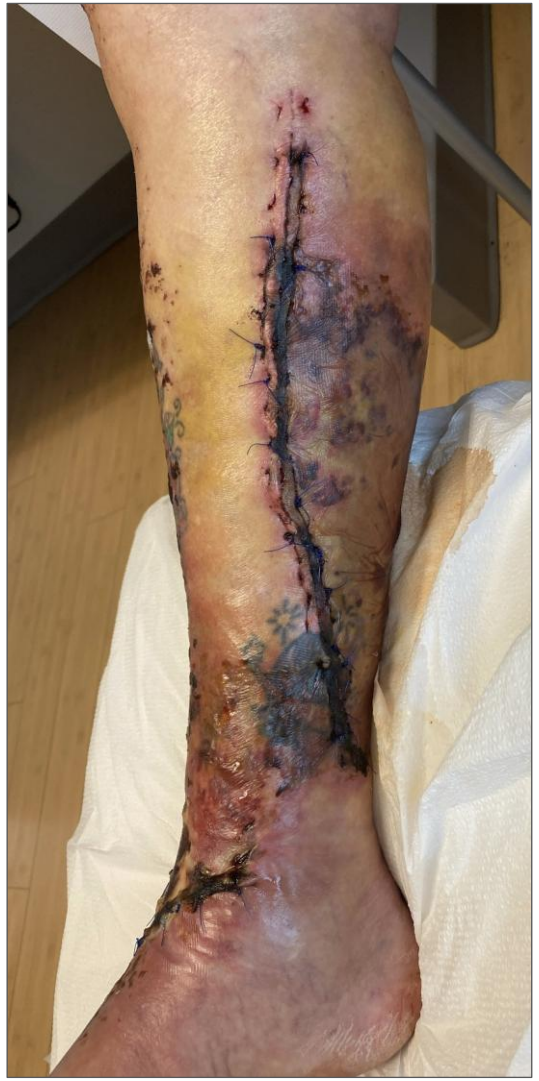
- Accidentally ran over her own right leg
- ER admission: Soft tissue crush injury
- Initial OR washout/debridement and partial closure by orthopedics
- Fibular fracture conservative management by orthopedics

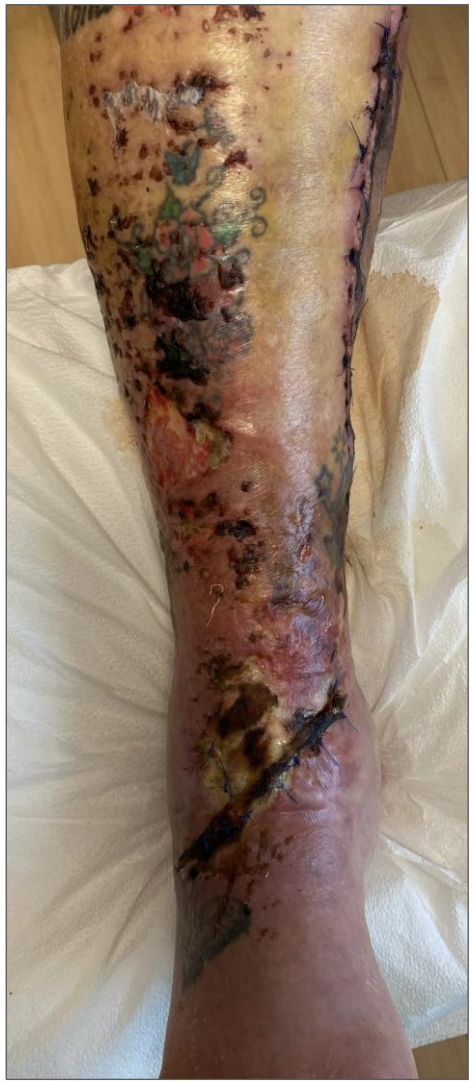




RLE Crush Injury

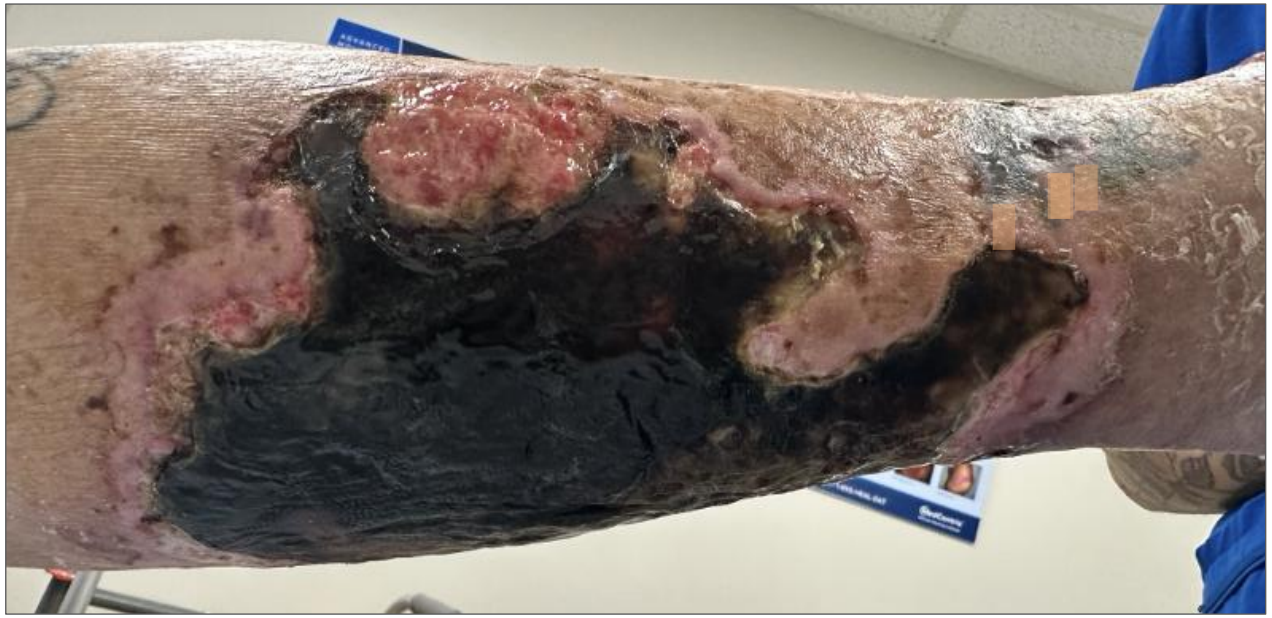
- Orthopedic clinic follow-up visit 2 wks later
- Significant leg edema
- New areas of soft tissue necrosis

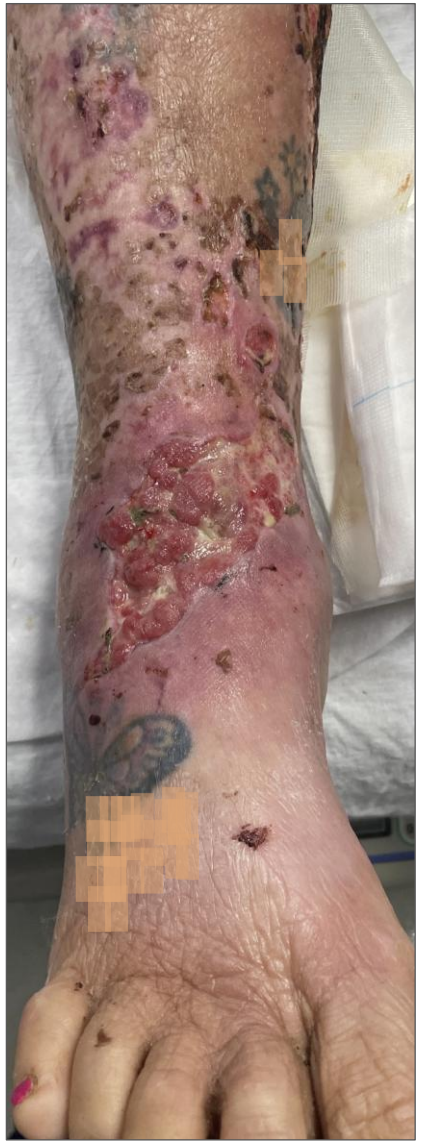


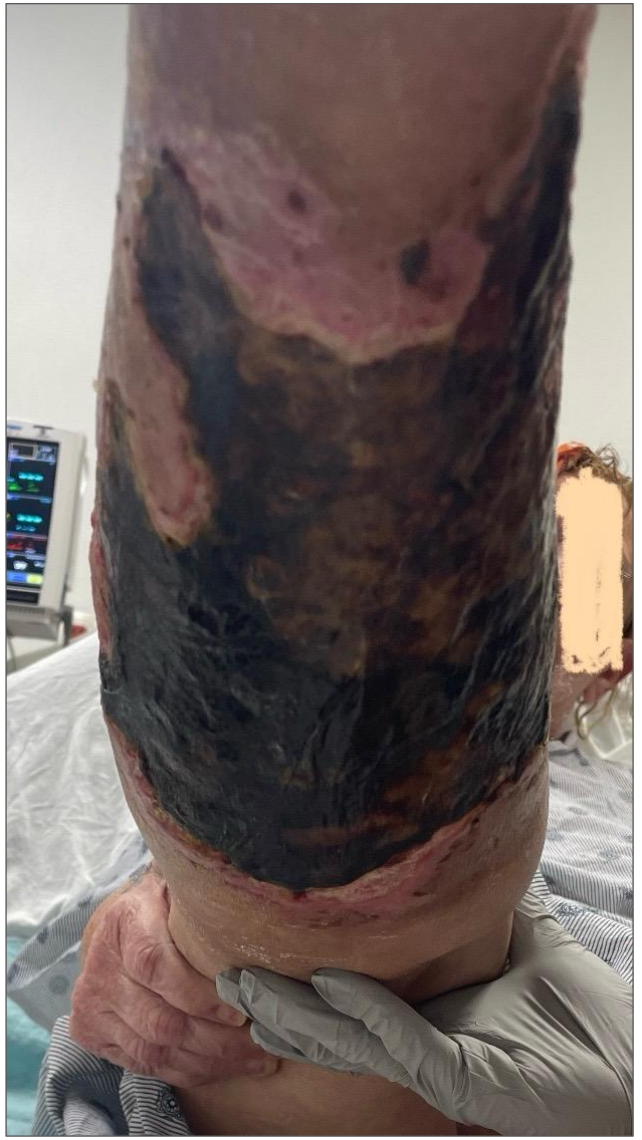


RLE Crush Injury

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

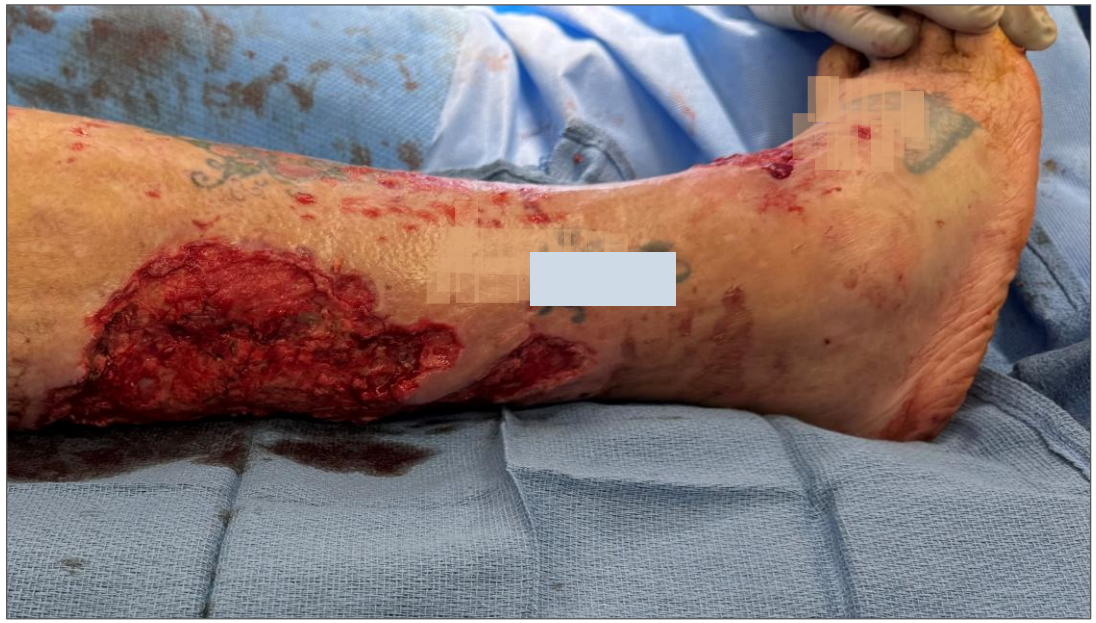


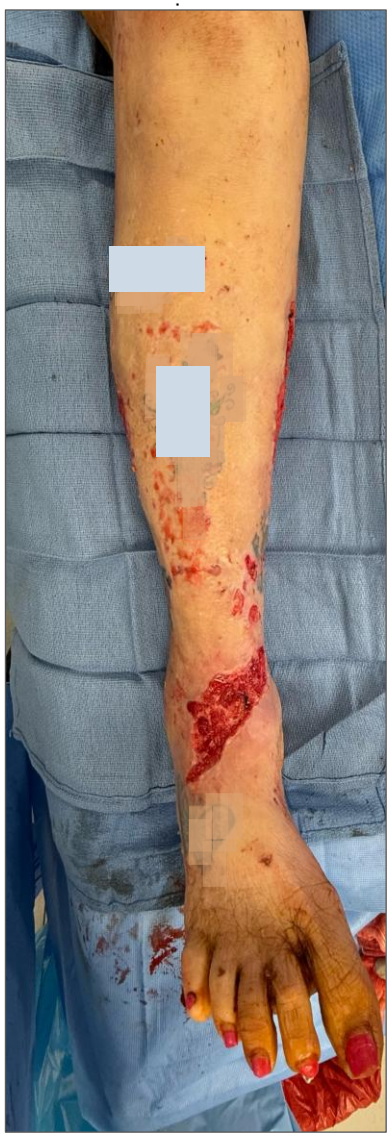


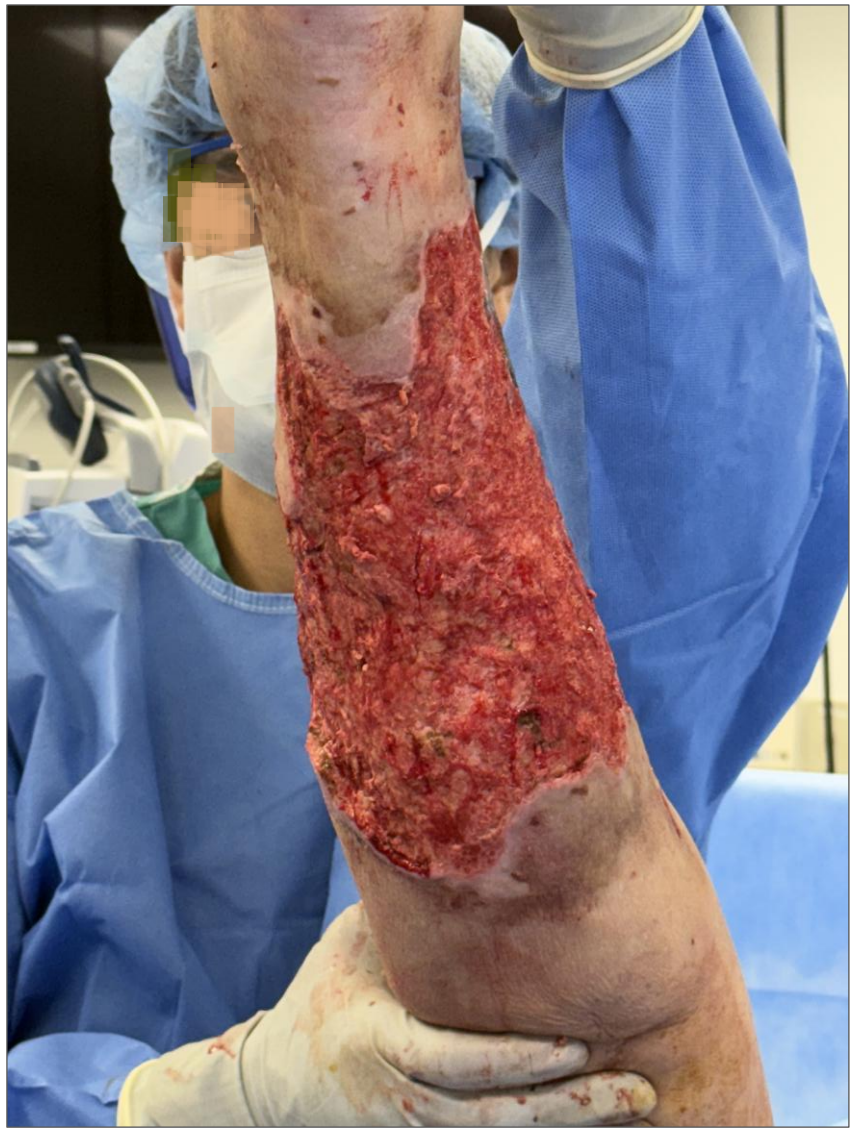


RLE Crush Injury

- 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

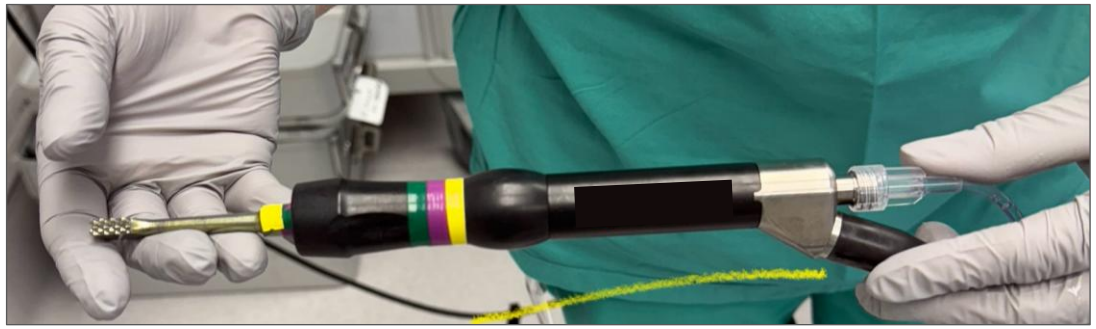


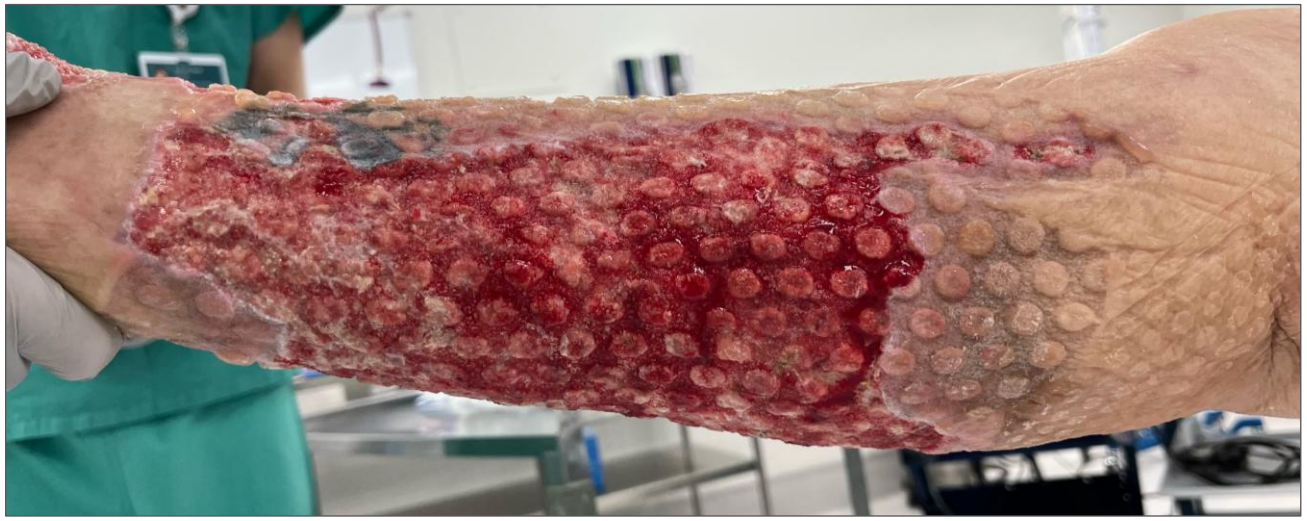


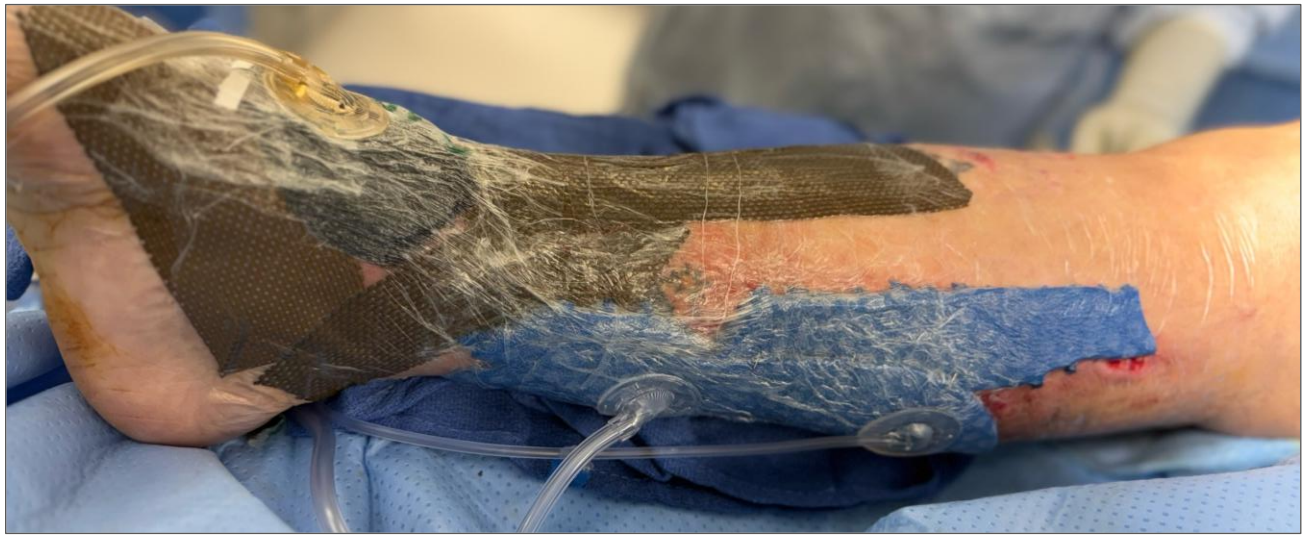


RLE Crush Injury

- POD 4: Return to OR for additional debridement and reapplication of NPWTi-d with pHA

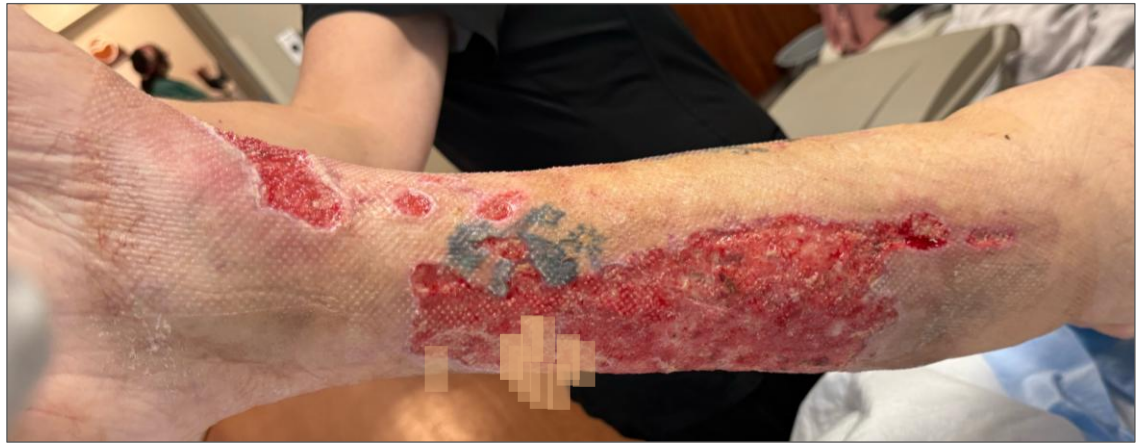




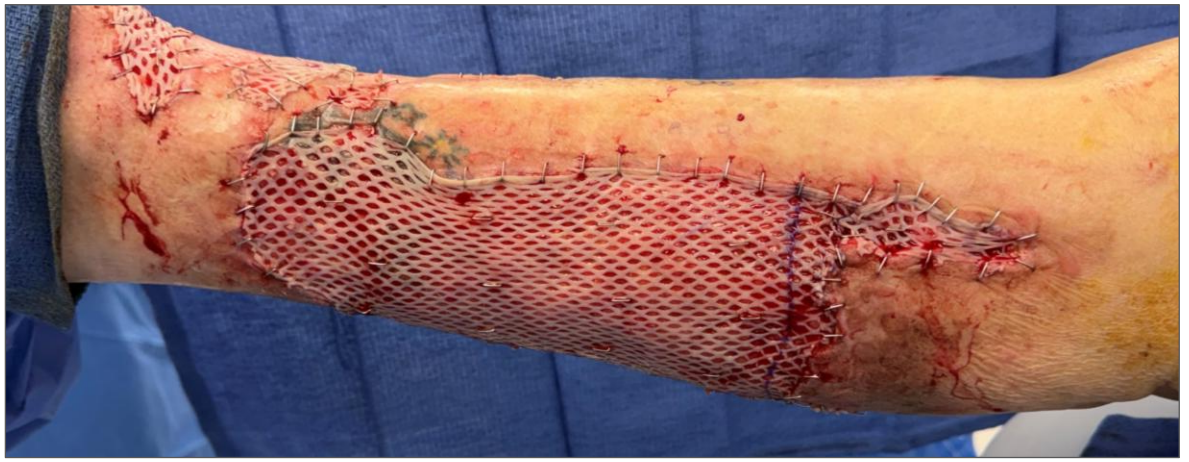


RLE Crush Injury

- POD7: NPWT dressing change
- Excellent granulation tissue is seen

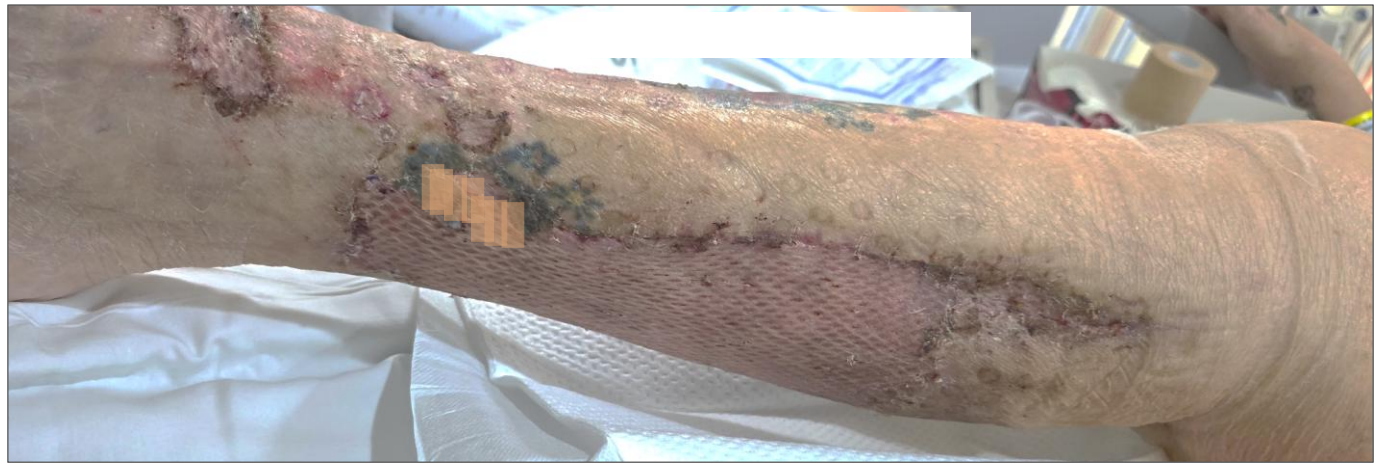


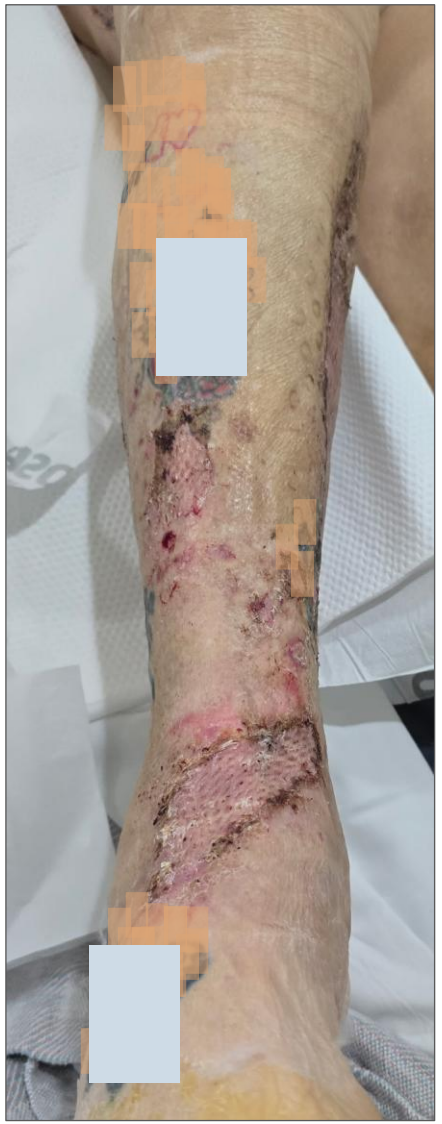
- POD 9: STSG application, NPWT



RLE Crush Injury

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



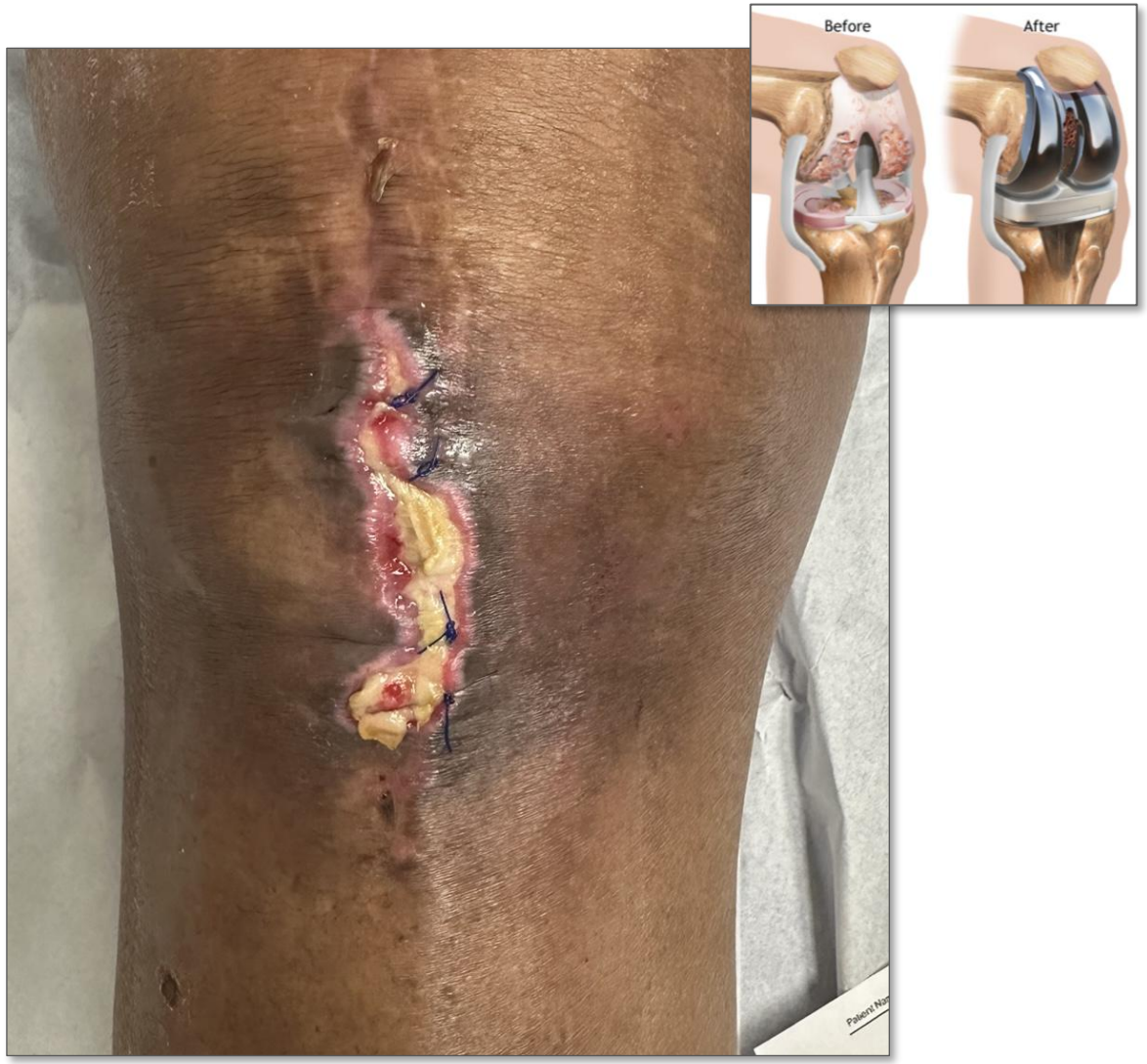


LTACH = long-term acute care hospital.

Total Knee Arthroplasty (TKA) Dehiscence Wound

- 70y Female
- DM, peripheral arterial disease (PAD)
- Right TKA performed 6 wks prior
- Early initiation of PT for ROM

- Superficial wound dehiscence
- Threatens prosthetic joint
- Plan operative excision and local flap reconstruction

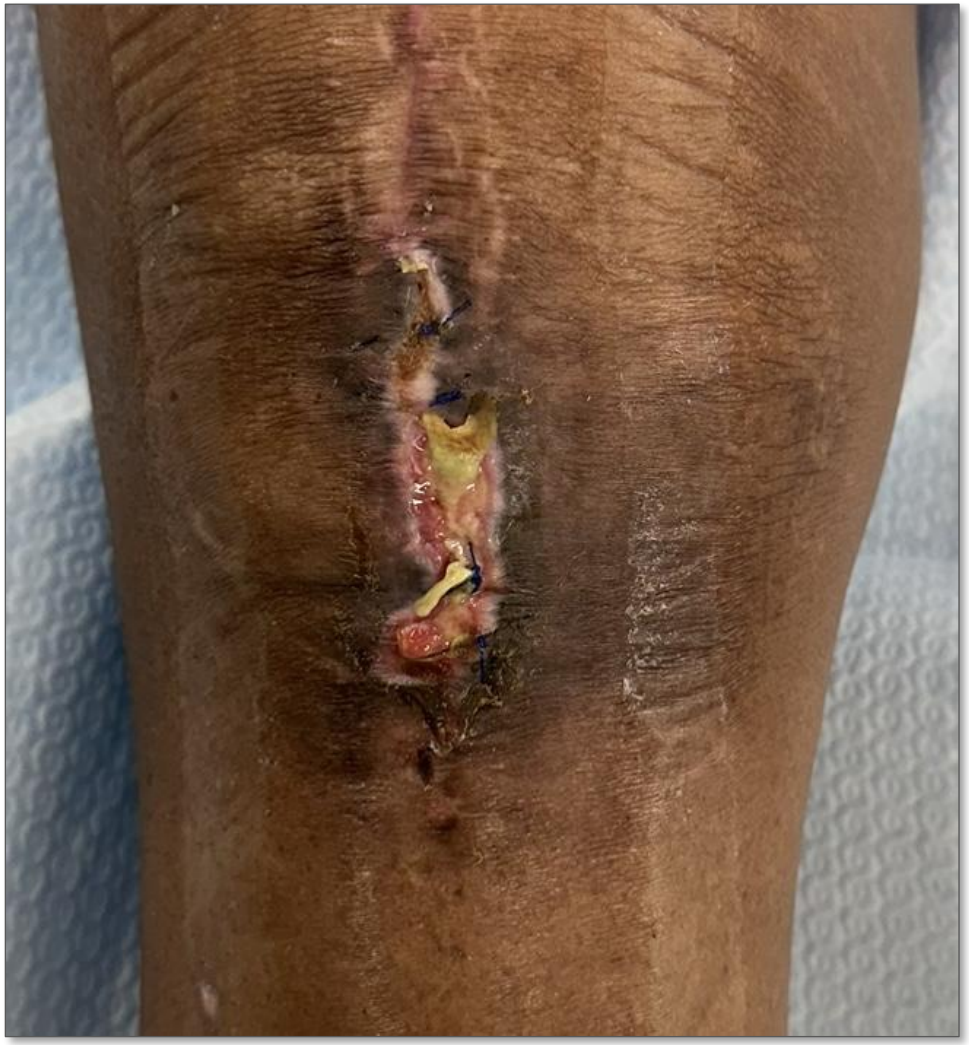


TKA = total knee arthroplasty; PAD = peripheral arterial disease; ROM = range of motion.
Image: MedlinePlus. National Library of Medicine (U.S.) Updated June 2024. medlineplus.gov

Total Knee Arthroplasty (TKA) Dehiscence Wound

- Day 6
- Novel dressing changed 3 times
- pHA soaks
- 70% reduction in slough

- Able to start in operating room with a much cleaner operative wound
  - Decreased slough = Decreased wound colonization

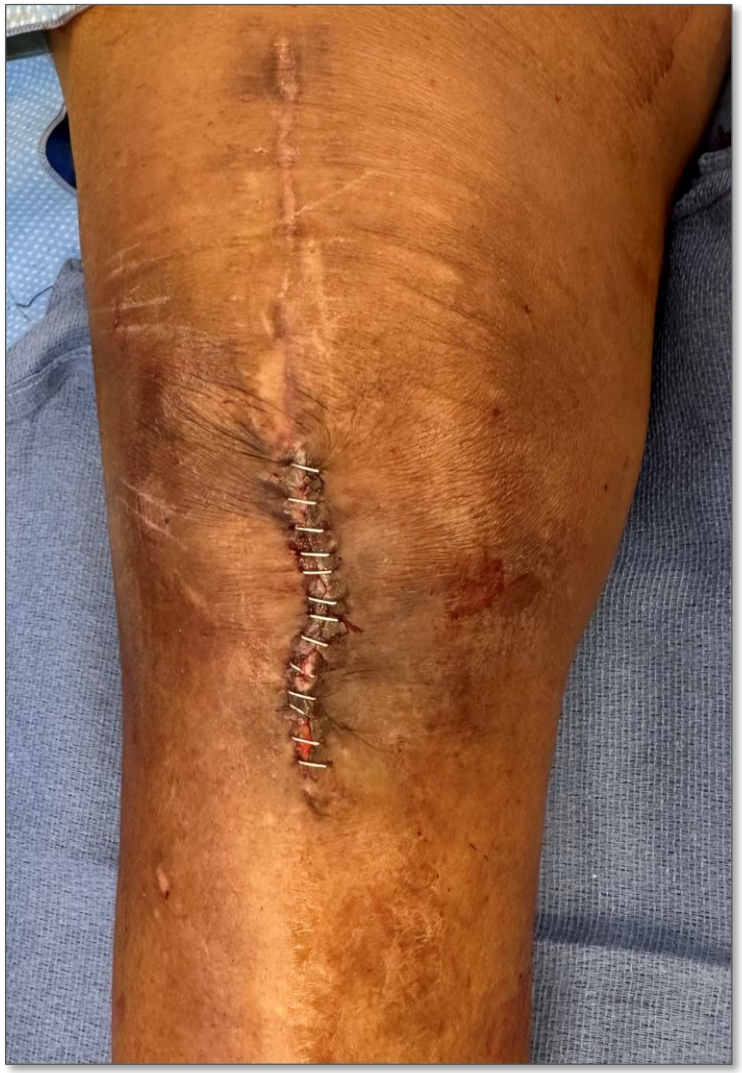


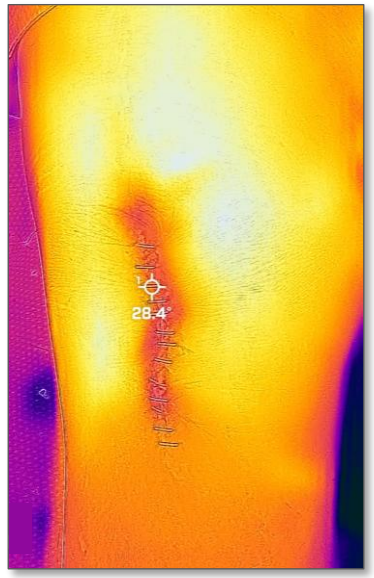
Total Knee Arthroplasty (TKA) Dehiscence Wound

- OR

- Excision of wound
- Irrigation with pHA

- Local tissue advancement closure
- Good perfusion of tissue
- Incisional negative pressure wound therapy (iNPWT)/knee immobilizer





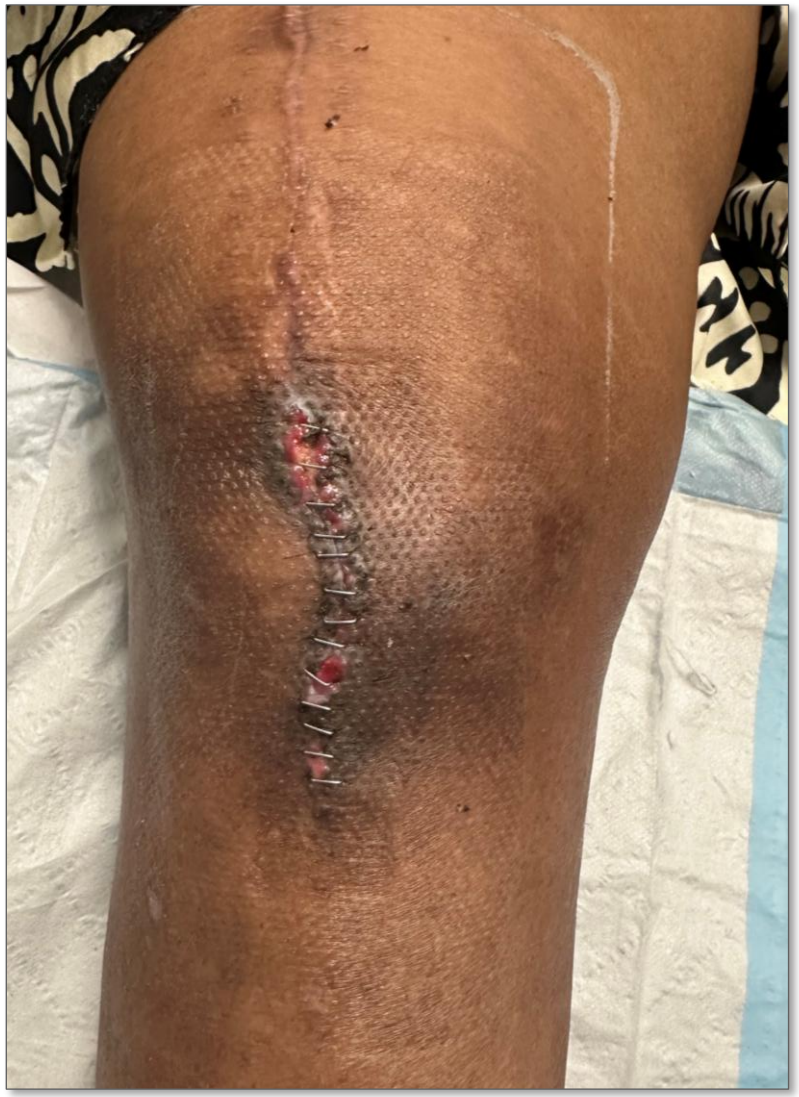
iNPWT = incisional negative pressure wound therapy.

Total Knee Arthroplasty (TKA) Dehiscence Wound

- POD 8

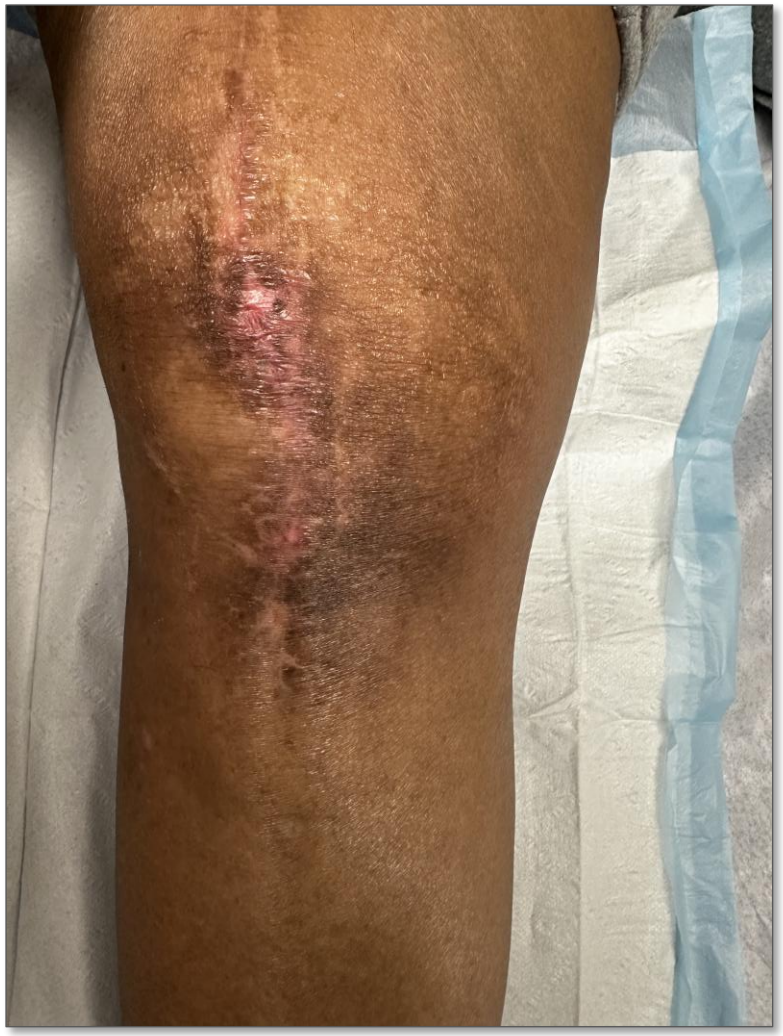
- Incision intact with 4mm superficial open area superiorly
- Reapply novel dressing
- Change q2 days by home health

- No signs of infection
- Continue knee immobilizer



Total Knee Arthroplasty (TKA) Dehiscence Wound

- Healed at 2 wks



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

- Integral debridement concepts applied postoperatively may **improve wound outcomes and decrease healing complications**

Mechanics and Physical Forces of Attraction Behind Debridement Technologies

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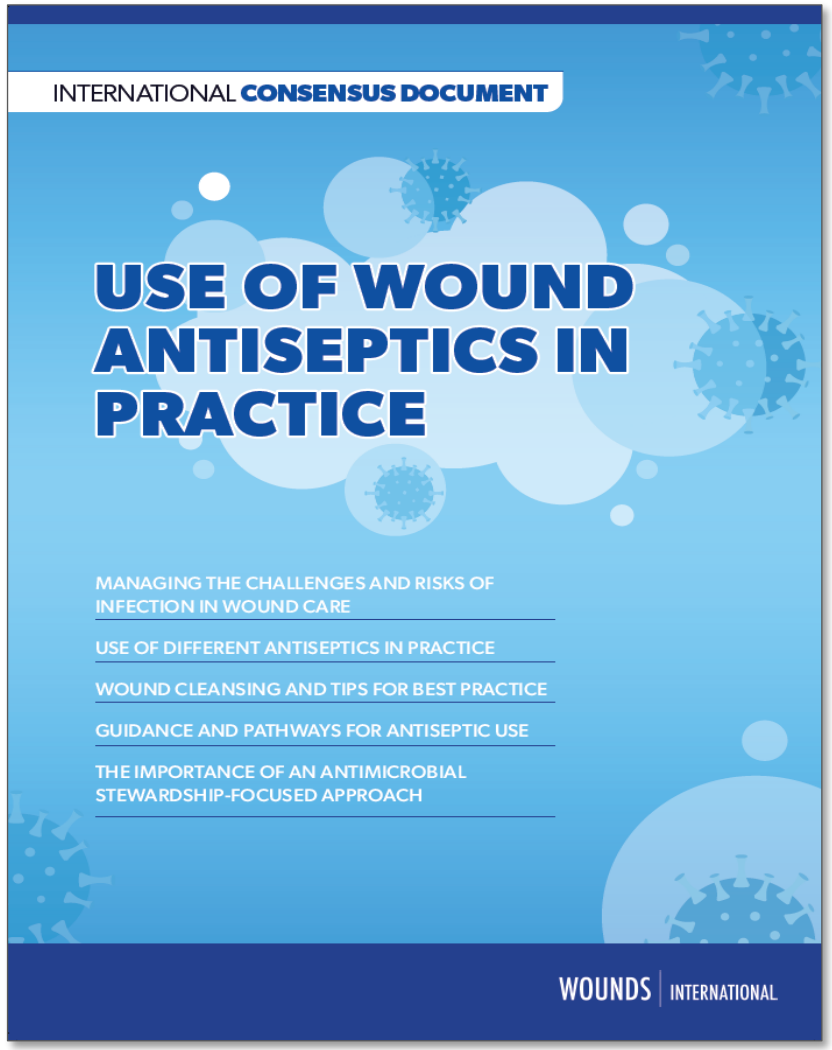
Associate Research Professor of Surgery, School of Medicine and Health Sciences, George Washington University
Washington, D.C.

International Consensus Guidelines, 2023

Use of Wound Antiseptics in Practice
Wounds International
Oct. 2023



Mrozikiewicz-Rakowska B, Sanches Pinto D, Stuermer EK, Nair HKR, Sander J, Matiasek J, Lázaro-Martínez JL, Ousey K, Assadian O, Kim PJ, Percival SL. Wounds Int. 2023.

Ideal Antimicrobial Preservative Cleanser Properties

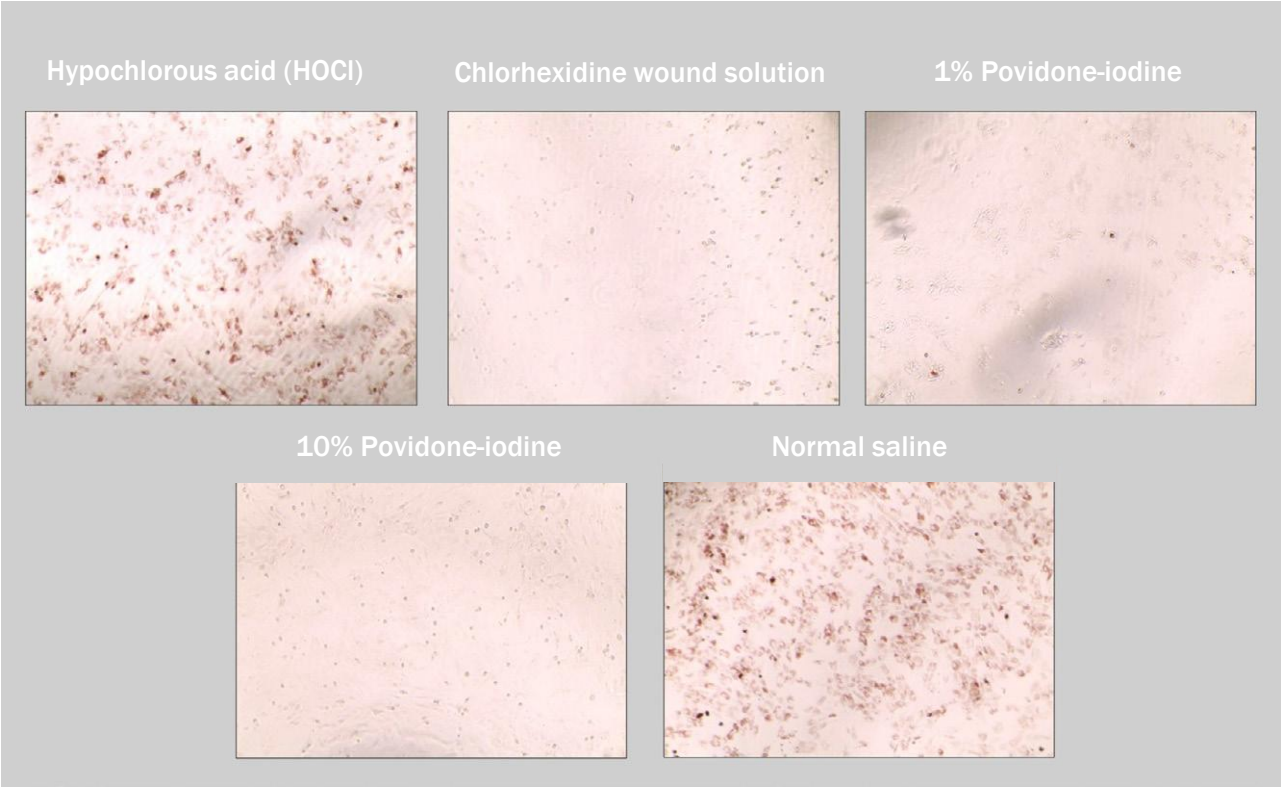
BOX 4 | Properties of an ideal antiseptic agent (To et al, 2016; Kramer et al, 2018; Babalska et al, 2021)

- Possess germ removal activity at the site of action against a broad spectrum of microorganisms, including Gram-positive and Gram-negative bacteria, fungi, and viruses
- Ability to penetrate microbes
- Does not cause resistance of cross-resistance
- Is fast-acting in acute wounds
- Can handle excess wound exudate (if it is a dressing)
- Cost-effective
- Non-traumatic
- Easy and safe to use
- Does not cause allergic reactions or pain
- Is not toxic, carcinogenic, or mutagenic
- Tolerability should be equal to Ringer solution physiological saline, or an inert hydrogel
- Suitable chemical and physical properties – eg, in regard to color (does not color the skin), smell, and consistency

Mrozikiewicz-Rakowska B, Sanches Pinto D, Stuermer EK, Nair HKR, Sander J, Matiasek J, Lázaro-Martínez JL, Ousey K, Assadian O, Kim PJ, Percival SL. *Wounds Int.* 2023.

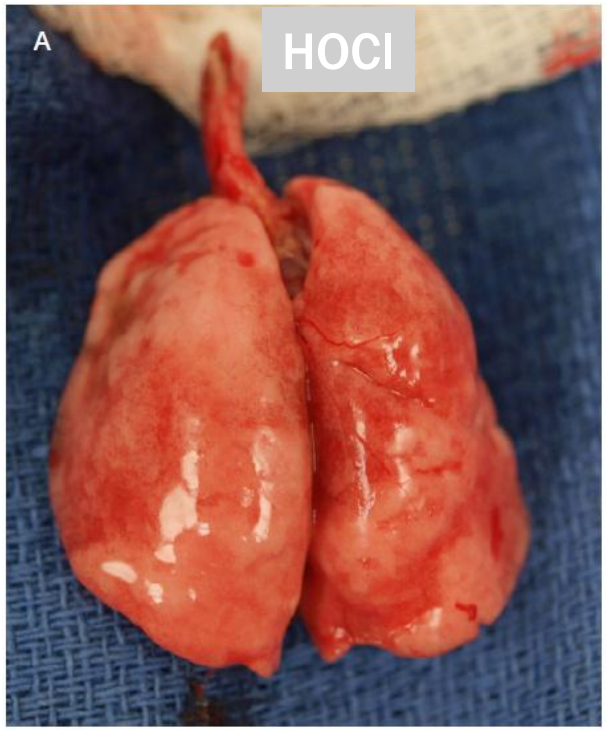
HOCl and Dakin's Exposure to Delicate Tissue Shows Visible Differences

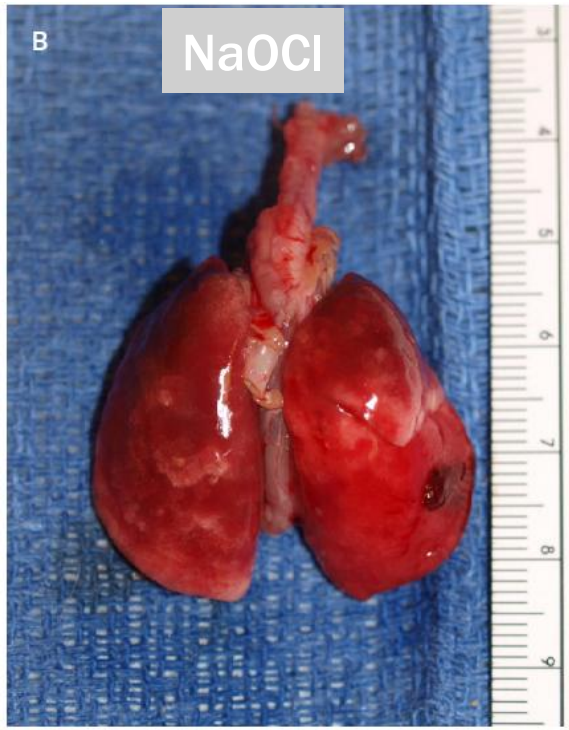
In vitro cytotoxicity



Representative images of fibroblasts from the neutral red dye assay. The presence of many stained cells indicates that the treatments to those cells were minimally cytotoxic.

Gross examination of organs after lavage



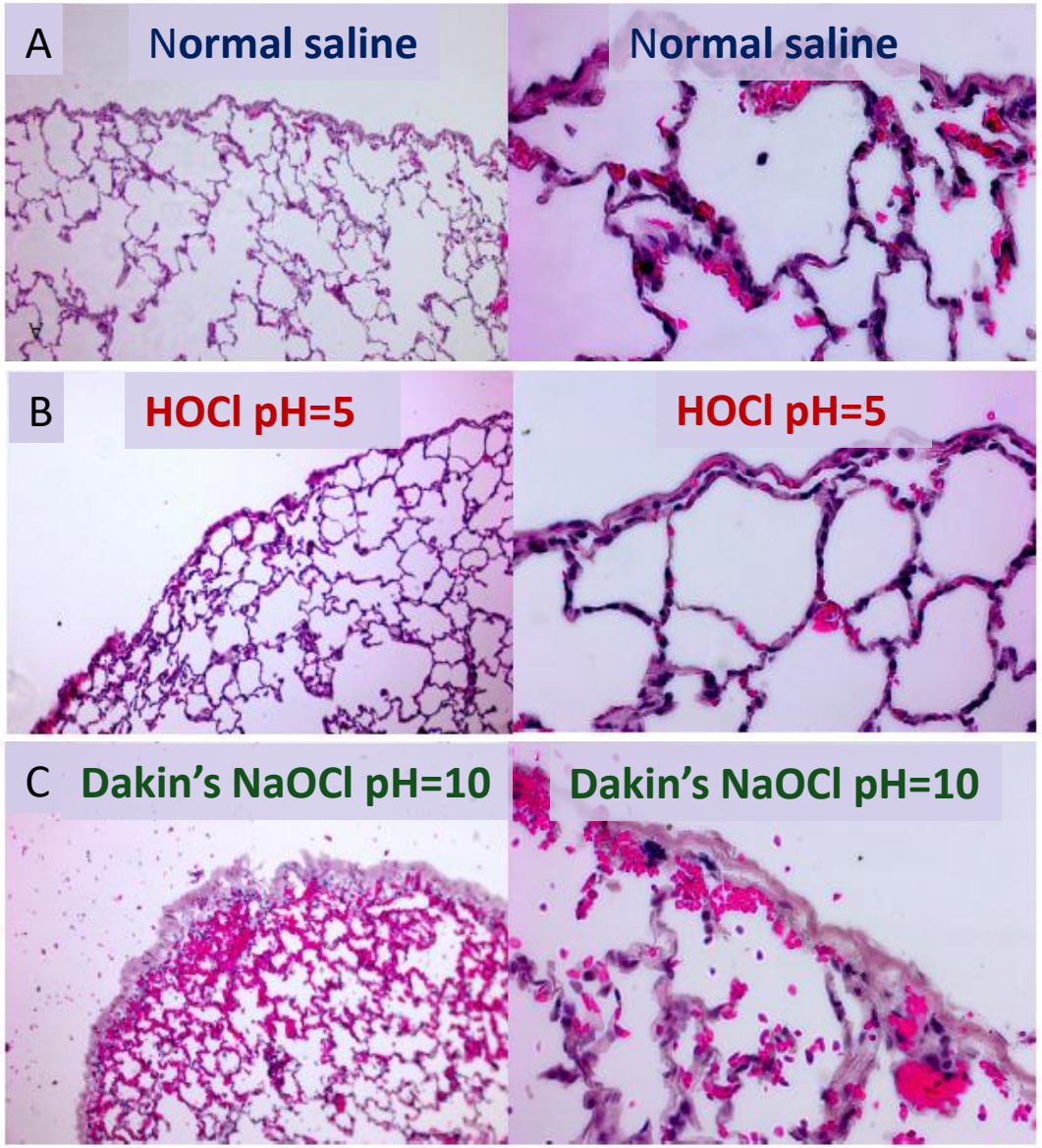


Gross specimens of lungs treated with (A) pH=5 HOCl and (B) Dakin's solution (NaOCl). The Dakin's-treated lungs show increased fibrosis and hemorrhage compared with pH=5 HOCl

HOCl cleanser not indicated for use on lung tissue.
Slide courtesy of Dr. Greg Schultz.
Keyloun JW, Shupp JW. *Wounds*. Supplement, October 2019.

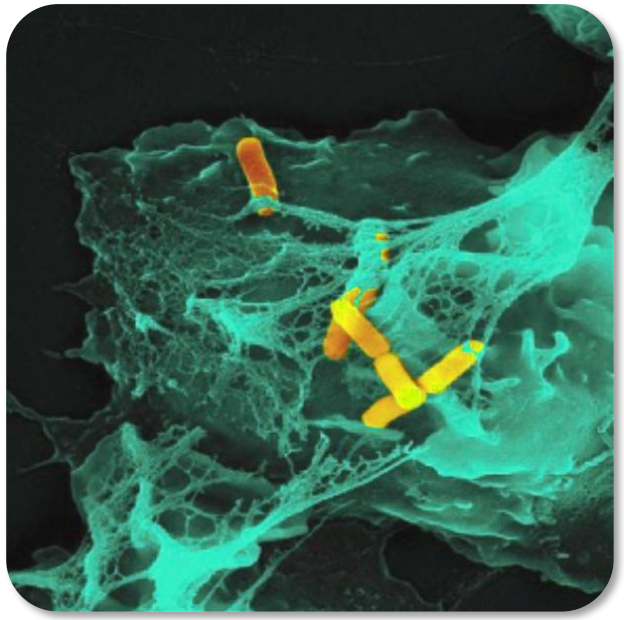
Microscopic Examination of Lungs after Lavage

- Representative hematoxylin and eosin-stained images of lung tissue treated with
  (A) Normal saline
  (B) HOCl pH=5
  (C) Dakin's solution
- Increased fibrosis and hemorrhage are appreciated in the Dakin's-treated tissue

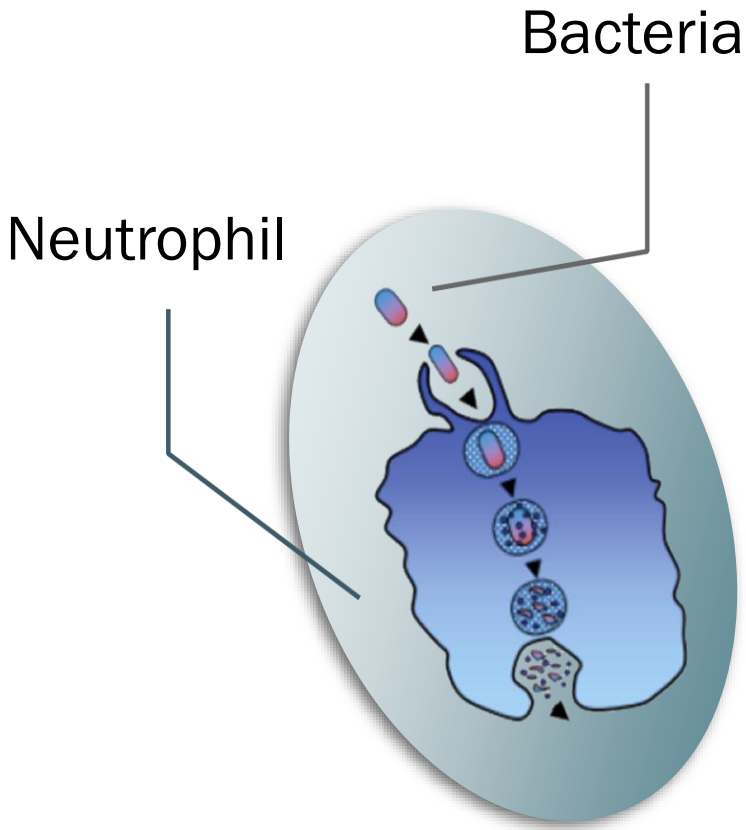


Slide courtesy of Dr. Greg Schultz
Keyloun JW, Shupp JW. *Wounds*. Supplement, October 2019.

HOCl: The Body's Natural Microbicide



Oxidative Burst Pathway



$H_2O + O_2$

↓ NADPH Oxidase

O_2^-

↓ Superoxide Dismutase

H_2O_2

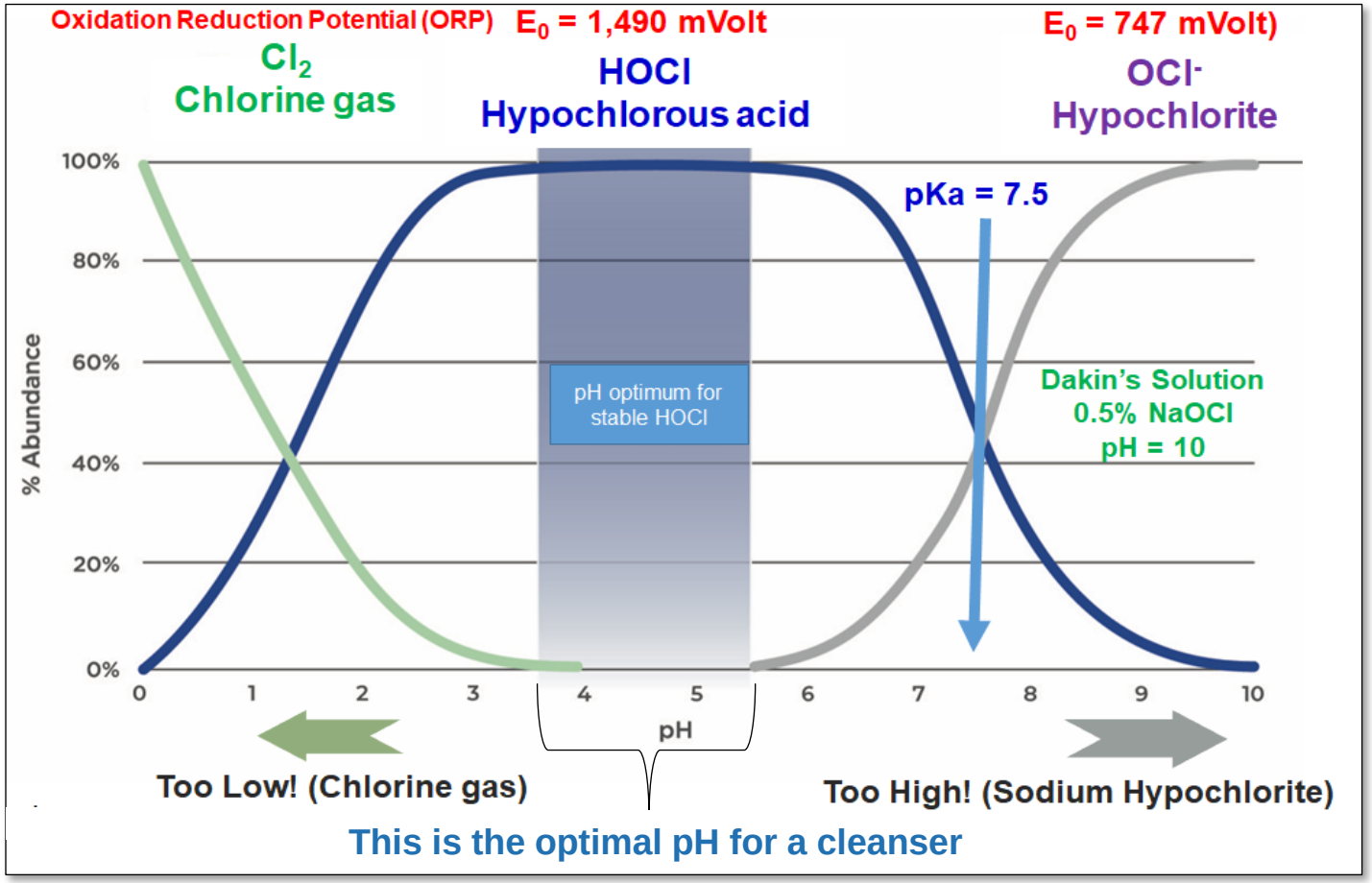
↓ Myeloperoxidase

HOCl

Slide courtesy of Dr. Greg Schultz

HOCl Dissociation Curve

- Stabilized HOCl solution has the highest concentration of HOCl ≈300ppm
- Mimics normal pH of healthy human skin
- Electrochemical manufacturing process allows for shelf stability in PET plastic



Slide courtesy of Dr. Greg Schultz
Modified from Robson M. The Scientific Bases for the Use of Hypochlorous Acid to Avoid Pitfalls. *Wounds*. 2019;Suppl.

Comparative Minimum Bactericidal Concentration Of HOCl, NaOCl, and H_2O_2

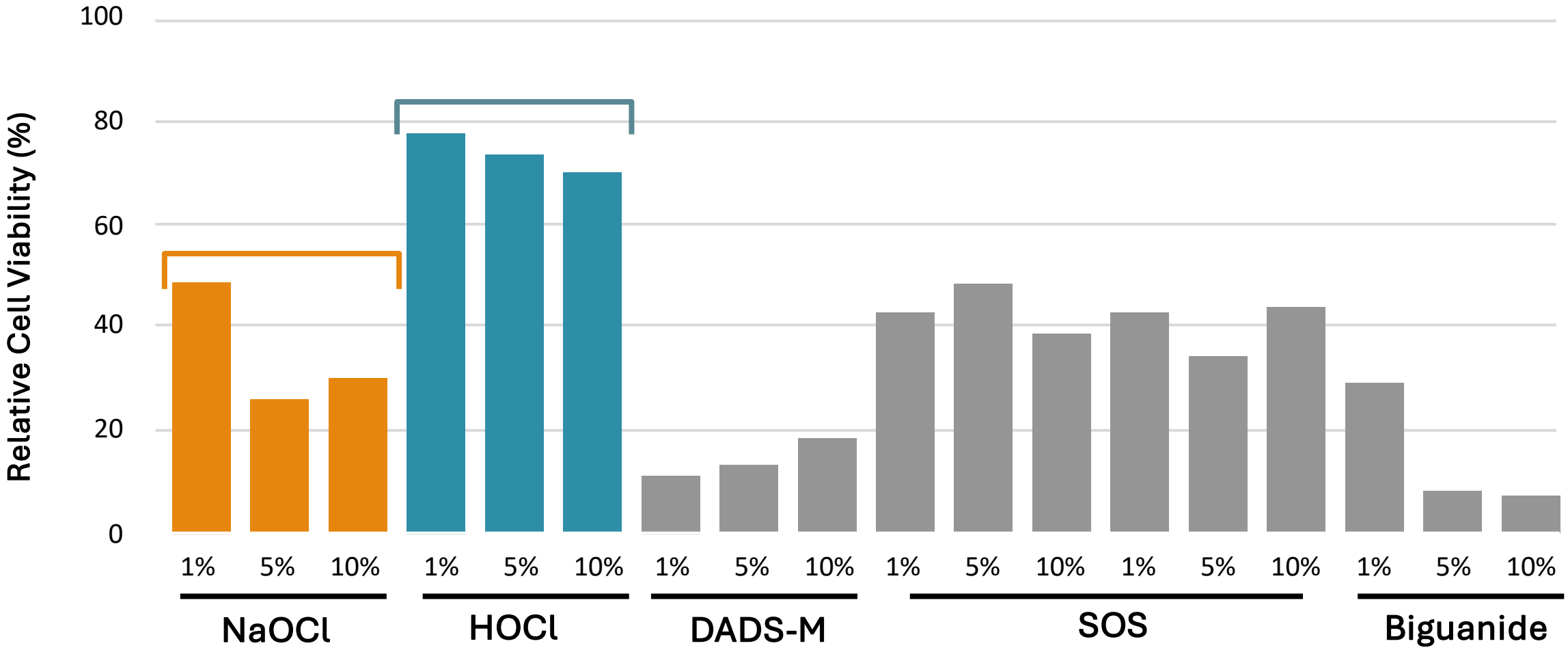
Tested Against 3 Organisms at Room Temperature for 60 Minutes

		MBC (µM)		
Pathogen	ATCC	HOCl	OCl^-	H_2O_2
Escherichia coli	25922	5.6	40	7,500
Pseudomonas aeruginosa	27853	6.2	10	>20,000
Staphylococcus aureus	29213	12.5	50	>20,000

ATCC = American Type Culture Collection; MBC = minimum bactericidal concentration..

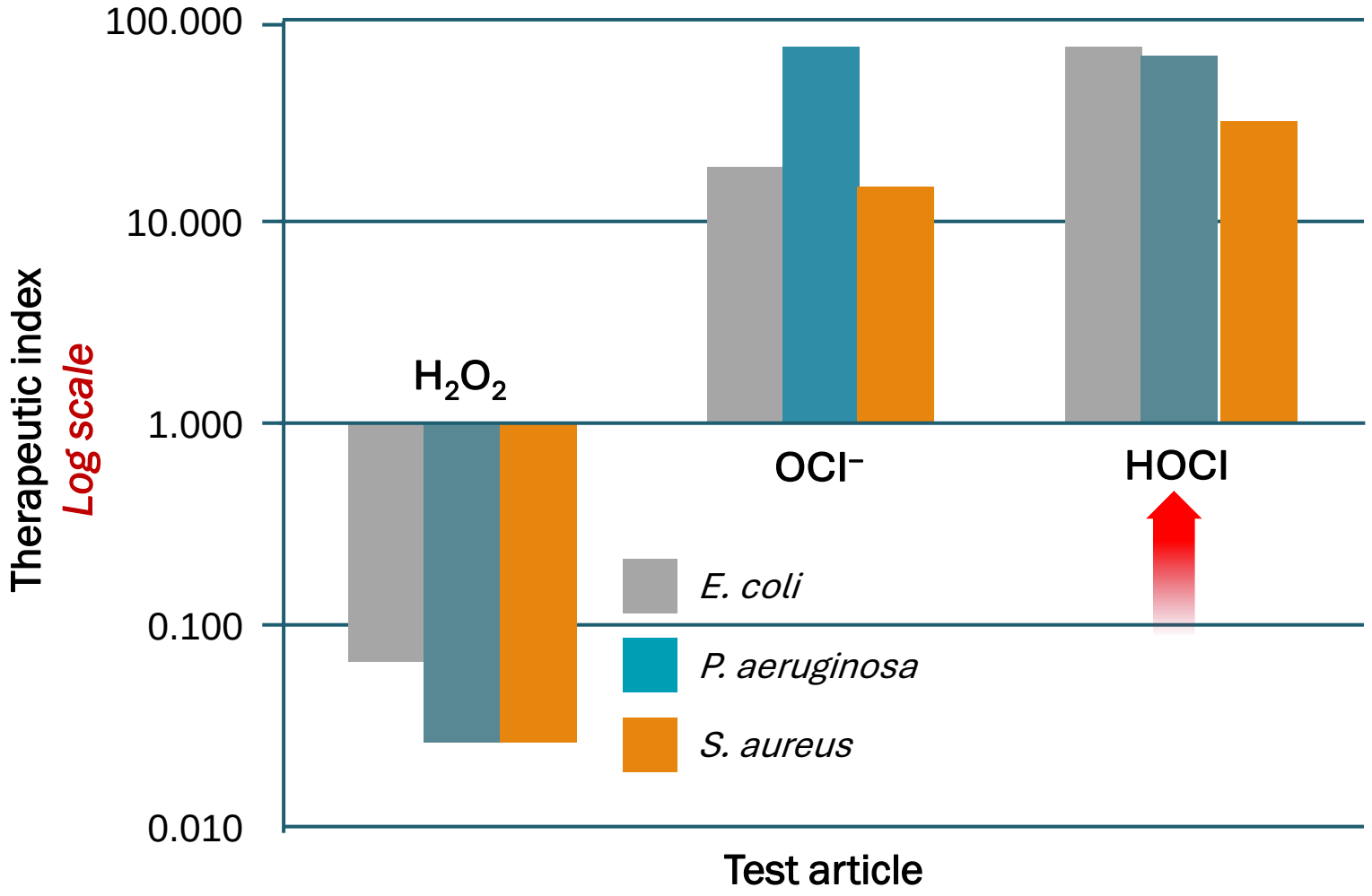
Slide courtesy of Dr. Greg Schultz
Wang L, et al. *J Burns Wounds*. 2007;6:e5.

Cytotoxicity of Various Liquid Antiseptic Formulations Against Human Fibroblast Cultures after 6 Hours



Slide courtesy of Dr. Greg Schultz
DADS-M = modified diallyl disulfide-oxide; SOS = superoxidation solution.
Ortega-Peña S, et al. *Int Wound J.* 2017;14(3):470-479.

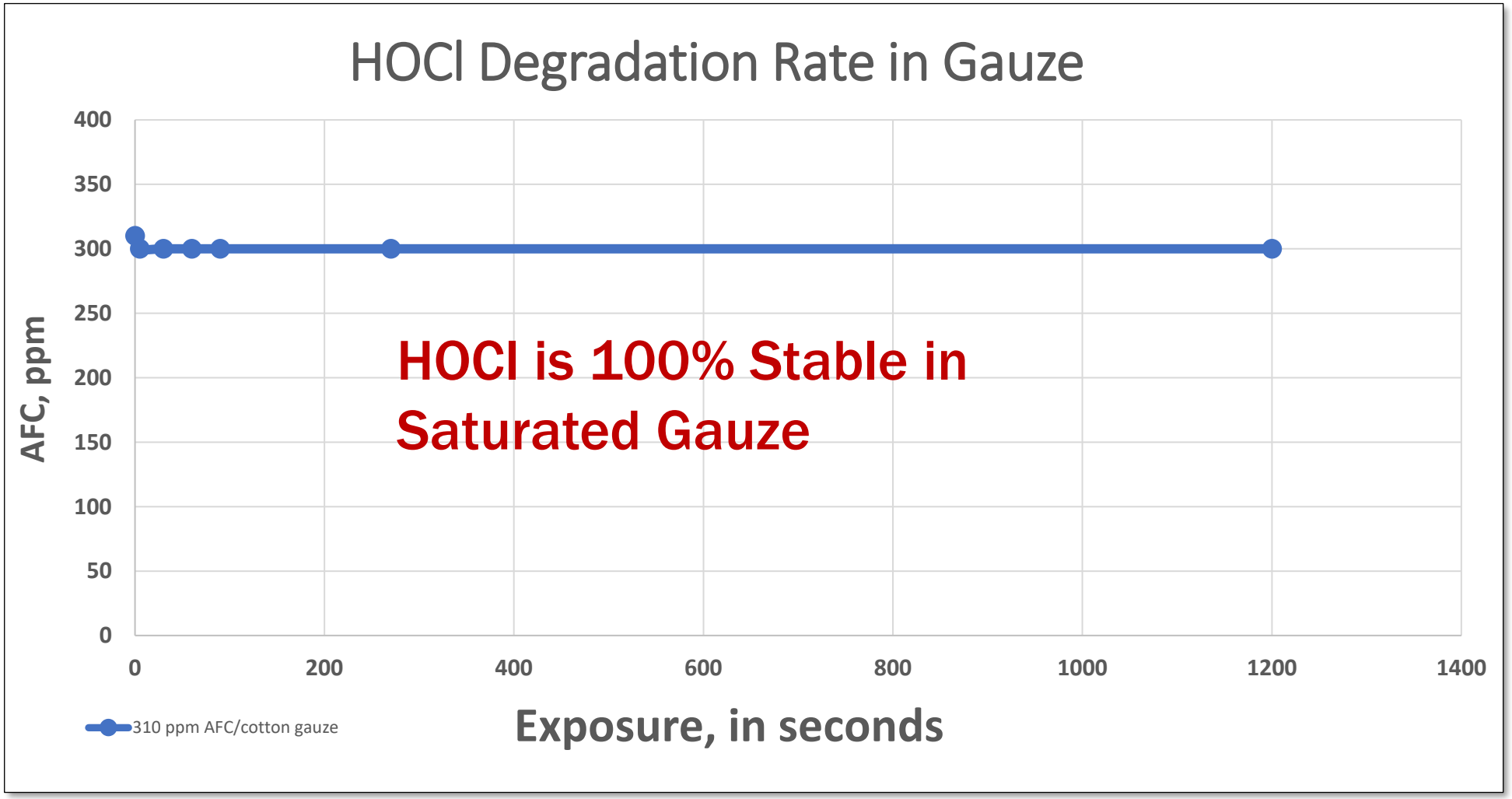
Relative Therapeutic Index of HOCl, OCl^-, and H_2O_2



- Relative therapeutic index of hypochlorous acid (HOCl; pH 4.0) hypochlorite (OCl^-; pH 10.5) hydrogen peroxide (H_2O_2; pH 7.0)
- **Therapeutic index is expressed as a ratio of the CT50 concentration (µg/mL) on L929 cells divided by the minimum bactericidal concentration (µg/mL)**
  - *S. aureus* 29,213
  - *P. aeruginosa* 27,853
  - *E. coli* 25,922
- **The higher the therapeutic index, the safer the test article will be**

Slide courtesy of Dr. Greg Schultz
Wang L, et al. *J Burns Wounds*. 2007;6:e5.

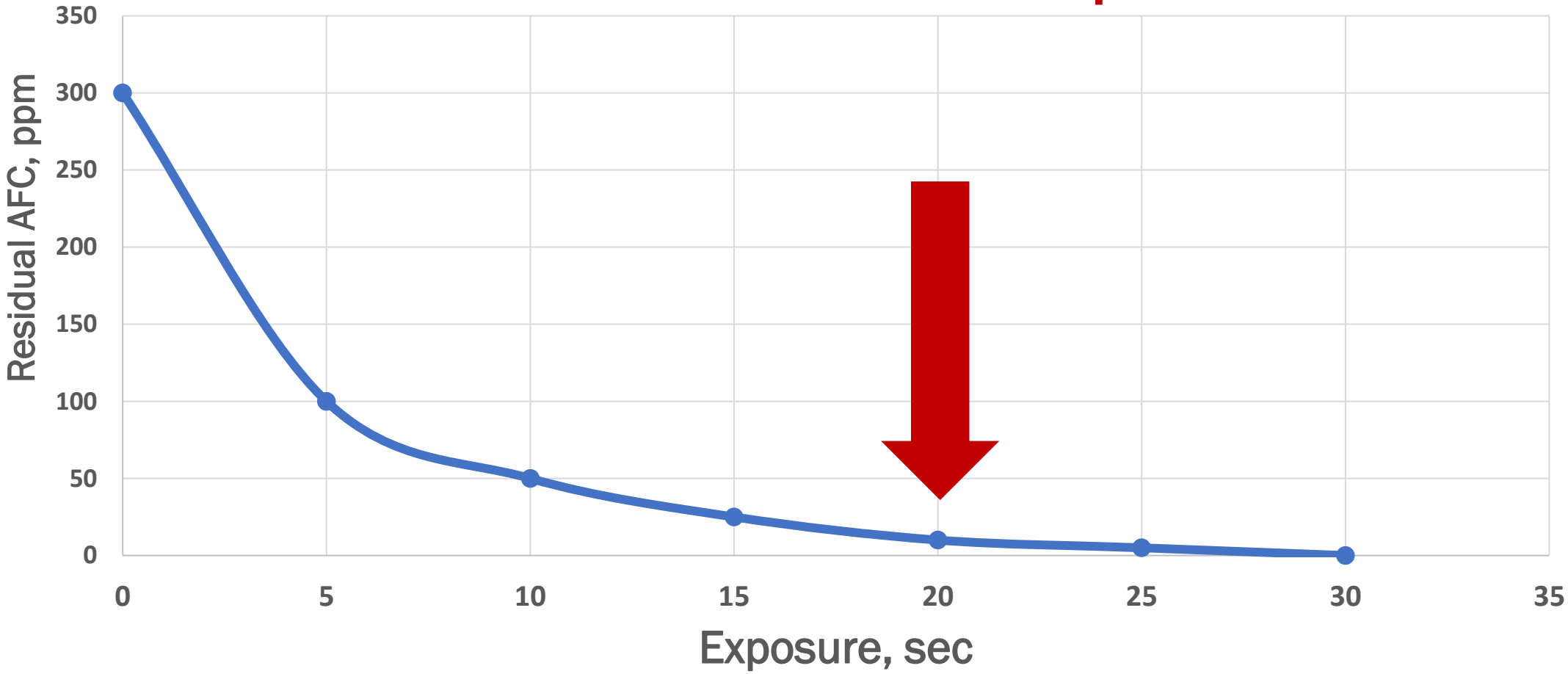
Soaking with Gauze as the Delivery System For a Reasonable Soak Time



Urgo laboratory data.

HOCl-Based Cleanser Safety Profile Is Due to Rapid Dissipation of HOCl at the Wound/Gauze Interface

HOCl is rapidly dissipated in direct contact with tissue protein



Urgo laboratory data.

NPWT and Instillation (NPWTi) with HOCl

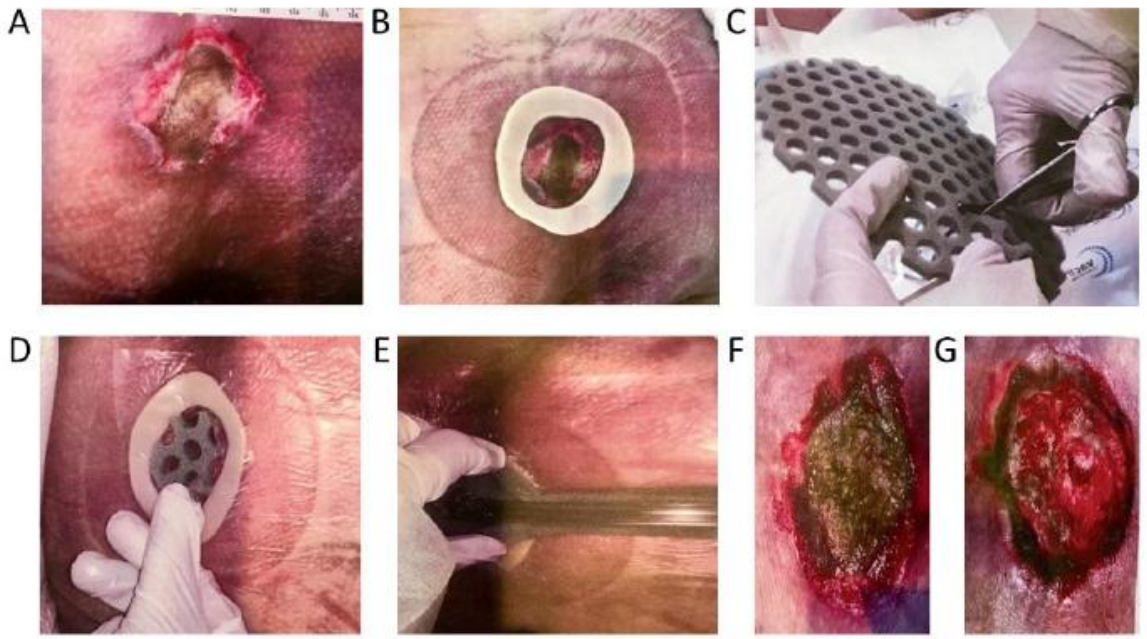


Figure 2: Wound management of coccyx pressure ulcer. A) Wound at presentation. B) Protected wound edges. C) ROCF-CC contact layer cut to fit wound. D) ROCF-CC contact layer applied to wound. E) Dressing applied and NPWTi-d initiated. F) Wound appearance after 3 days of NPWTi-d. G) Wound appearance after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

Fernandez et al., J Trauma Treat 2017, 6:5
DOI: 10.4172/2167-1222.1000410

Journal of Trauma & Treatment

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

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

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

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

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.

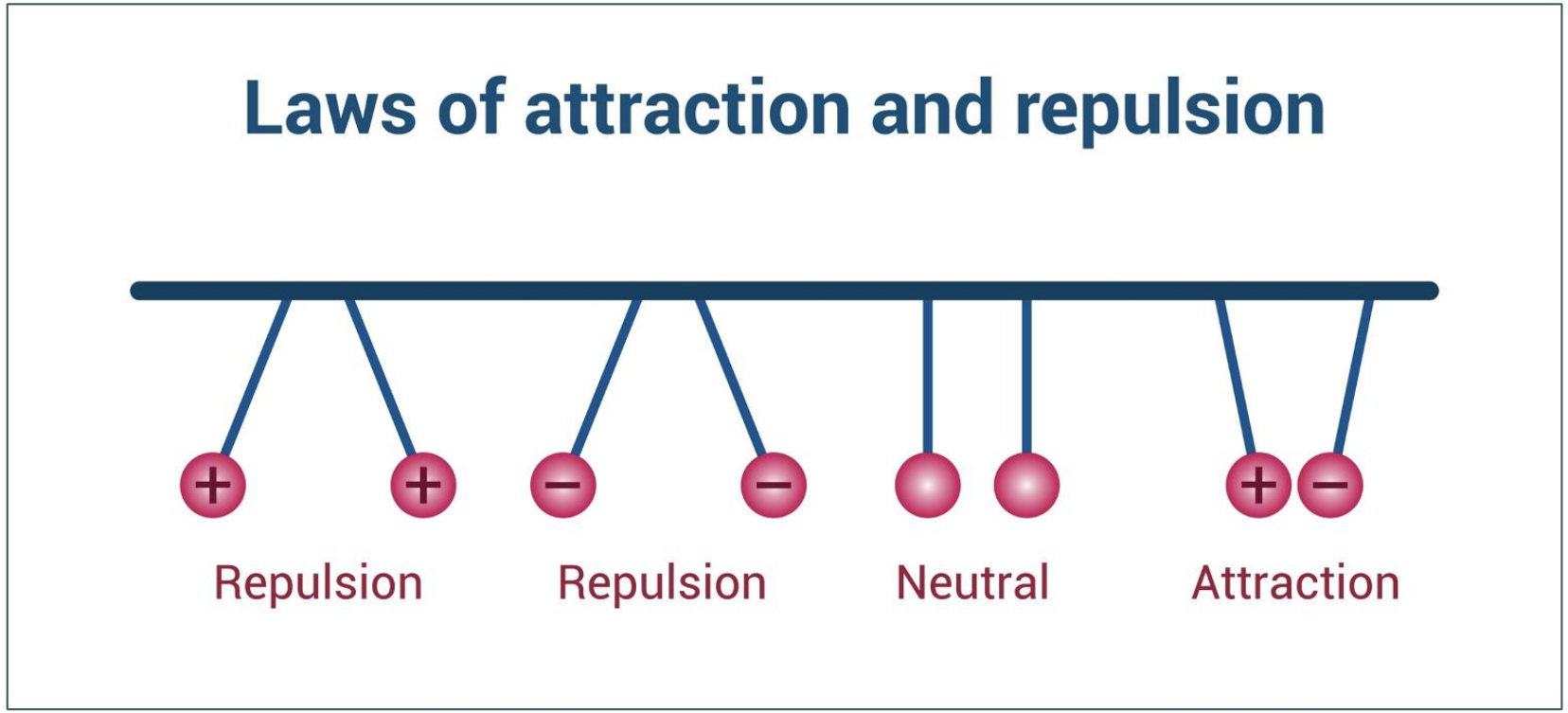
For highly exudative wounds, alginate dressings (a seaweed-derived non-woven fiber dressing) are typically used because of their ability to absorb copious amounts of fluid. We have also used autolytic debridement in wounds with a moist wound environment; however, this form of therapy is not capable of 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

Laws of Charges

Opposites Attract

Works by electrostatic interactions



How Do Charged Fibers Work in Supporting Autolytic Debridement?

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

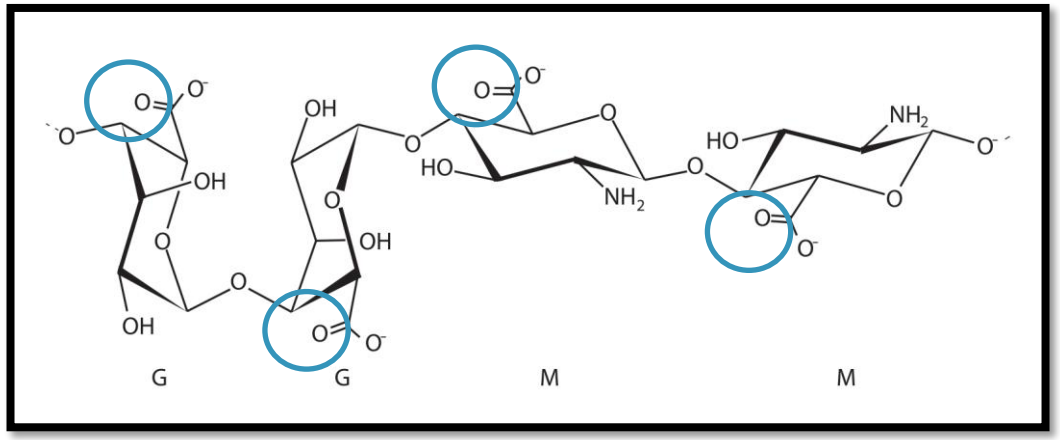
- Steric Exclusion
- Hydrophobic Interactions
- Hydrogen Bonds

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

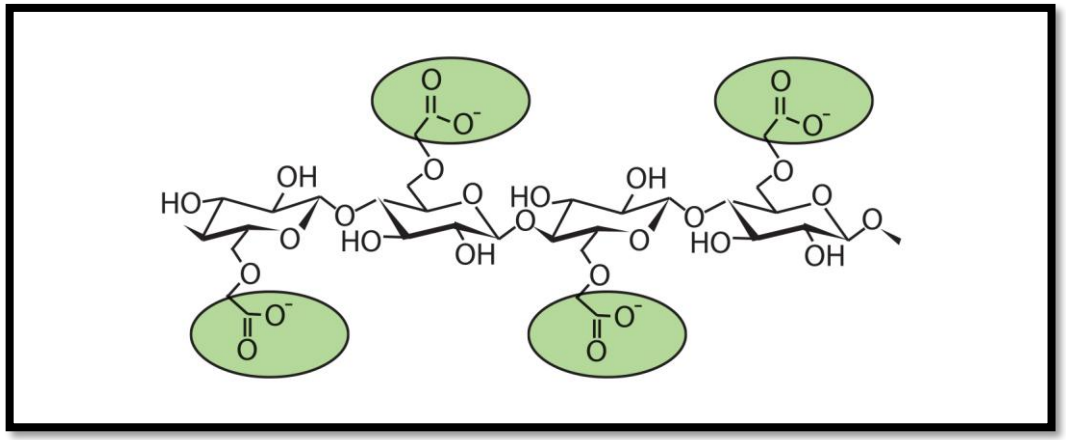
Meaume S, et al. *J Wound Care*. 2014;23(3):105-116.

Let's Compare Other Dressings

Alginate:
Negative charges are far apart

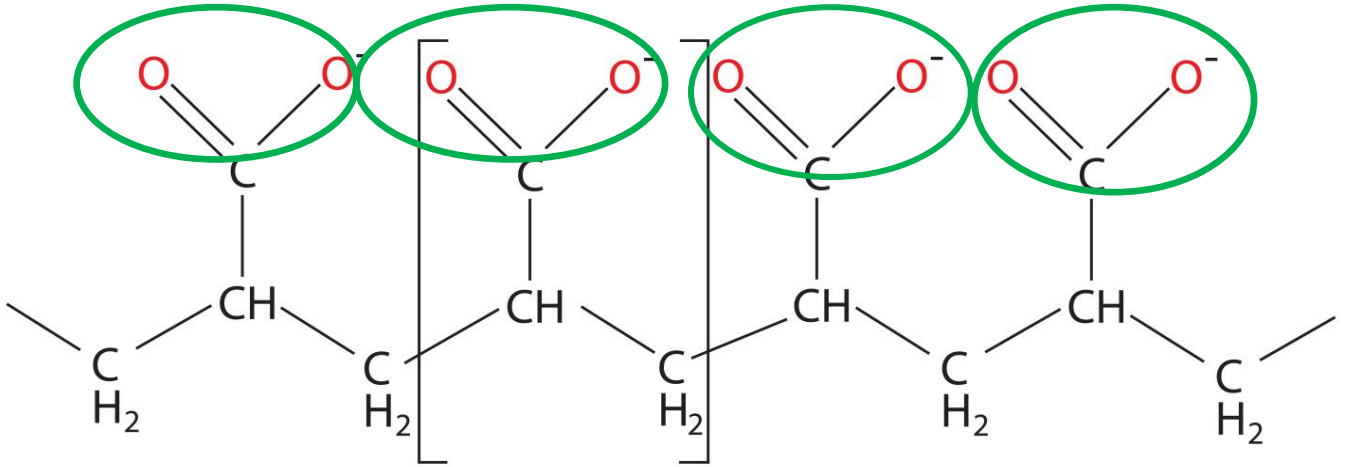


Carboxymethylcellulose (CMC):
Negative charges are far apart



Meaume S, et al. *J Wound Care*. 2014;23(3):105-116.

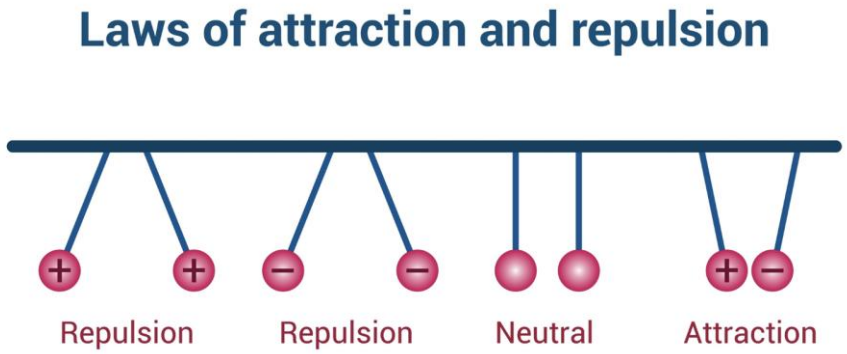
NCF Dressings Negative Charges are ***VERY CLOSE***



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

- A cleanser, such as an HOCl-based cleanser, can mechanically soften slough and make it easier for a charged fiber dressing to autolytically aid slough removal

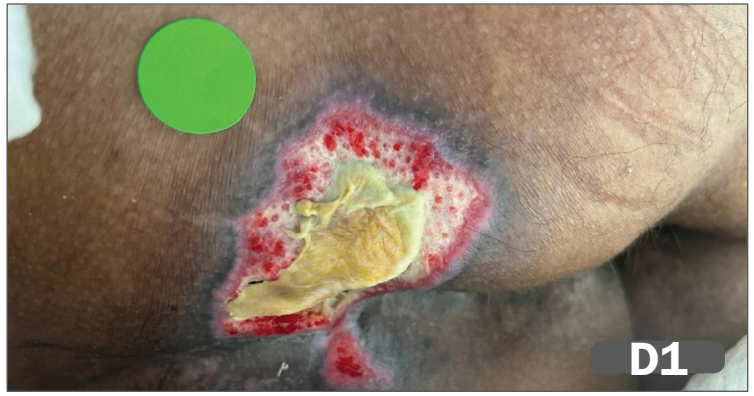


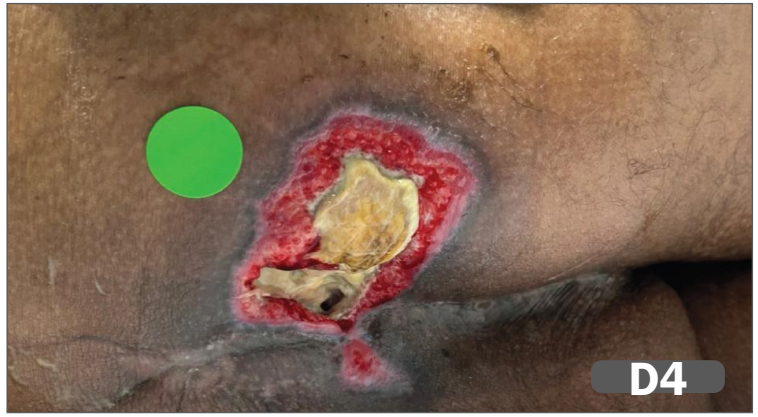
NCF = negatively charged fiber; TLC-Ag = two antimicrobial contact layers impregnated with silver

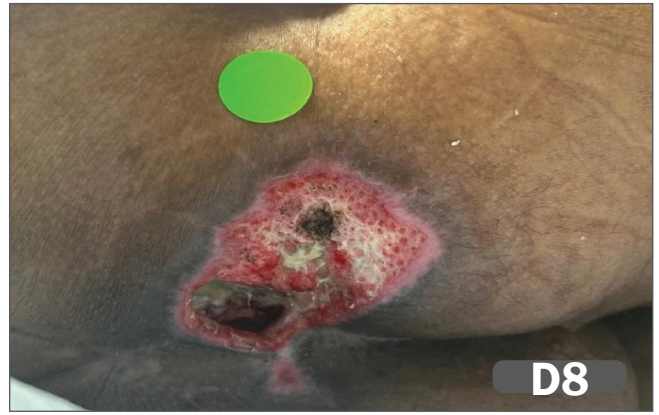
Cases

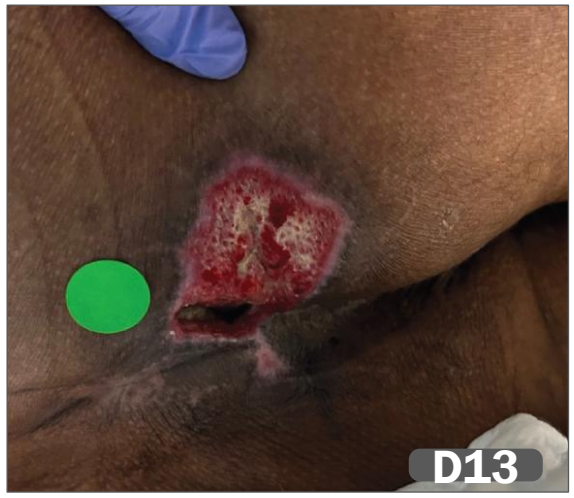
Case:
Sacral Pressure Injury

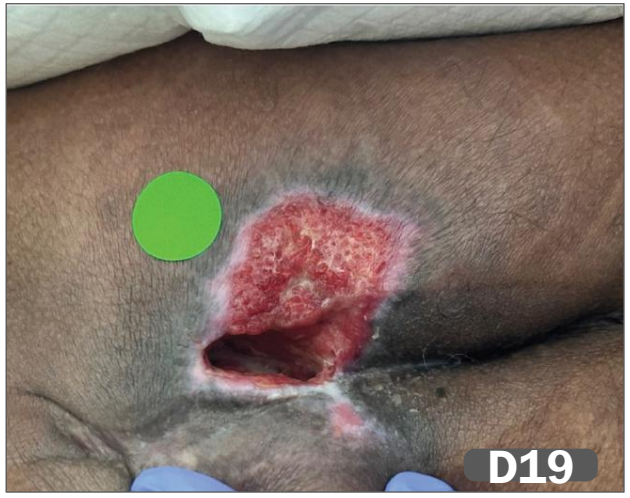
- 55y with chronic desmoid tumors, enterocutaneous fistula (ECF), chronic pain, malnutrition developed an unstageable hospital-acquired pressure injury (HAPI) on buttock 2/2 deconditioning
- Was having twice weekly OR dressing changes of ECF
  - Planned OR debridement of ulcer, but improved too quickly with NCF







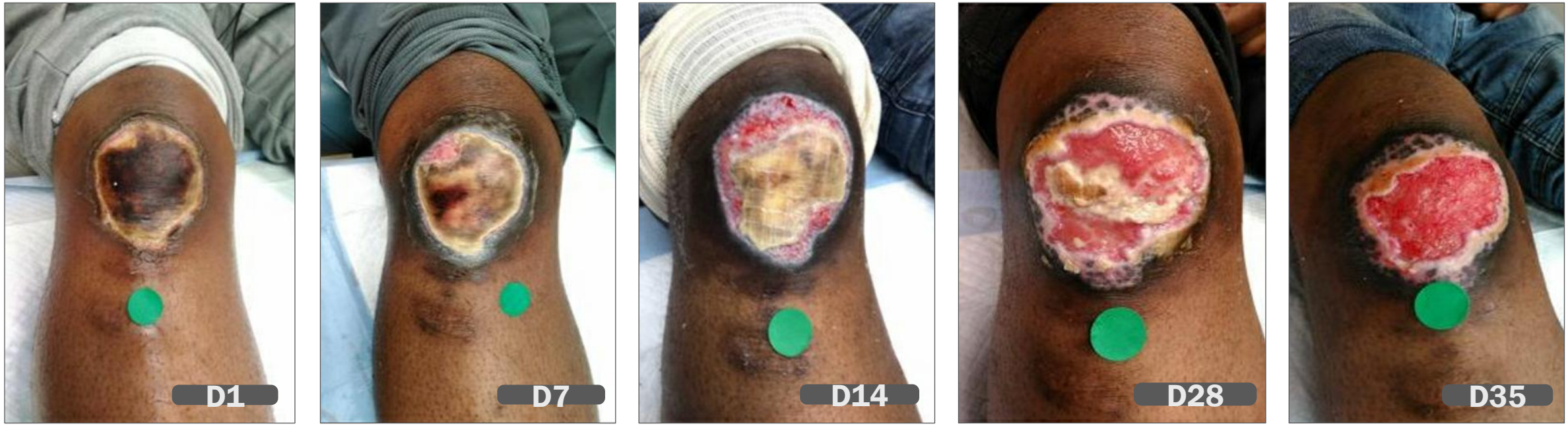




HAPI = hospital-acquired pressure injury; ECF = enterocutaneous fistula.

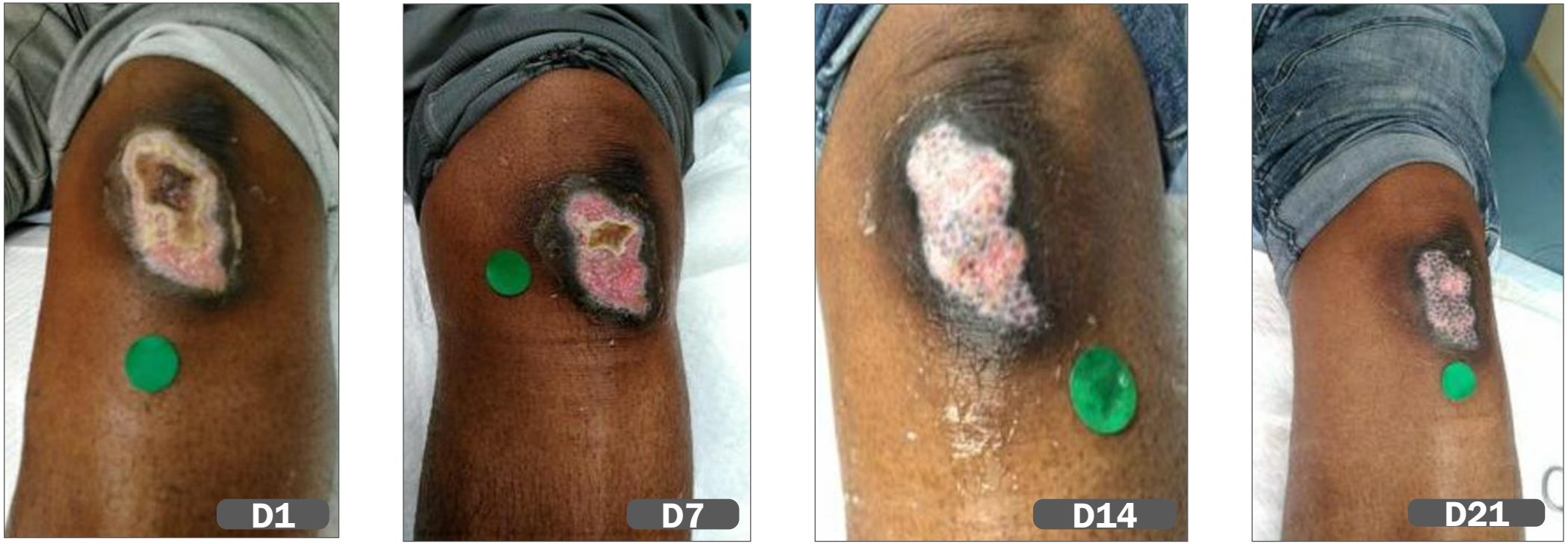
Case: Right Leg Knee Burn

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



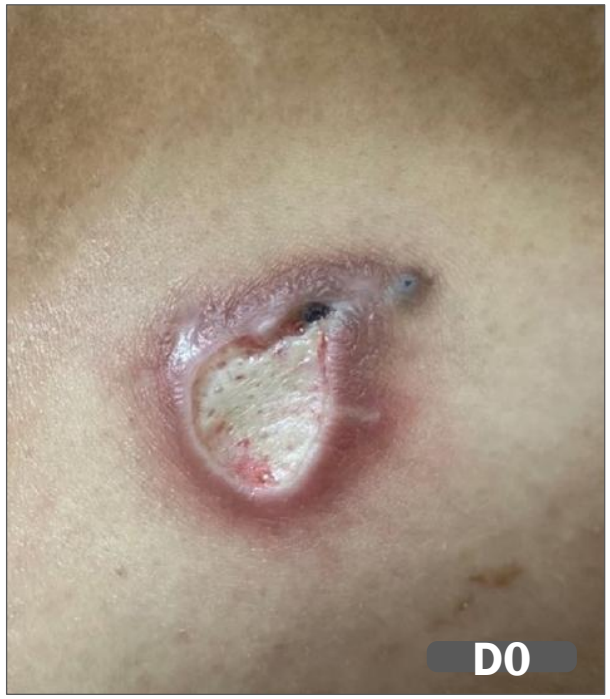
Case: Left Leg Knee Burn

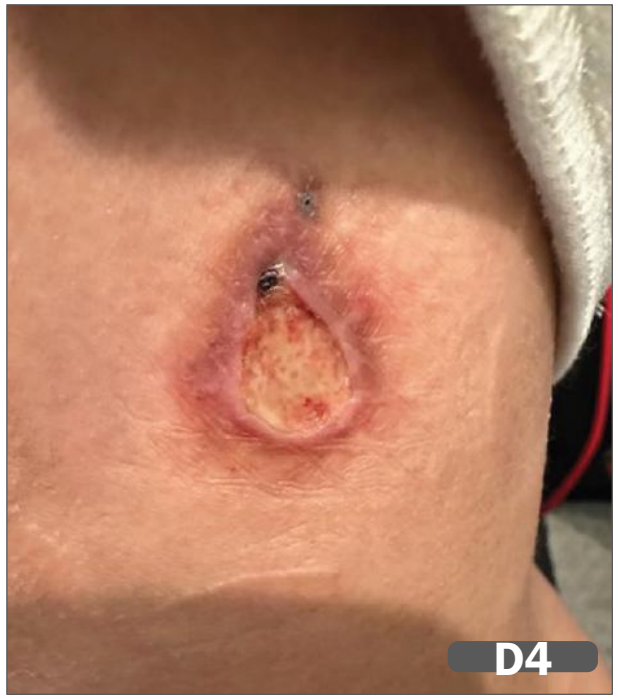
- Same patient; this is the other leg

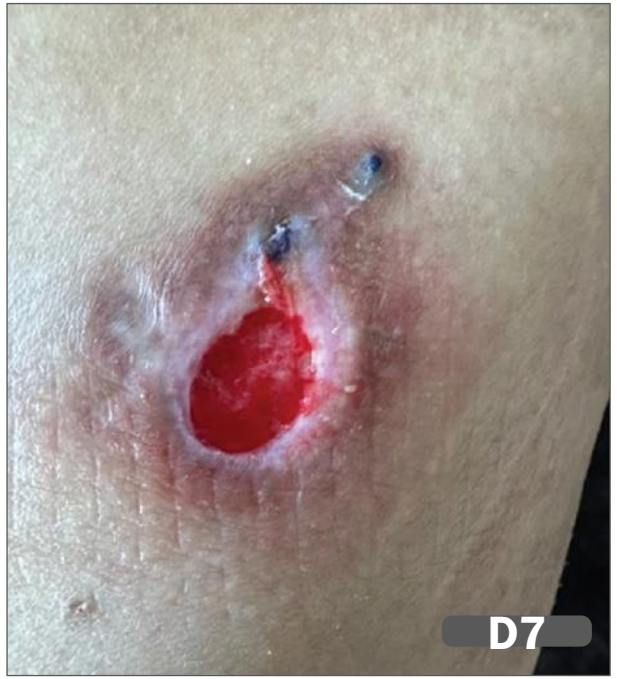


Case: Chest Tube Non-Healing Wound

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





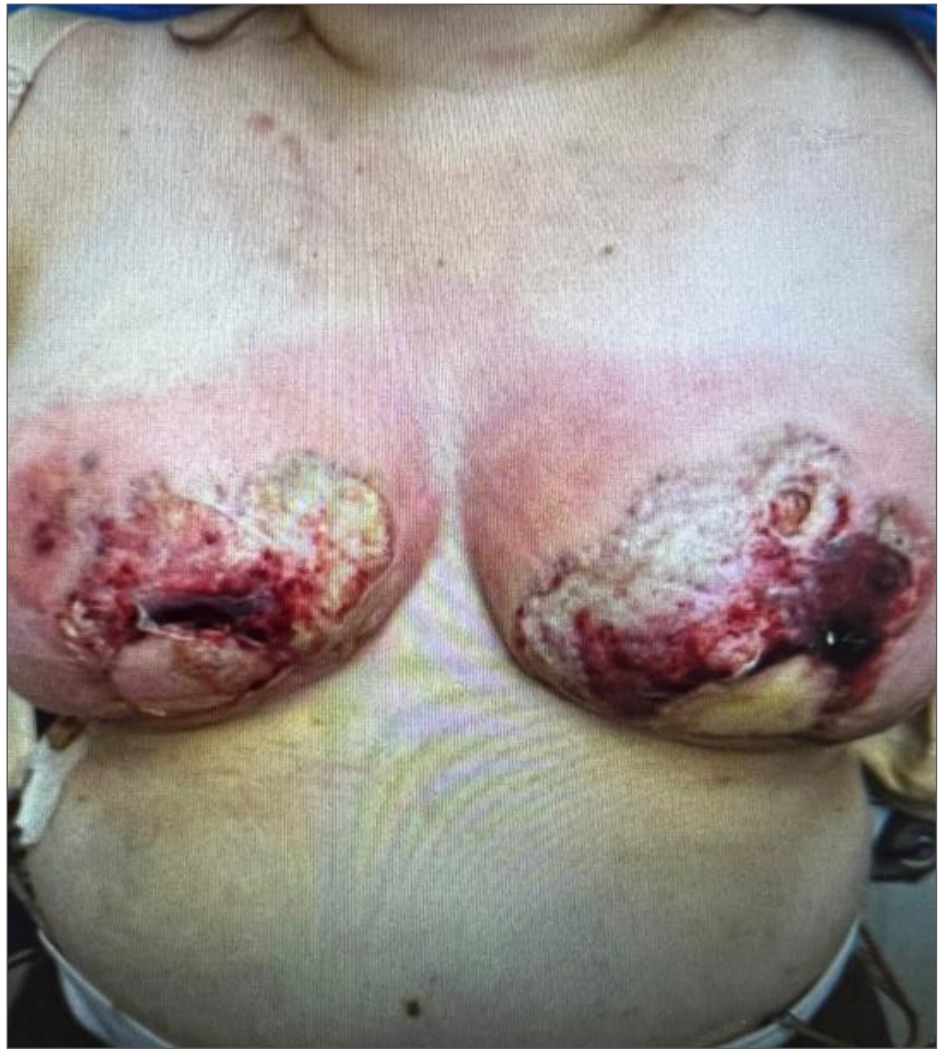


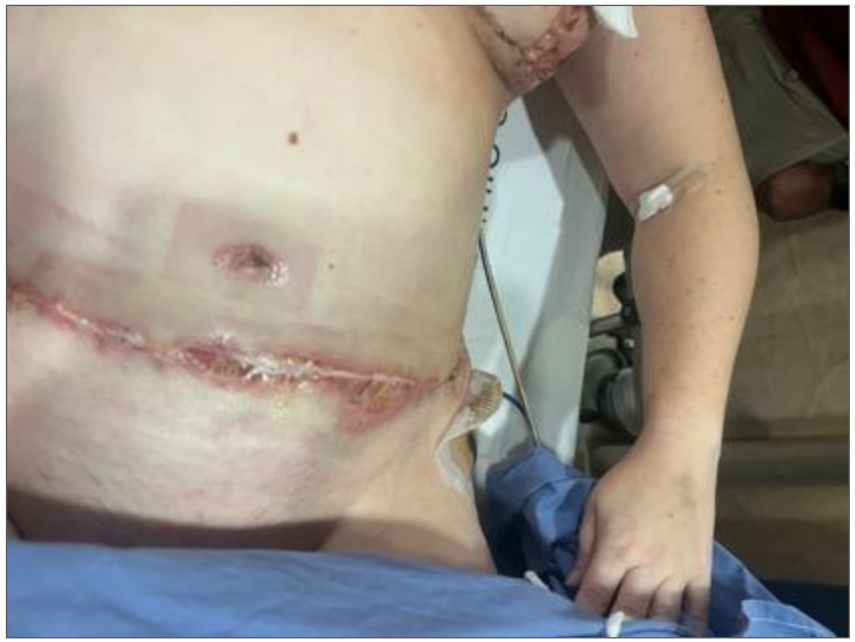
Case: Pyoderma Gangrenosum (PG)

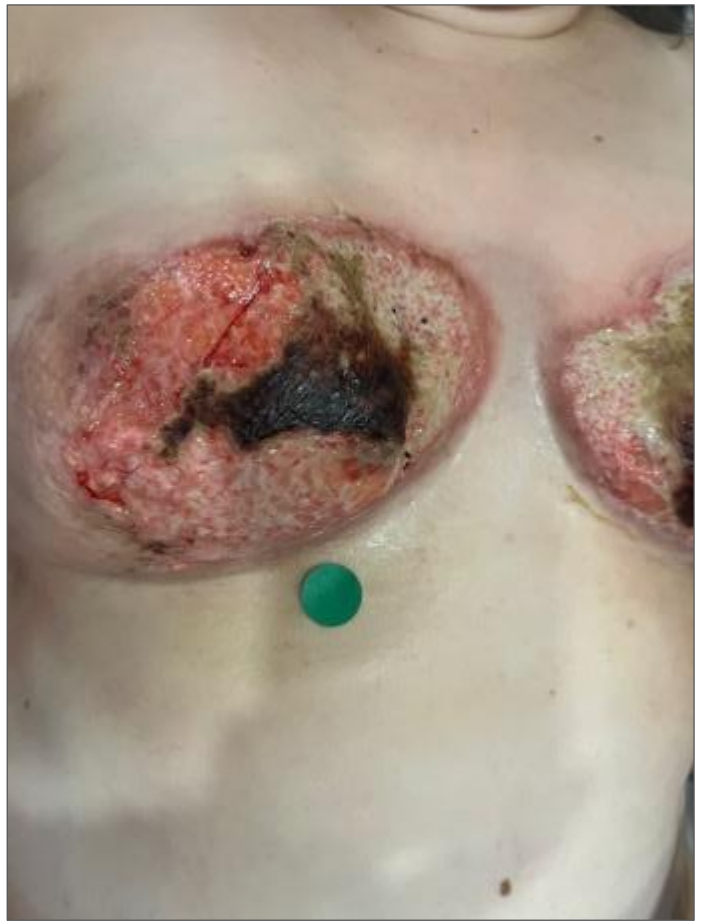
- 39y Female with BRCA gene underwent preventive mastectomies bilaterally with immediate reconstruction using DIEP flaps
- POD4: Developed fever, chills
- POD7: Noted redness, blistering along sternum, which got progressively worse
- Saw Plastics daily x2 days, started on cefadroxil
- POD10: Admitted; biopsy showed pyoderma gangrenosum (PG)
- Started cyclosporine ≈2wks after symptoms started
- Wounds treated with HBO x30 dives; HOCl cleanser compresses daily and NCF covered with bordered silicone foam dressings
- Initial debridement done at day 6 of NCF dressing

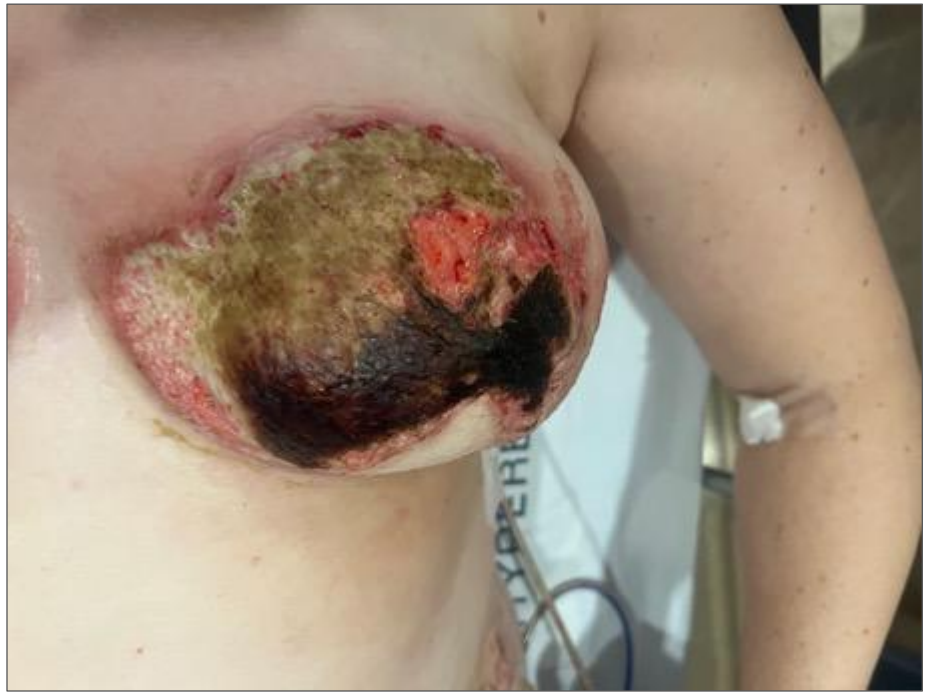
Case: PG, Day of Admission

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





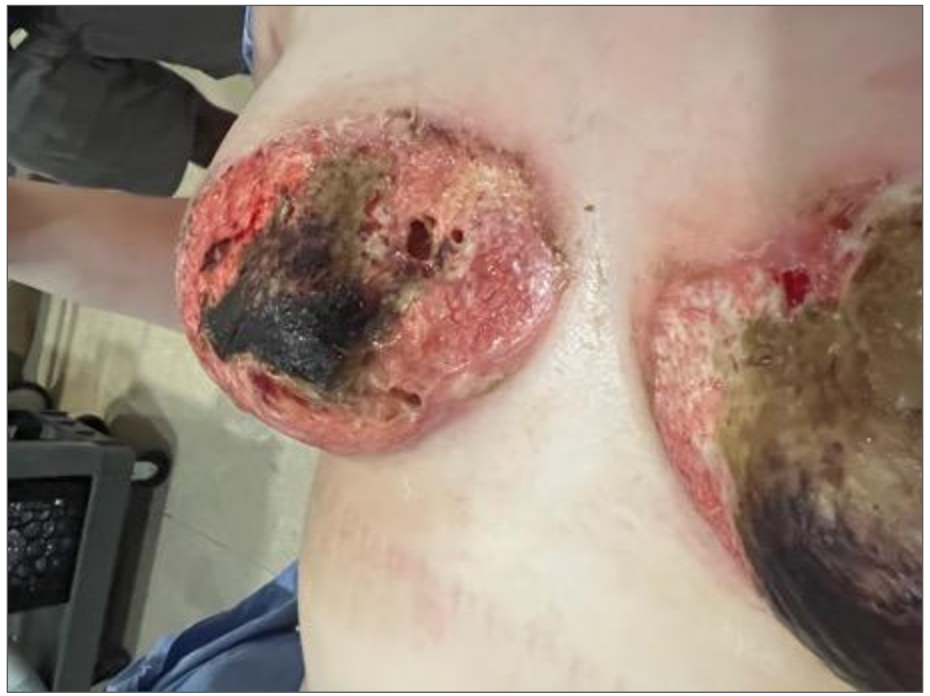


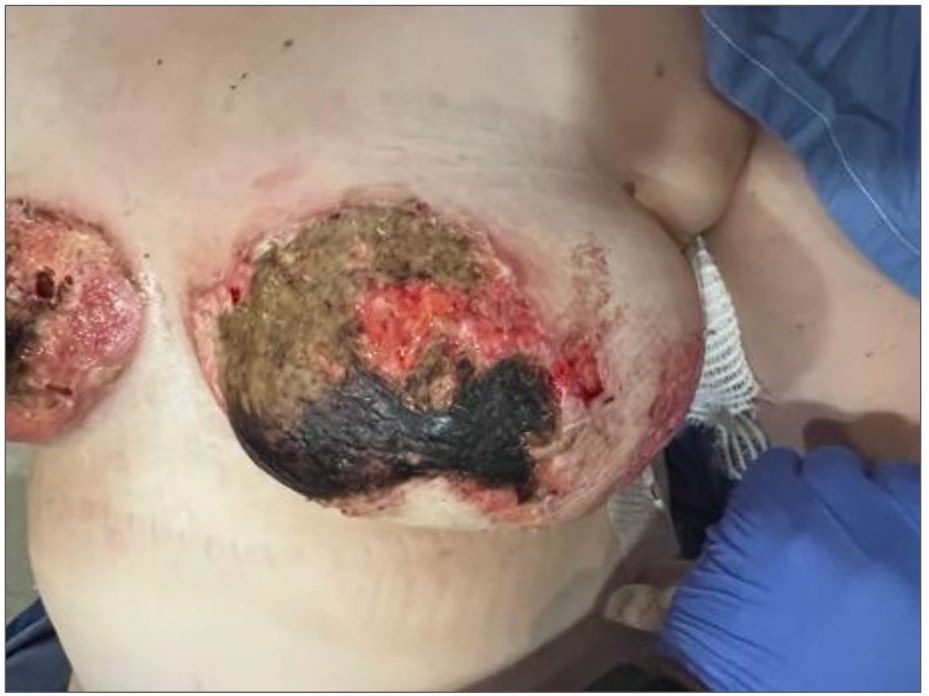


Case 6: PG

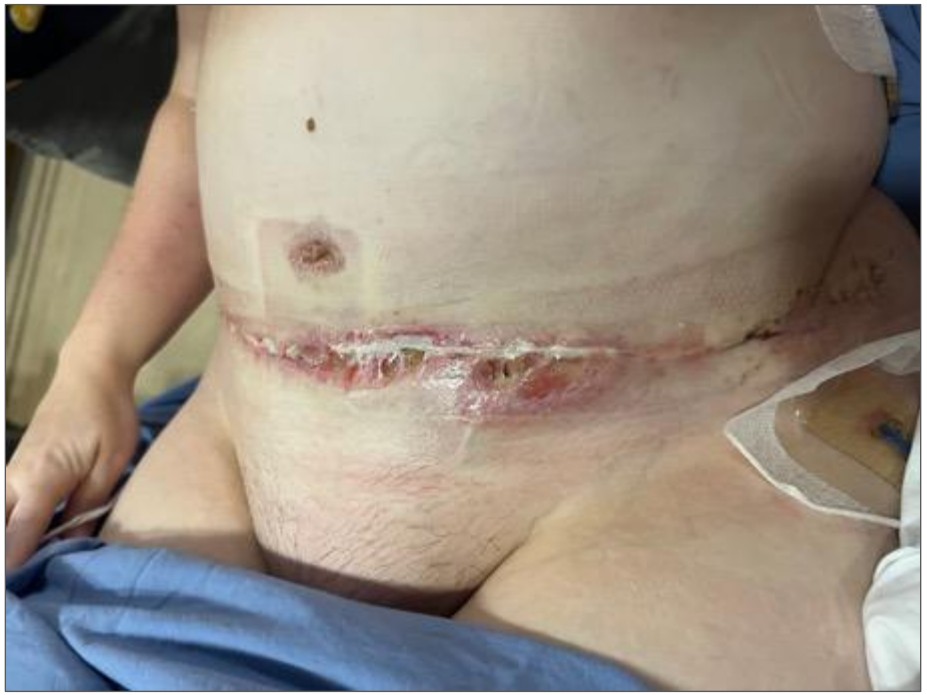
- Rapid removal of slough and eschar via autolysis with charged fiber dressing
- Drainage contained with bordered foam dressings
- Started on cyclosporine on 5 days after admission when biopsy came back

Case 6: PG, 2 Wks into Issue



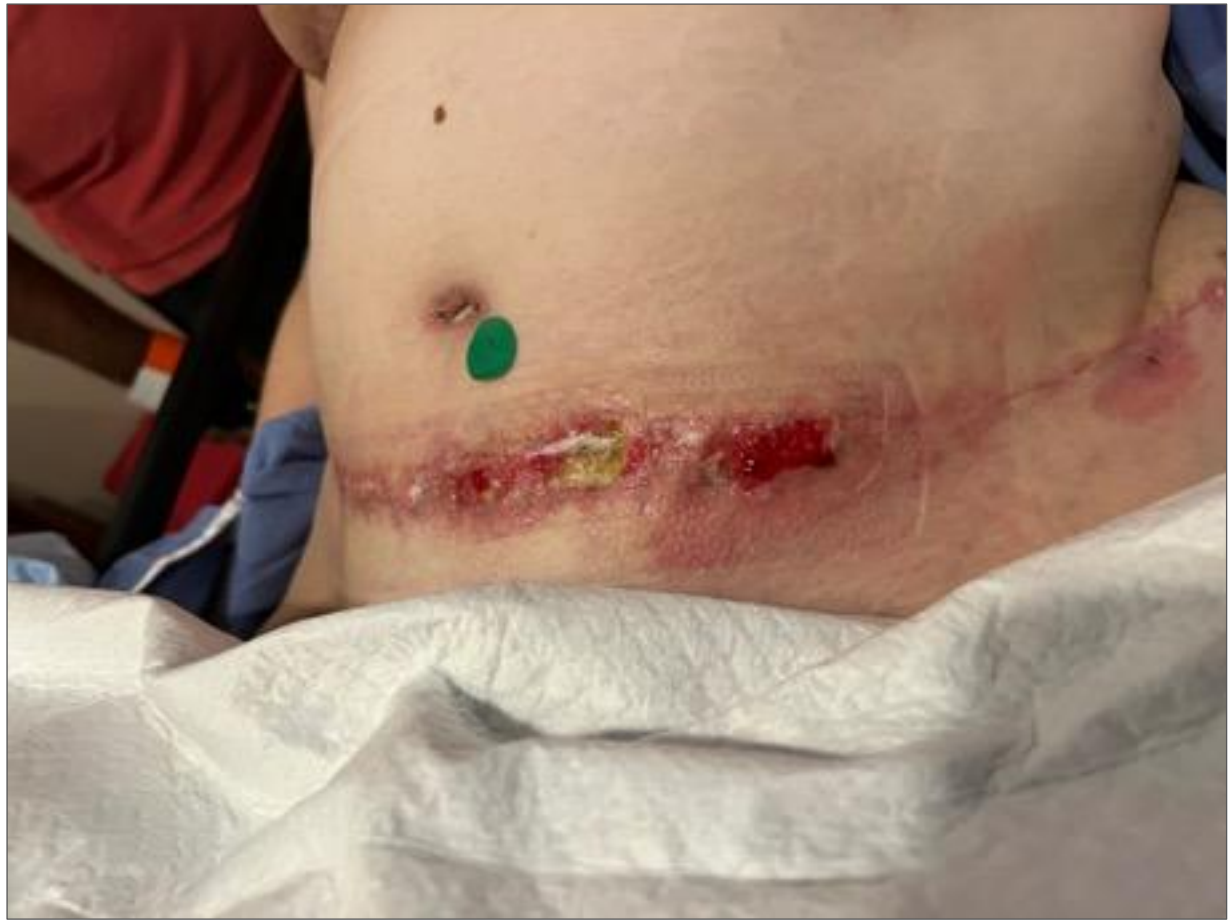


Case 6: PG, 2 Wks

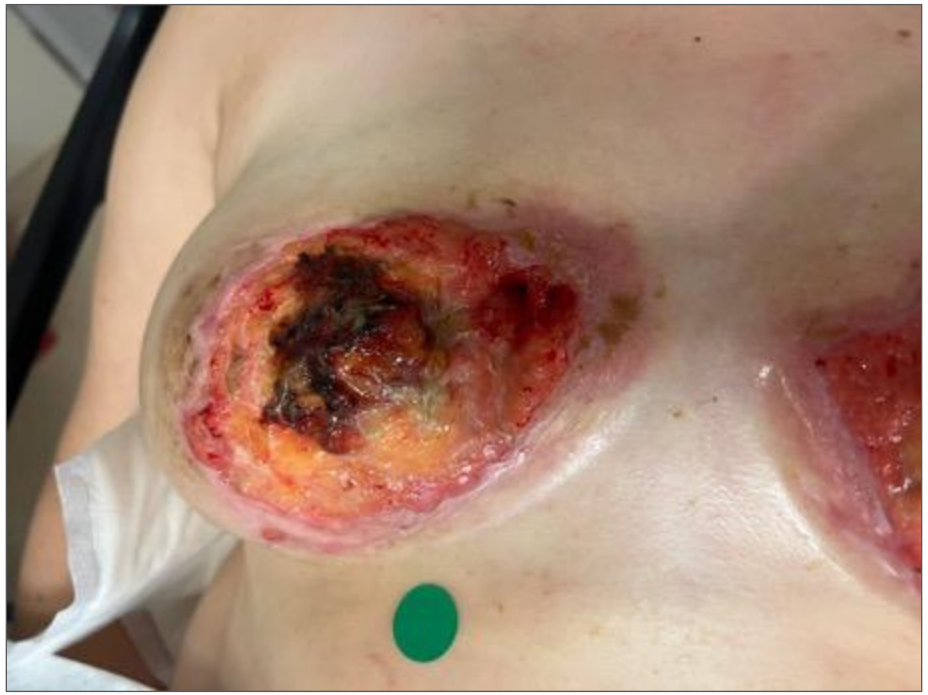


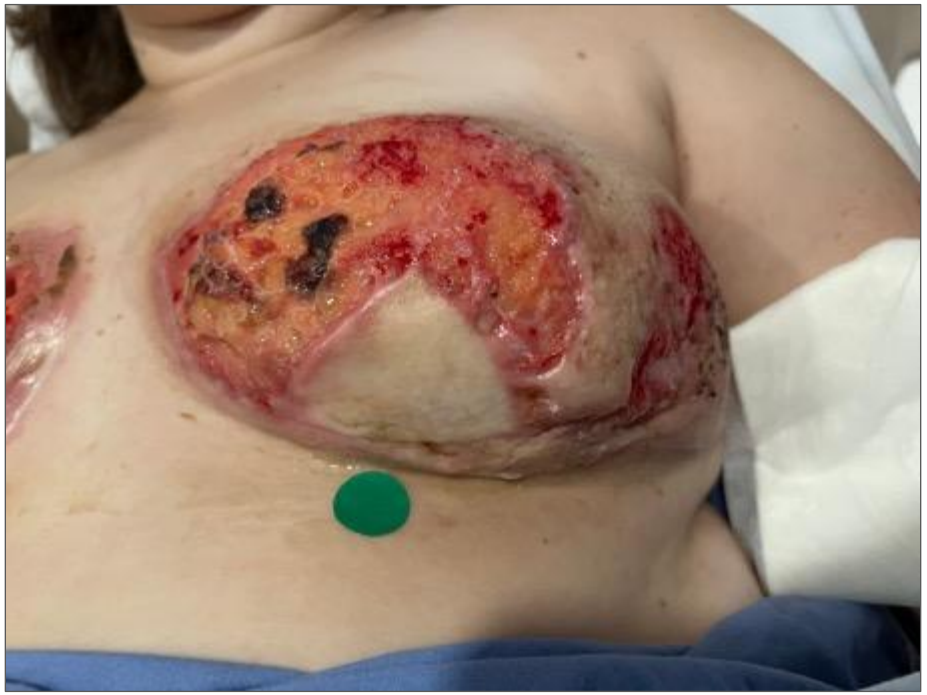
Case 6: PG, DIEP Donor Site

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

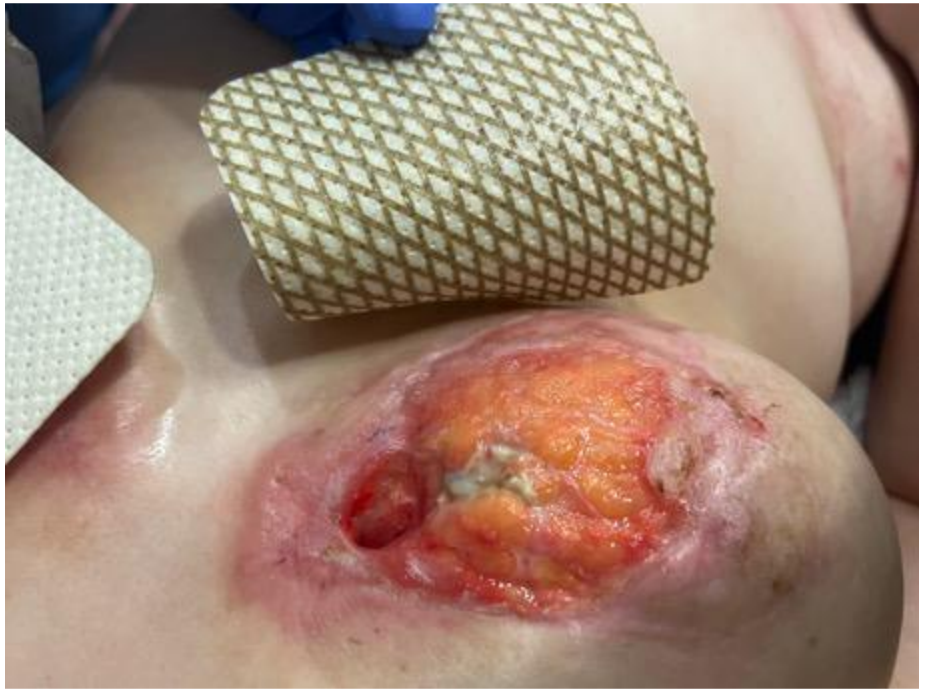


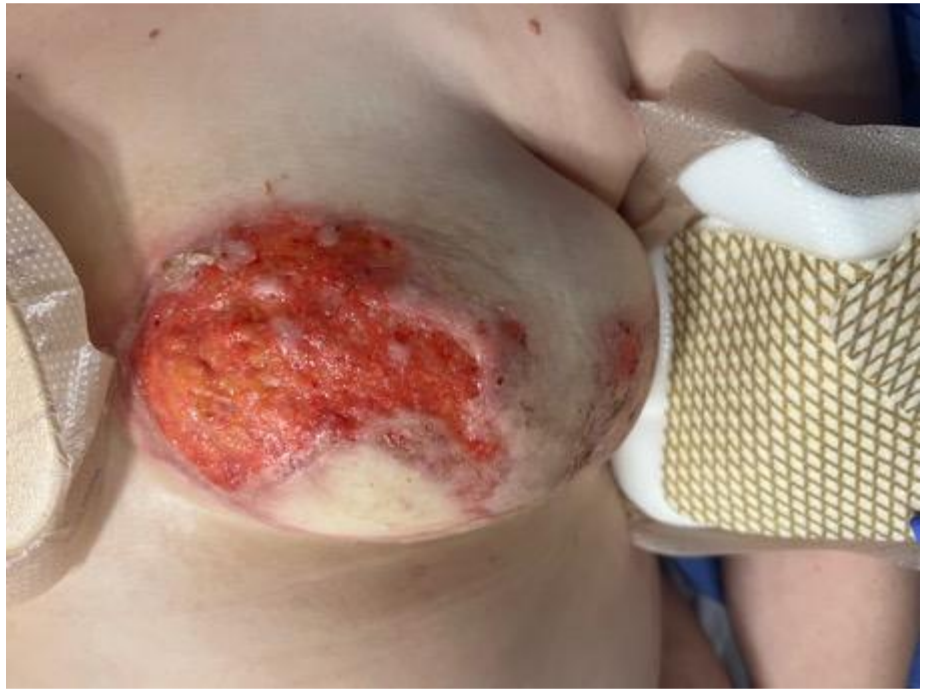
Case 6: PG, 1 month



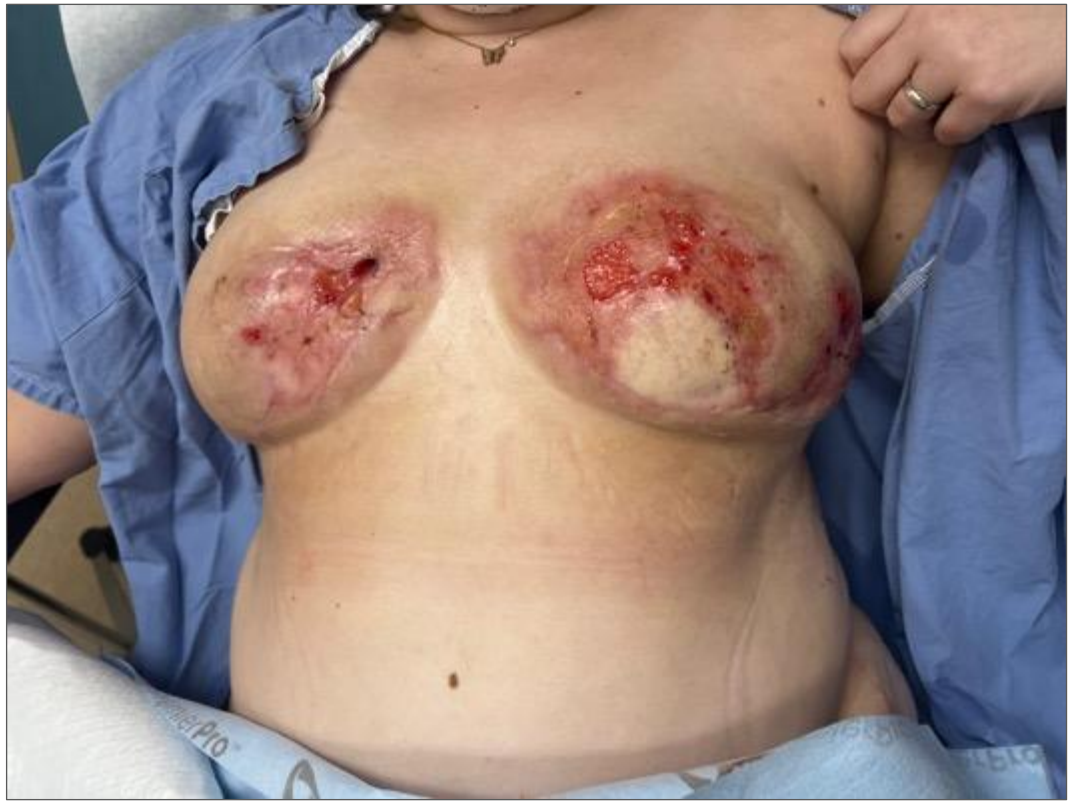


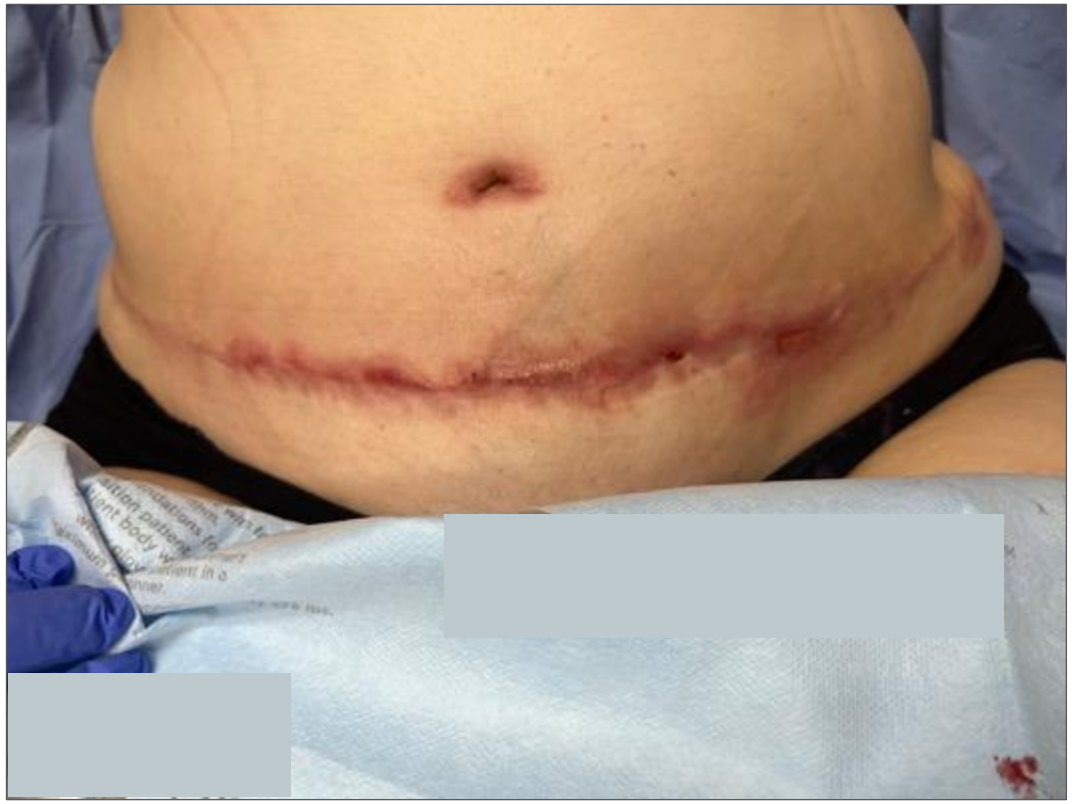
Case 6: PG, 6 Wks





Case 6: PG, 2 months





Collaborative Products for Necrotic Tissue and Slough Removal

Micah W. Siegel, MD, FAWM, CWSP, CHT
President/Medical Director
Extreme Environmental Medicine
New Orleans, LA

Types of Debridement

- **Traditional Autolytic:** Body's enzymes (eg, hydrocolloids, alginates, hydrogels)
- **Enzymatic:** Topical agents (eg, collagenase, bromelain)
- **Mechanical:** Gauze, irrigation, monofilament pads
- **Surgical/sharp:** Scalpel, scissors (by trained professionals)
- **Biological:** Maggot therapy

Why Combine Products?

- No single product fits all wounds
- Synergistic action = faster, more efficient debridement, quicker wound healing
- Can address multiple wound characteristics (eg, moisture + microbes + necrosis)

Examples

- Hydrogel + Alginate
- Collagenase + Foam Dressing
- Monofilament Pad + Hydrogel
- Honey + Alginate

Hydrogel + Alginate

- **Hydrogel (autolytic):** Moisture donation, softens slough
- **Alginate:** Absorbs exudate, supports autolytic debridement
- **Outcome:** Hydration + exudate management

Collagenase + Foam Dressing

- **Collagenase ointment (enzymatic):** Breaks down collagen in necrotic tissue
- **Foam:** Manages moisture, protects wound
- **Outcome:** Ongoing debridement + optimal healing environment

Honey + Alginate

- **Medical-grade honey:** Osmotic effect, supported autolytic
- **Alginate dressing:** Maintains moisture balance
- **Outcome:** Gentle, yet effective, bioactive debridement

Monofilament Pad + Hydrogel

- **Monofilament pad (mechanical):** Removes loose slough painlessly
- **Hydrogel (autolytic):** Softens remaining devitalized tissue
- **Outcome:** Immediate + delayed action on slough

Hypochlorous Acid + Charged Fiber Dressings

- **Hypochlorous Acid (HOCl):** Effective removal of germs while maintaining an optimal pH for wound healing
- Naturally produced by neutrophils in the immune system
- Broad-spectrum antimicrobial preservative
- Non-cytotoxic at appropriate concentrations
- Assists wound bed preparation by removing germs and necrotic debris

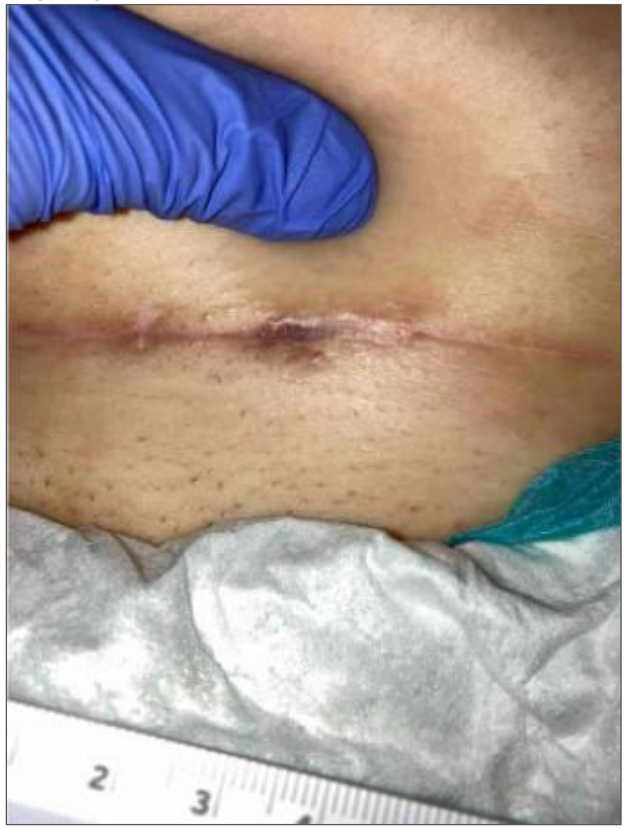
Hypochlorous Acid + Charged Fiber Dressings

- **Charged Fiber Dressing:** Supports autolytic debridement
  - Maintains clean environment
  - Promotes autolytic debridement via charged fibers
- **Outcome:** Efficient removal of slough and antimicrobial barrier function

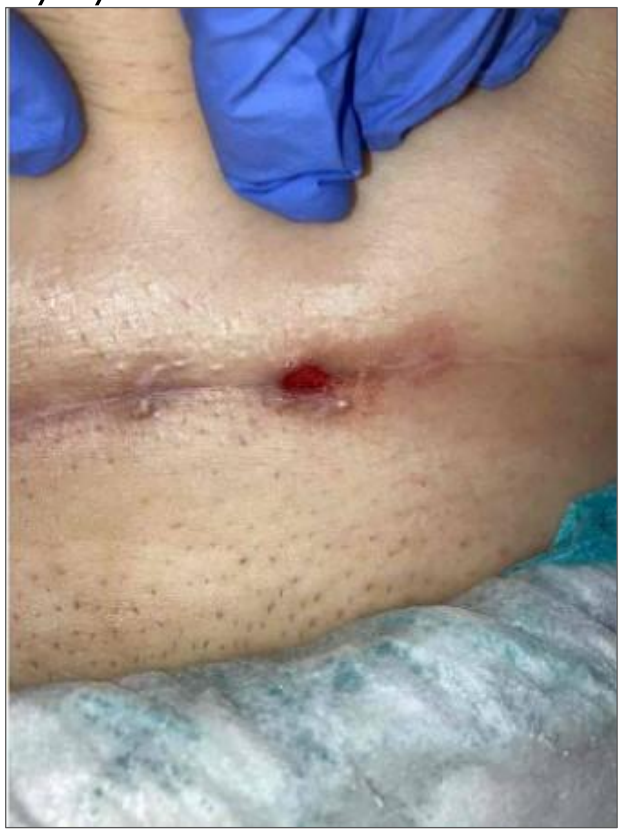
Cases

Non-Healing Surgical Wound

3/8/24

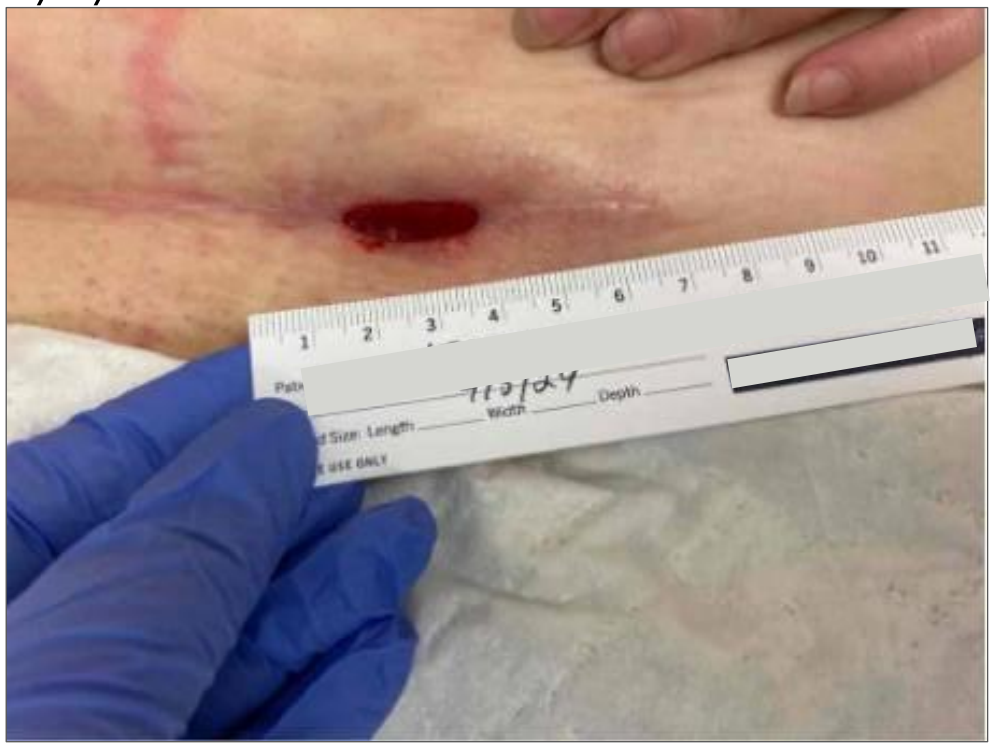


3/8/24



Post probing

4/5/24



First application

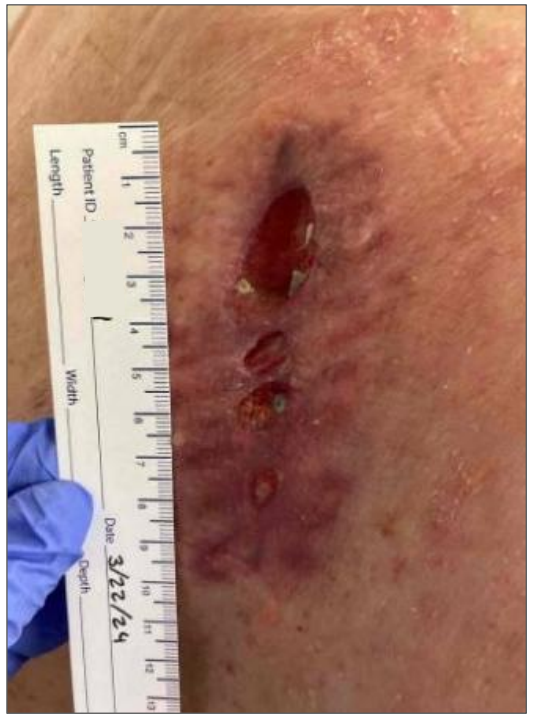
Non-Healing Surgical Wound

4/12/24

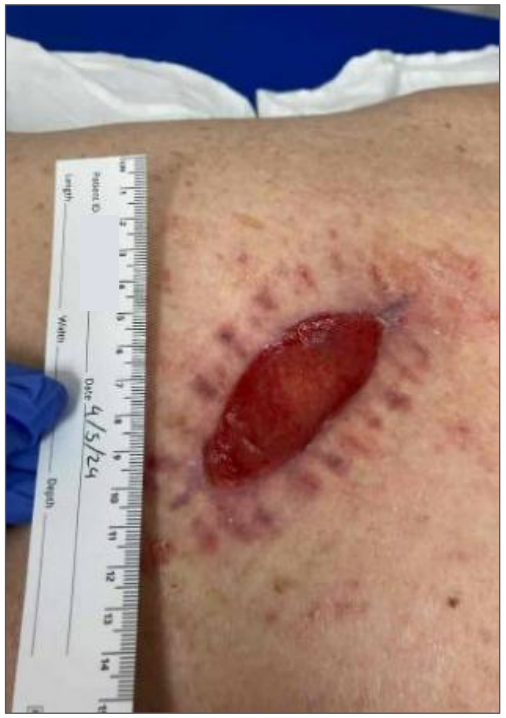
4/19/24

Dehisced Wound

3/22/24



4/5/24



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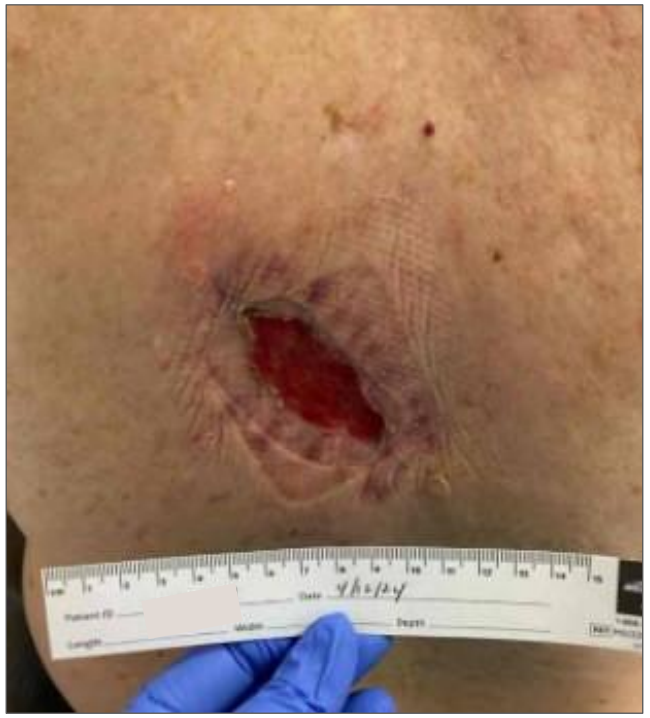
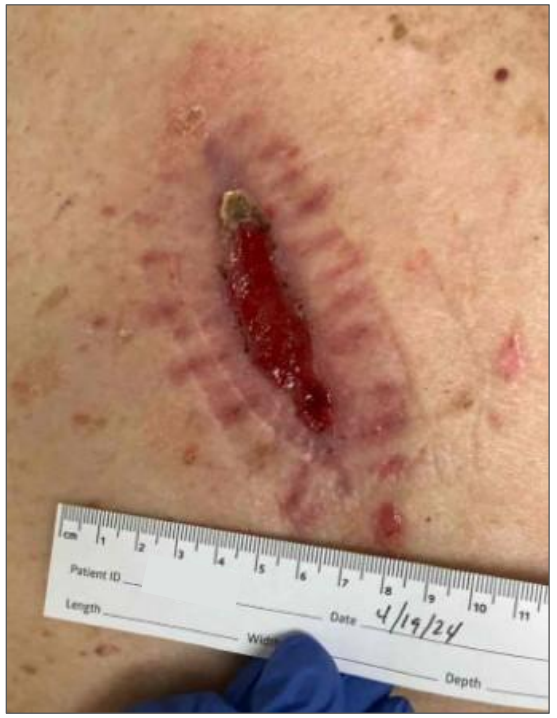


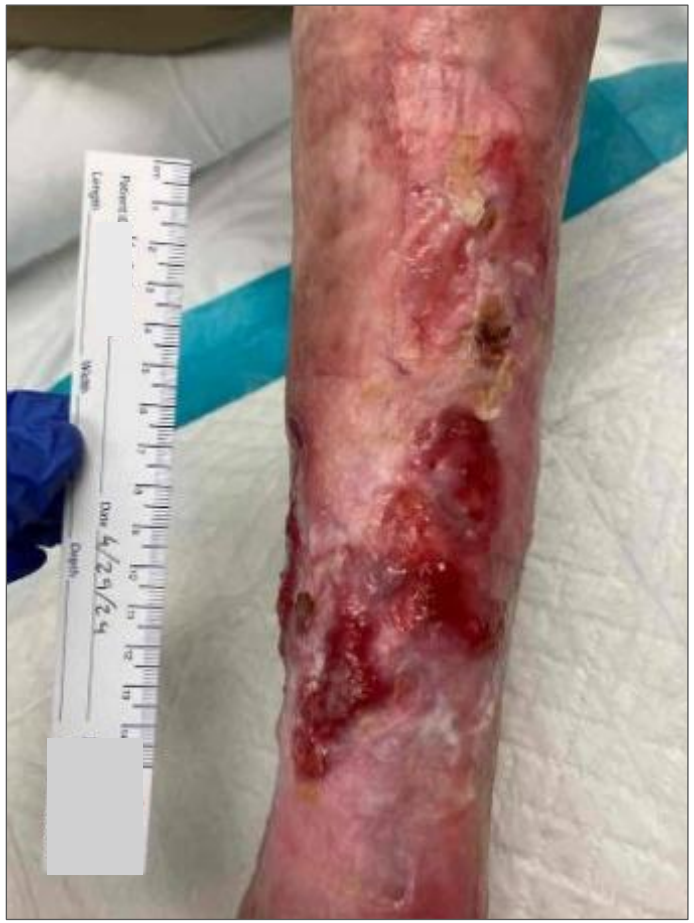
4/19/24

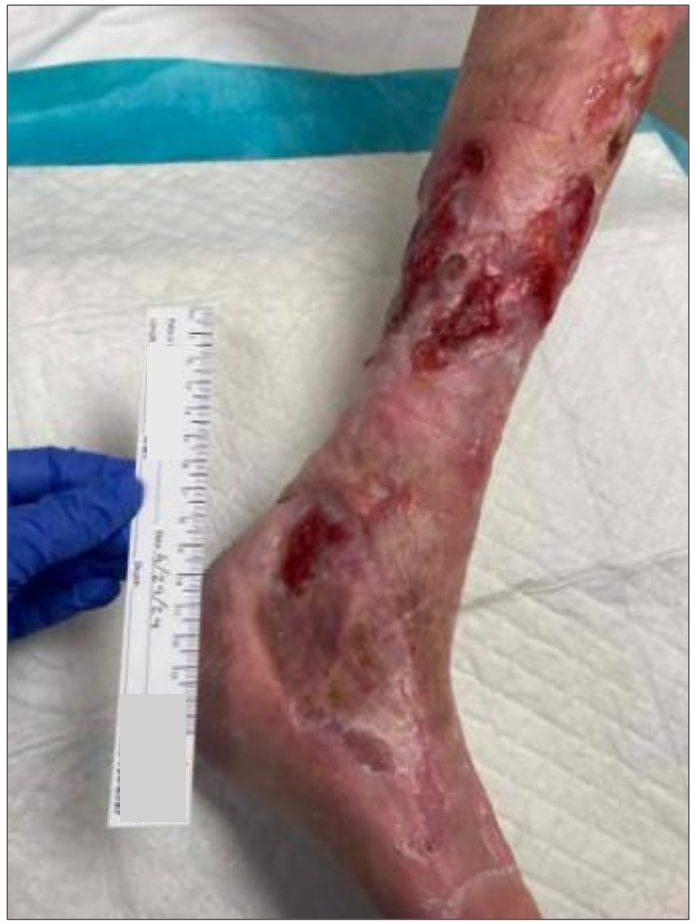


Start application

Lower Extremity Cutaneous Calcinosis

4/29/24





Drainage on dressing

Thank You

Please submit your questions via the Question Box