Insights from the Lab and Clinical Practice:

Combined Use of Hypochlorite-Free pHA Cleanser and Highly-Charged Fiber Dressings for Wound Healing

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Faculty Disclosures

- **Sujay Dutta, MD, MS** has nothing to disclose in relation to this activity
- **Mark D. Suski, MD, FACS**
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- **Dot Weir, RN, CWON, CWS**
  Consultant, Speakers Bureau: Convatec; LifeNet Health; Lynch Regenerative Medicine; Mölnlycke Health Care; Organogenesis Inc; Smith+Nephew; Solventum, Medical Surgical Business; Urgo Medical North America

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  - This activity has been independently reviewed for balance

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Learning Objectives

- Explain why effective germ removal is critical to optimal wound healing
- Examine how HOCl-based cleansers and gels work and the rationale behind why cleansers should be hypochlorite-free
- Describe how highly-charged fibers capture slough, and analyze how HOCl-based cleansers support and enhance the desloughing process
- Evaluate how the clinical implementation of science-based desloughing and debriding products influence patient outcomes and overall wound care quality

HOCl = hypochlorous acid; NaOCl = sodium hypochlorite.

Q&A

Submit your questions
via the question box
at any time

Hypochlorite-Free pHA Cleansers + Highly-Charged Fiber Dressings

Sujay Dutta, MD, MS
Mark D. Suski, MD, FACS

Part I: Why is removal of microbes critical to optimal wound healing?

Wounds and Bacteria

- Wounds are highly susceptible to microbial contamination as the skin is broken
- All chronic wounds are contaminated by bacteria
- Wound healing can occur in the presence of bacteria
- Certain bacteria (*Staphylococcus aureus*) appear to aid wound healing

Thus, it is not the presence of the microorganisms,
but their type and numbers that determine
their influence on wound healing

Sibbald G, et al. *Adv Skin Wound Care.* 2006;19(8):447-461. Laato M, et al. *Eur Surg Res.* 1998;20(1):33-38. Levenson SM, et al. *Arch Surg.* 1983;118(3):310-320.

IWII Wound Infection Continuum

INTERNATIONAL WOUND INFECTION INSTITUTE

Increasing microbial burden in the wound

As the continuum green shading darkens, microbial burden increases

CONTAMINATION	COLONISATION	LOCAL WOUND INFECTION COVERT (subtle)	LOCAL WOUND INFECTION OVERT (classic)	SPREADING INFECTION	SYSTEMIC INFECTION
• Microorganisms are present within the wound but are not proliferating • No significant host reaction is evoked • No delay in healing is clinically observed	• Microorganisms are present and undergoing limited proliferiation • No significant host reaction is evoked • No delay in wound healing is clinically observed	• Hypergranulation • Bleeding, friable granulation • Epithelial bridging and pocketing in granulation tissue • Increasing exudate • Delayed wound healing beyond expectations	• Erythema • Local warmth • Swelling • Purulent discharge • Wound breakdown and enlargement • New or increasing pain • Increasing malodour	• Extending induration • Spreading erythema • Inflammation or erythema >2cm from wound edge • Crepitus • Wound breakdown/ dehiscence with or without satellite lesions • Lymphangitis (swelling of lymph glands)	• Malaise • Lethargy or nonspecific general deterioration • Loss of appetite • Fever/pyrexia • Severe sepsis • Septic shock • Organ failure • Death

Factors Influencing Microbial Load in a Wound

Wound Type

- The type of wound (eg, surgical, traumatic, pressure ulcer) can influence the potential for microbial contamination

Wound Depth and Location

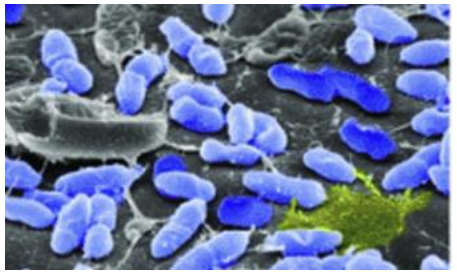
- Deeper wounds and those in areas with higher microbial populations (eg, near the gastrointestinal tract) are at higher risk of contamination

Tissue Perfusion

- Poor blood flow to the wound can impair the body's ability to fight infection, leading to increased microbial load

Host Immune Response

- The strength of the host's immune system plays a crucial role in controlling microbial growth and preventing infection



Asghari E, et al. *Microorganisms*. 2021;9(5):992.

Presence of Biofilms/Microbial Colonies

- Biofilms, which are communities of microorganisms encased in a protective matrix, can be a common finding in chronic wounds and can make infections more difficult to treat

Kalan LR, Brennan MB. *Semin Cutan Med Surg*. 2021;40(3):143-149. Jarnsholt T, et al. *J Wound Care*. 2022;31(Sup2):S1-S28.

Assessing Microbial Load in a Wound

Clinical Examination

- Visual inspection of the wound for signs of infection, such as redness, swelling, pain, and pus, can help assess the level of microbial load

Wound Cultures

- Taking a sample of the wound tissue or fluid and culturing it in a laboratory can help identify the types and number of microorganisms present

Molecular Techniques

- Molecular methods, such as PCR, can be used to detect and identify microorganisms, even those that are difficult to culture

Quantitative Cultures

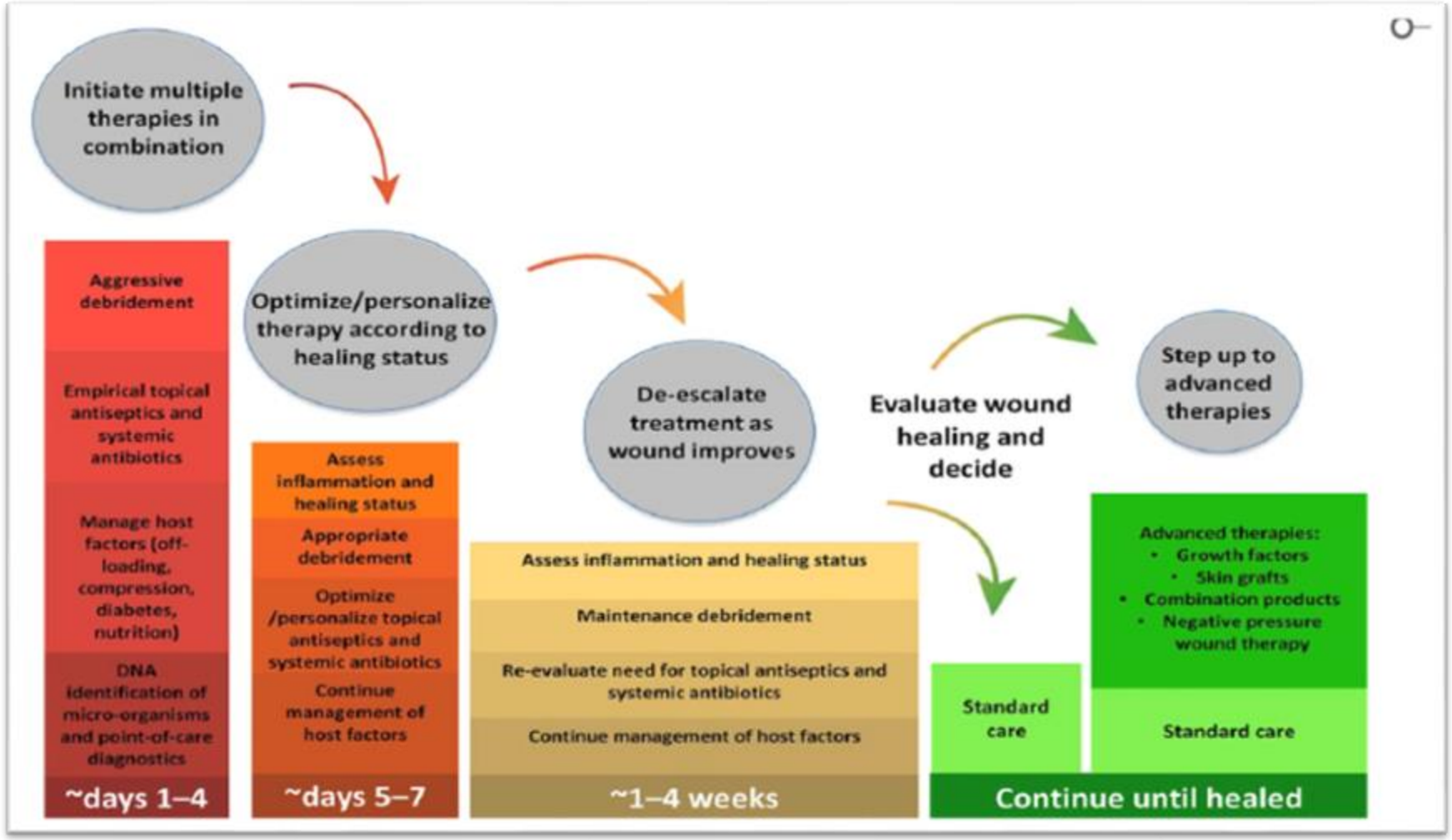
- These cultures measure the number of microorganisms per gram of tissue or milliliter of fluid, helping to determine if the wound is colonized or infected

Semiquantitative Cultures

- These cultures assess the growth of microorganisms on a plate, providing a relative measure of the microbial load

Malone M, et al. *J Wound Care.* 2017;26(1):20-25. Misic AM, et al. *Adv Wound Care*. 2014;3(7):502-510.

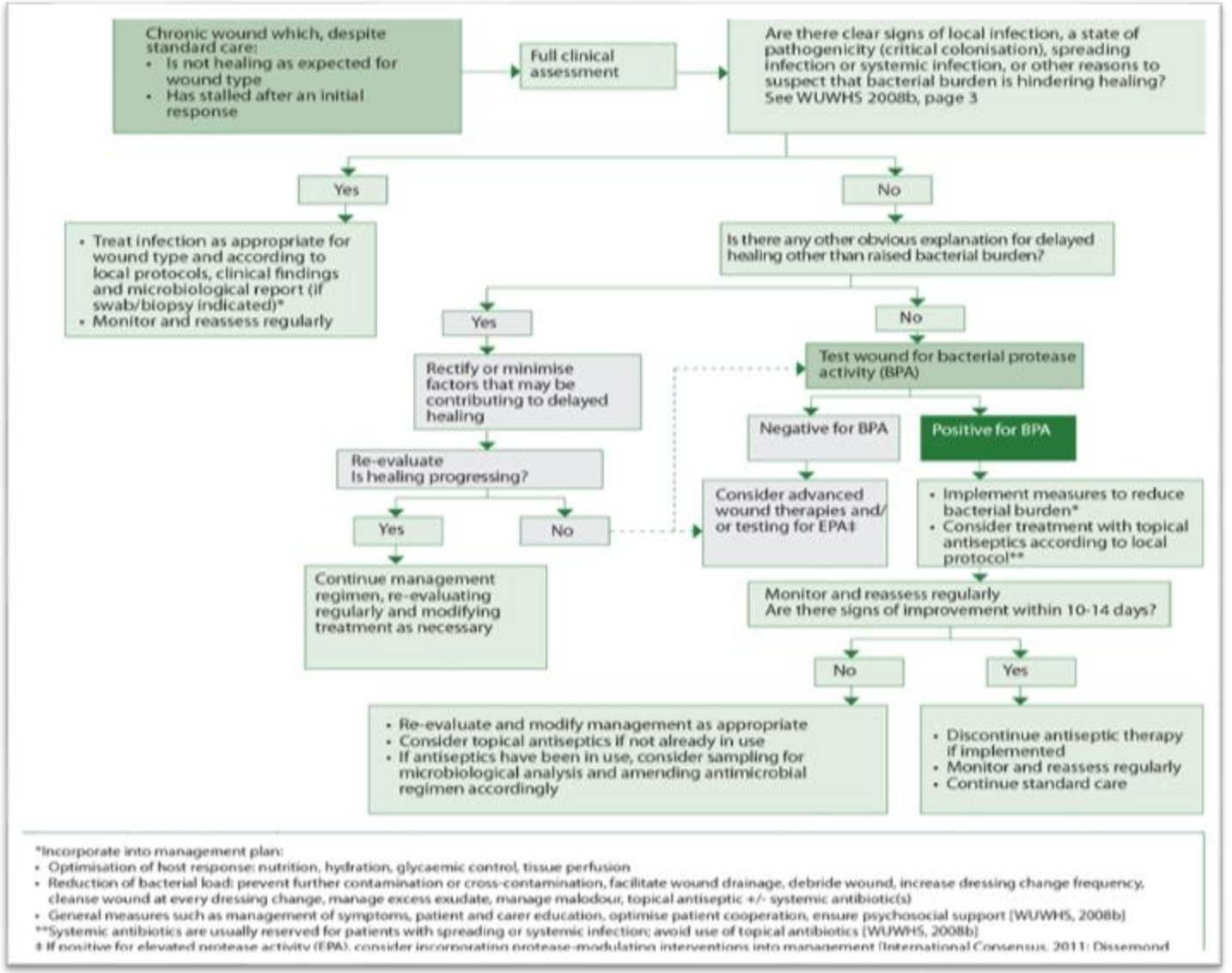
Early Intervention — with Multiple Interventions and Antimicrobial Therapy — Is Key



Schultz GS, et al. *Int Wound J.* 2004;1(1):19-32.

Bacterial Protease Activity (BPA)

- Elevation of proteases leads to degradation of extracellular matrix (ECM), growth factors, and receptors
- Contributes to prolonged inflammation
- May impede wound healing
- Point of Care: Qualitative assessment of bacterial protease activity amongst common bacteria in wounds that correlate with pathogenicity

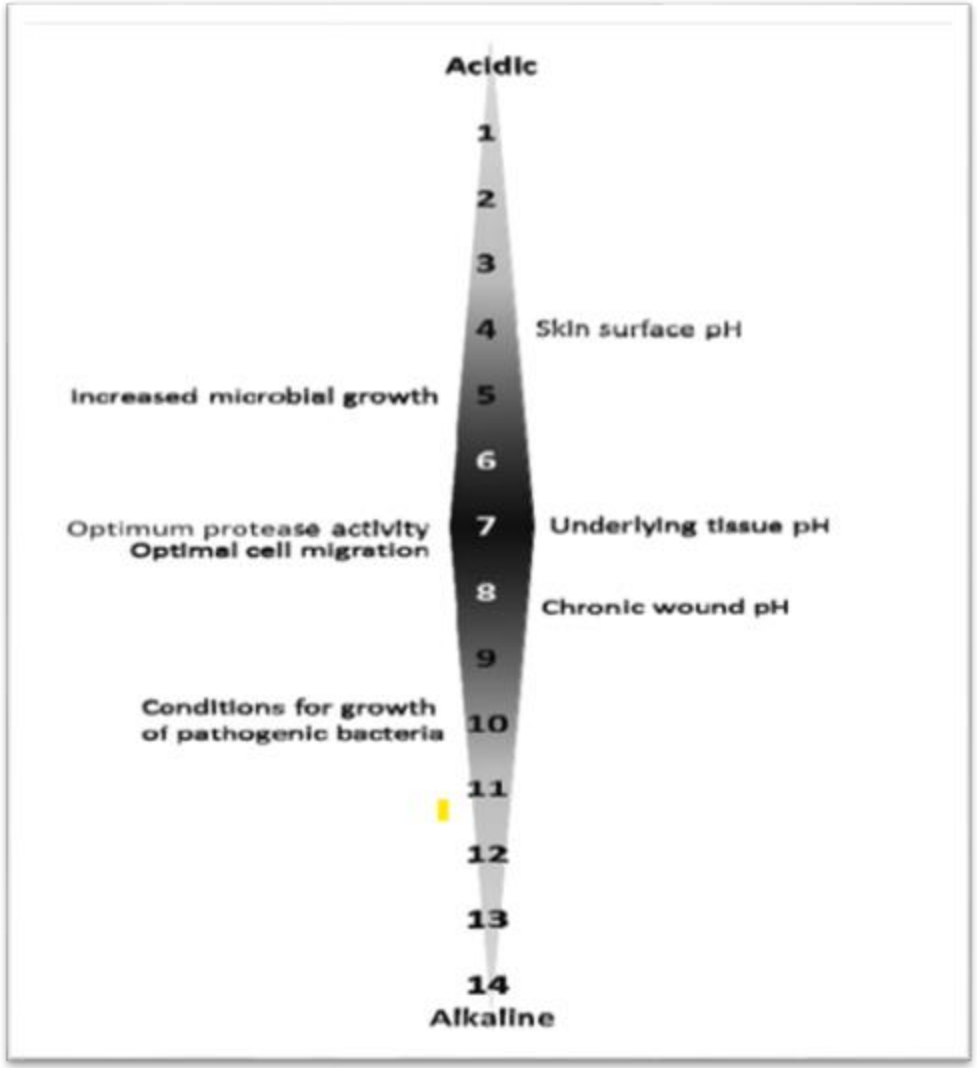


BPA = bacterial protease activity; ECM = extracellular matrix.

Armstrong DG, et al. *Diagnostics*. 2020;11(1):50. Läuchli S, et al. *Wounds International*. 2015;6(4).

Wound pH

- Increases with bacterial colonisation
- Rarely an indicator of infection
- Wounds alter the skin's acidic environment, exposing underlying tissues to a more neutral pH (≈7.4)
- However, as healing progresses, re-epithelialization exhibits a higher acidic pH
- As a result, the pH of acute wounds is closer to neutral



Kordestani SS, et al. *Adv Skin Wound Care*. 2023;36(1):35-40. Percival SL, et al. *Wound Repair Regen*. 2014;22(2):174-186.

Why Does pH Increase with Infection?

- Secretion of alkaline proteases increases the pH
- An alkaline environment allows bacterial species to survive and multiply, as well as increases the activity of gelatinases (MMP-2 – MMP-9)
- Most pathogenic bacteria are inhibited in a lower pH environment
- An increase in the pH of infected wounds may influence bacterial virulence, as well as bacterial growth
- Wound pH can also impact the effectiveness of antibiotics and antiseptics
- Alkaline environment is favorable for bacterial growth

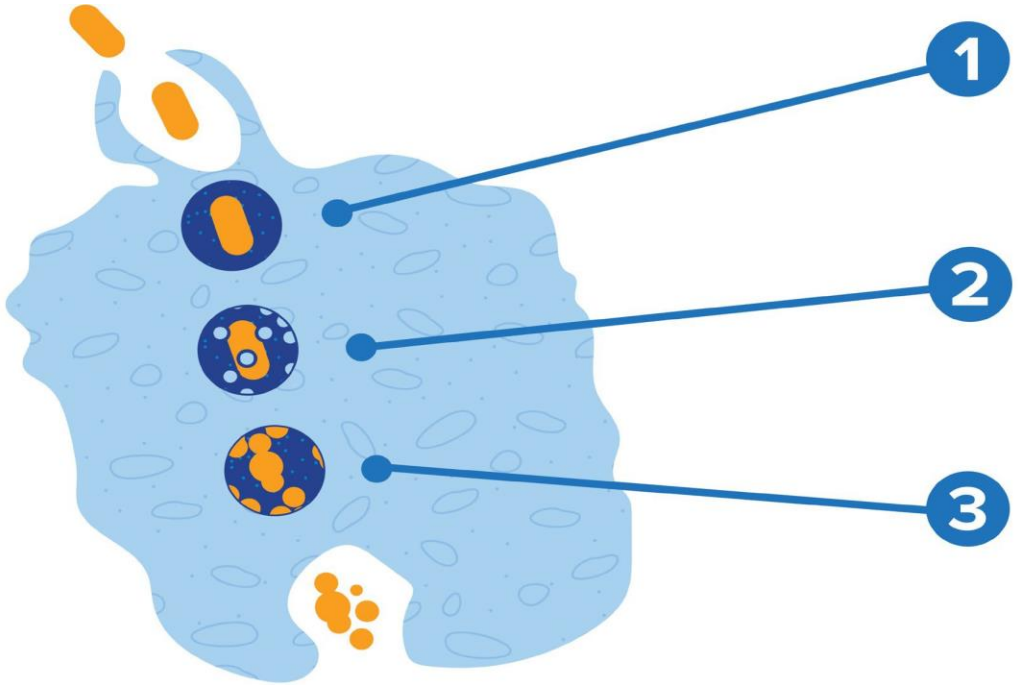
Kordestani S, et al. *Adv Skin Wound Care* 2023;36(1):35-40. Tang N, et al. *Micromachines.* 2021;12(4):430.

Part II:

How do pHA wound cleansers work, and why should they be NaOCl-free?

What Is Hypochlorous Acid?

- The activated leukocytes at the site of inflammation use the heme-containing enzyme myeloperoxidase to produce the strong oxidant hypochlorous acid (HOCl) from hydrogen peroxide (H_2O_2) and chloride (Cl^-)
- *Pure* hypochlorous acid (pHA) is used by the human body as a natural response to invading pathogens



1. Pathogens are targeted and engulfed by white blood cells.
2. **Hypochlorous acid (HOCl)** is generated within the white blood cell.
3. Pathogens are destroyed by HOCl action.

pHA = pure hypochlorous acid.

Nagoba BS, et al. *Wounds*. 2015;27:5. Andrés CMC, et al. *Int J Mol Sci.* 2022;23(18):10735.

Pure Hypochlorous Acid Preserved Cleanser (Hypochlorite-Free) Microbicidal Effect

HOCl plays a critical role in host defense as a microbicidal agent, killing microbes within milliseconds.

Organism	Time to kill	% Reduction
MRSA	15 seconds	99.999%
VRE	15 seconds	99.999%
Escherichia coli	15 seconds	99.999%
Acinetobacter baumannii	15 seconds	99.999%
Bacteroides fragilis	15 seconds	99.999%
Candida albicans	15 seconds	99.999%
Enterobacter aerogenes	15 seconds	99.999%
Enterococcus faecium	15 seconds	99.999%
Haemophilus influenzae	15 seconds	99.999%
Klebsiella oxytoca	15 seconds	99.999%
Klebsiella pneumoniae	15 seconds	99.999%

Organism	Time to kill	% Reduction
Micrococcus luteus	15 seconds	99.999%
Proteus mirabilis	15 seconds	99.999%
Pseudomonas aeruginosa	15 seconds	99.999%
Serratia marcescens	15 seconds	99.999%
Staphylococcus epidermidis	15 seconds	99.999%
Staphylococcus haemolyticus	15 seconds	99.999%
Staphylococcus hominis	15 seconds	99.999%
Staphylococcus saprophyticus	15 seconds	99.999%
Streptococcus pyogenes	15 seconds	99.999%
Staphylococcus aureus	15 seconds	99.995%
C. difficile endospores	15 seconds	99.93%

Pure hypochlorous acid (*p*HA) has the ability to disrupt microbial colonies after short exposure

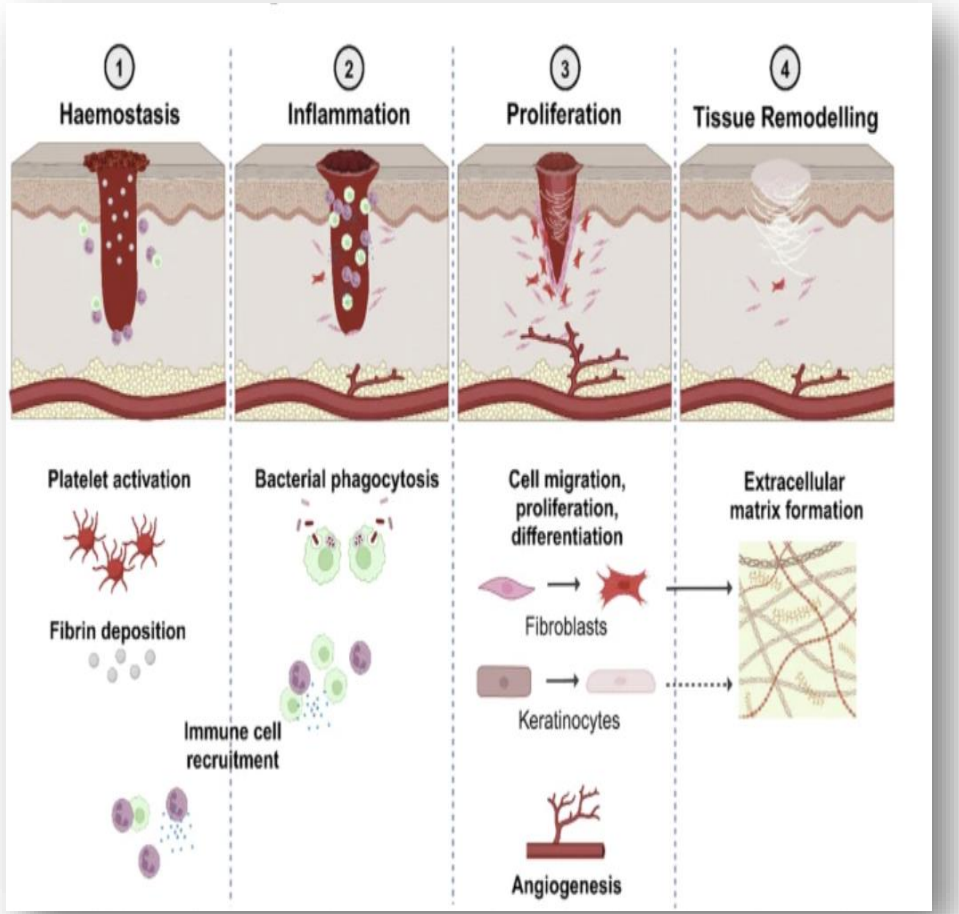
There is no known clinically relevant resistance to ***p*HA,** unlike other solutions (antimicrobials and antibiotics)

Nagoba BS, et al. *Wounds*. 2015;27(1):5-11. Robson MC. *Today's Wound Clinic*. 2014;8(9):20-21.

Pure Hypochlorous Acid (Hypochlorite-Free) Role in Wound Care Application

- Wound healing is a sequence of complex and well-orchestrated 4 events
- Coordinated activity among these phases is crucial for wound healing facilitated by leukocytes, fibroblasts, and keratinocytes
- An open wound is a favorable niche for bacterial colonization and infection
- However, the immune system reacts and attacks pathogens by generating rapidly highly reactive oxygen species (ROS), such as HOCl
- Thus, the use of HOCl in medicine has shifted from well-accepted disinfection to a potent *in vivo* product for wound care

Wound Healing Process



ROS = reactive oxygen species.

Sakarya S, et al. *Wounds.* 2014;*26*(12):342-350. Bornstein P, Sage EH. *Curr Opin Cell Biol.* 2002;14(5):608-616. Hunt M, et al. *Commun Biol.* 2024;7(1):1534.

Pure Hypochlorous Acid Solution (Hypochlorite-Free) Efficacy in Wound Care

- HOCl has a **broad antimicrobial spectrum,** leading to rapid killing of pathogens
- HOCl plays a critical role in host defense by **disrupting pathogens** through breaking down their structural components
- HOCl leads to **pathogen cell death** by numerous mechanisms of action
  - Oxidation of sulfhydryl amino acids
  - Ring chlorination of amino acids
  - Decreased uptake of nutrients
  - Inhibition of protein synthesis
  - Depressed DNA synthesis
- The primary targets of the HOCl are proteins, they are naturally abundant in microbes and their rapid reaction kinetics with HOCl is proven
- HOCl solution supports **wound healing** by enhancing wound cleansing through cleansing, moisturizing, and debridement (mechanical amplification), thereby removing contaminants and dead tissue from the wound bed

Boecker D, et al. *GMS Hyg Infect Control.* 2023;18:Doc07. Andrés CMC, et al. *Int J Mol Sci.* 2022;*23*(18):10735. Sakarya S, et al. *Wounds.* 2014;26(12):342-350. Dychdala GR. Chlorine and chlorine compounds. In: Block SS, ed. Disinfection, sterilization, and preservation. Philadelphia: Lippincott Williams & Wilkins; 2001:135-157.

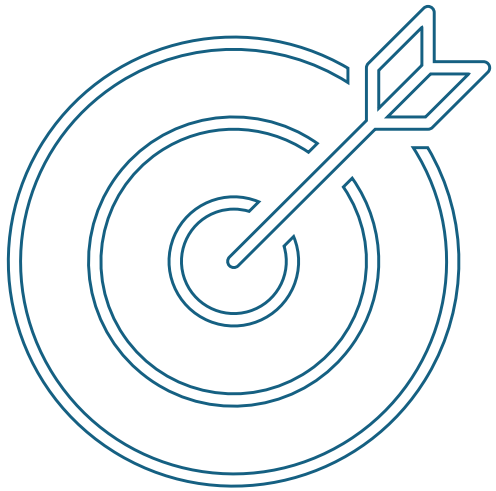
Pure Hypochlorous Acid Gel (Hypochlorite-Free) Efficacy in Wound Care

- In addition to the wound healing benefits of pure HOCl solution, the pure hypochlorous acid gel further enhances wound healing through
  - Maintaining the **optimal moist environment** needed for cell migration and tissue remodeling
  - **Increasing antimicrobial activity,** which is impacted by the higher viscosity of the HOCl gel formula
  - Creating a **protective barrier** for the wound bed and shielding it from external contamination
  - **Enhancing the wound healing phases** of proliferation and remodeling by supporting granulation and epithelization
- High tolerance in human cells to HOCl wound care products was observed when applied topically to tissues, with no significant cytotoxicity at clinically effective concentrations.

Junker JPE, et al. *Adv Wound Care.* 2013;*2*(7):348-356. Guo S, Dipietro LA. *J Dent Res.* 2010;*89*(3):219-229.

Synergistic Effect Between Pure Antimicrobial HOCl Solution and Pure Antimicrobial HOCl Gel

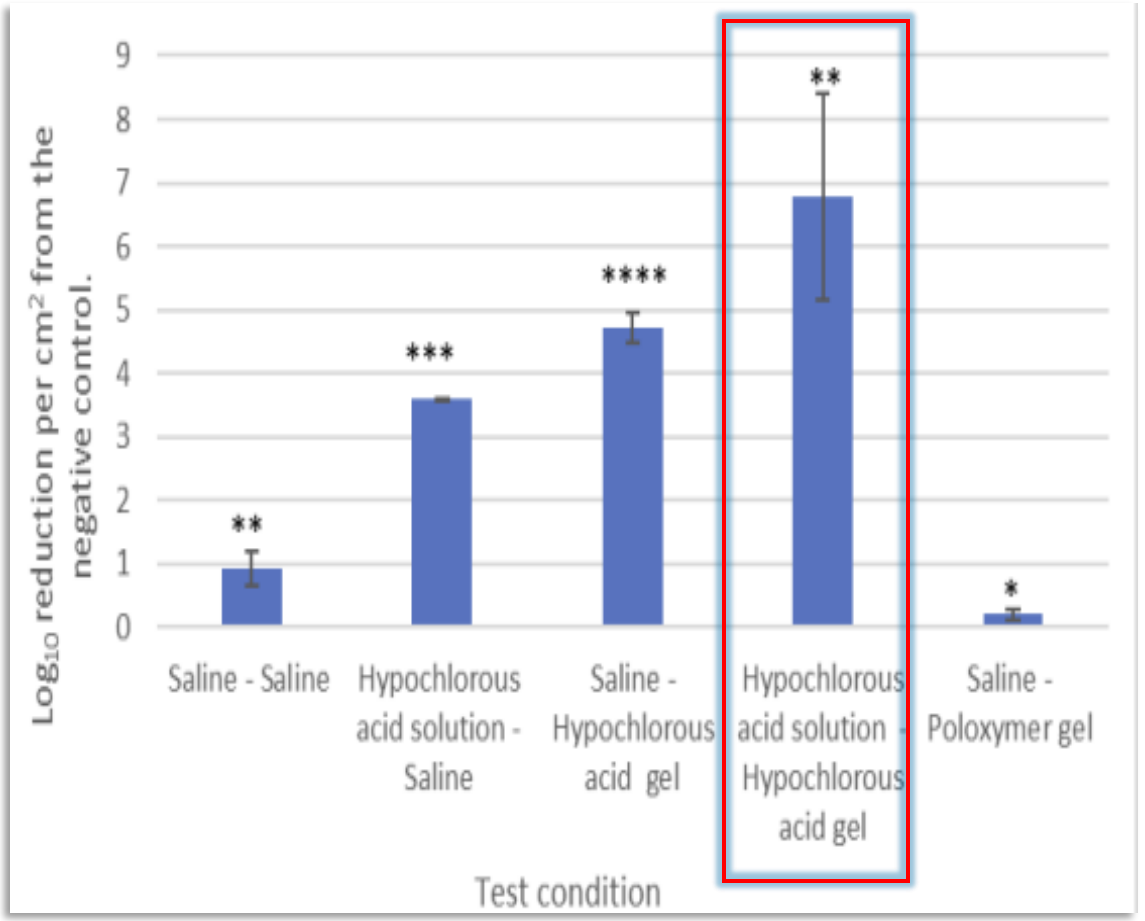
- HOCl wound care ***solution and gel*** have a synergistic effect on wound healing, where
  - Pure HOCl wound care solution enhances wound cleansing, removing germs and necrotic matter mechanically
  - Pure HOCl wound care gel product enhances the germ removal activities and increases moisture level needed for wound healing
- Therefore, pure HOCl antimicrobial solution provides immediate cleansing activity, whereas pure HOCl antimicrobial gel provides sustained protection for wound healing



Herruzo R, et al. *Wound Repair Regen*. 2023;31(3):401-409.

Synergistic Effect Between Pure Antimicrobial Preserved HOCl Solution and Pure Antimicrobial HOCl Gel

- This synergistic effect between HOCl antimicrobial preserved wound solutions and HOCl antimicrobial gel was observed in an *in vitro* study where
  - A 48-hr age *P. aeruginosa* AATCC 15442 colony was established on a wounded porcine explant model, then submerged in hypochlorous acid solution or saline for 10 min, before being placed for 4 hrs in 1 of the combinations shown in the graph
- The most successful synergistic treatment was the use of ***Hypochlorous acid solution*** *followed by* ***Hypochlorous acid antimicrobial gel***, which demonstrated a **>6 $\log_{10}$** reduction



Pure Hypochlorous Acid (Hypochlorite-Free) Lower Cytotoxicity

In normal physiological conditions, the body controls excess HOCl through

- **Sacrificial Scavenger *Taurine***: The neutrophils are rich in taurine in their cytoplasm, which reacts with HOCl, forming the stable and less reactive molecule *Taurine Chloramine*
  - Tissue also contains measurable amounts of taurine, which helps neutralize HOCl activity *in vivo*
- **HOCl Compartmentalization**: Inside the neutrophils, HOCl is produced in the phagolysosomes, keeping HOCl oxidant dedicated to attacking pathogens rather than spreading throughout the tissue
- **Human Body Antioxidant Defense**: The human body's key antioxidant defenders against HOCl are the *thiol group* mainly on albumin, ascorbate or vitamin C, and catalase enzymes
- **Evolutionary adaptation of oxidative killing mechanisms:** Early in eukaryotic evolution, phagocytic cells capable of engulfing microorganisms first emerged, which utilize the NADPH oxidase-myeloperoxidase system to produce the strong oxidant hypochlorous acid (HOCl) within phagosomes to kill pathogens

Boecker D, et al. *GMS Hyg Infect Control.* 2023;8:Doc07._Marcinkiewicz J, Kontny E. *Amino Acids*. 2014;46(1):7-20. Wang L, et al. *J Burns Wounds.* 2007;6:e5. Goemans CV, Collet JF. *F1000Res.* 2019;8:F1000 Faculty Rev-1678. Hu ML, et al. *J Lab Clin Med.* 1993;121(2):257-262. Nauseef WM. *Cell Microbiol.* 2014;16(8):1146 1155._Schuller-Levis GB, Park E. *Neurochemical Res.* 2004;29(1):117-126. EBSCO.com Caffrey C. Published 2024. Accessed March 16, 2026. https://www.ebsco.com/research-starters/chemistry/catalase

Comparison of Hypochlorous Acid (HOCl) and Hypochlorite (OCl^-) in Antimicrobial Applications

Hypochlorous Acid HOCl	Hypochlorite OCl^-
HOCl is a **weak acid** with pH range between 3.0-6.5	OCl^- is a **weak base** with an alkaline pH >8
Desirable acidic pH range in which it exists as a pure ingredient	**Undesirable alkaline pH range in which it exists as a pure ingredient**
Easier microbial cell penetration: As HOCl is a neutral molecule, it reacts quickly with macromolecules	More difficult microbial **cell penetration**: OCl^- is negatively charged, limiting its intracellular penetration and antimicrobial activity
Fast and broader antimicrobial spectrum: HOCl has a broader microbicidal effect and lower tissue cytotoxicity. High therapeutic index.	**Higher cytotoxicity and smaller antimicrobial efficacy**: To mimic HOCl kill kinetics, higher total chlorine is needed at higher pH, where OCl^- is the dominant species. Lower therapeutic index.

Mehendale FV, et al. *J Glob Health Reports.* 2023;7:e2023052. Clayton GE, et al. *Front Environ Sci.* 2019;7(7):35. Smith JL, et al. *Br Med J.* 1915;2(2847):129-136. da Cruz Nizer WS, et al. *Microorganisms.* 2020;8(8):1220. Yan P, et al. *Microorganisms.* 2021;9(1):136.

Hypochlorite Cytotoxicity Peer-Reviewed Evidence

- **Hypochlorite compounds (OCl^-)** show **non-uniform but consistent cytotoxicity** influenced by cation type, pH, formulation, and chlorine-release kinetics
- **Hypochlorite solutions can impair wound-healing pathways**, delay re-epithelialization, and reduce cell viability even at clinically used strengths
- **Hypochlorite cytotoxicity is non-selective**, affecting both bacterial cells and essential host cells, reducing overall therapeutic benefit
- ***Sodium hypochlorite*** **(NaOCl) is highly cytotoxic**, impairing fibroblasts, keratinocytes, macrophages, and osteoblasts at clinically used concentrations
- **Dilution reduces hypochlorite cytotoxicity**, but also decreases the available free chlorine, meaning **both antimicrobial power and toxicity drop together**, creating a narrow therapeutic window
- **HOCl shows lower cytotoxicity** and **higher antimicrobial activity** at lower ppm levels

Cotter JL, et al. *Antimicrob Agents Chemother.* 1985;28(1):118-122. Hidalgo E, Dominguez C. *Life Sci.* 2000;67(11):1331-1344. Aubut V, et al. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2010;109(2):e120-5. Heggers JP, et al. *J Burn Care Rehabil.* 1991;12(5):420-424.

The Importance of Effective Removal of Microbes for Optimal Wound Healing

- Natural defenses, both innate and acquired, can eradicate microbial invasion (infection) into tissue injury if the inoculum is small and host immunity is intact
- But, if acute inflammation is overwhelmed, acute sepsis can develop (host dies without intervention), or a chronically infected wound develops
- Acute inflammation is more effective at microbial eradication than chronic inflammation
- Biofilms promote chronic inflammatory state, worsened by host factors
  - Diabetes, arterial or venous insufficiency, etc.

Important Goal of Microbial Eradication in Chronic Wounds

- Convert chronic inflammatory state back to acute
- Wound cleansers should favor milieu of acute inflammation with minimal tissue destruction
- Most effective wound cleanser — ie, pure hypochlorous acid (pHA) — will match the pH of healthy skin: 5.5
- After initial tissue injury, pH is that of healthy internal tissue: 7.4
- Subsequently, pH becomes acidic (metabolic changes) as skin re-epithelializes
- Chronic wounds with chronic inflammation have alkaline pH: ≈8

pHA = pure hypochlorous acid.

Effective Removal of Microbes (Bacteria, Fungi) Is Essential

- Prevent formation of biofilms; biofilm microorganisms can be up to 1000 times more resistant to antibiotics
- Biofilm microorganisms evade host immunity
- Chronic infection/inflammation promotes excess matrix metalloproteinase (MMP) production, destroying tissue and preventing healthy granulation
- Chronic alkaline environment promotes activity of MMPs
- Chronic infection/inflammation “stuns” fibroblasts and keratinocytes – they do not multiply and cannot migrate; growth factor receptors are down-regulated
- Chronic hypoxic environment is promoted, worsening pre-existent ischemia

MMP = matrix metalloproteinase.

Ideal Wound Cleansers

- Disrupt microbial colonies
- Promote acidic environment
- Not toxic to fibroblasts, keratinocytes
- Effectively kill microorganisms by multimodal action
- Therapeutic index (TI): Minimum concentration for cellular toxicity/ minimum bactericidal concentration
  - AKA: Biocompatibility Index (BI)
- Ideal wound cleansers have high TI (>1.0)
- pHA TI ranges from 5.5-10.5 (depending on specific bacteria)
- Povidone-iodine TI is low: 0.4-0.9
- NaOCl is very low: <0.01
  - More cytotoxic than bactericidal

TI = therapeutic index; BI = biocompatibility index.

How pHA-Based Wound Cleansers Work, and Why They Should Be NaOCl-Free

- Multimodal activity against infection and biofilms
- Oxidative damage destroys microbial cell walls (fungi and most bacteria have cell walls), cell membranes, and essential proteins
- Destroys DNA strands and inhibits DNA replication of microbes
- pHA can rapidly kill bacteria, ciruses, and fungi (under 12 seconds)
- Microbial metabolism/ATP production is inhibited
- The longer the solution/gel stays on an open ulcer, the more it can eradicate microorganisms

pHA-Based Is also Important:

- Disrupt and eradicate microbial colonies: Complex microbial communities, which protect microorganisms from antibiotics, anti-microbials, and host immune system
- High TI: Kills microorganisms without damage to essential cells of healing (fibroblasts and keratinocytes)
- Mimics the oxidative burst of neutrophils
- Lower excess production of MMPs
- Decreased tissue destruction and chronic inflammation
- Gel preparations can prolong activity vs microorganisms

pHA Allows the Next Steps to Proceed

- Wound regeneration and repair can proceed since pHA-based cleansers are not cytotoxic
- Povidone-iodine-based cleansers have low TI: more cytotoxic than anti-microbial
- NaOCl-based cleansers have very low TI and alkaline pH: promote tissue destruction and chronic inflammatory state, even though they can kill microorganisms
- pHA is 80-200 times more germicidal than NaOCl
- pHA can penetrate bacterial membranes more effectively due to neutral charge

More Advantages of pHA

- NaOCl (OCl) negative ion is repelled by bacteria, which are also net negatively charged: Less penetration into cell walls and membrane
- pHA (HOCl) is more favorable: More effective killing at lower concentrations; non-cytotoxic
- pHA-based wound cleansers and thus more compatible with other modes and products which kill microbes and promote healthy granulation and optimal wound healing
- Decreases the need to use topical and systemic antibiotics

Slough:
What It Is, What We Can Do about It, and Why We Should

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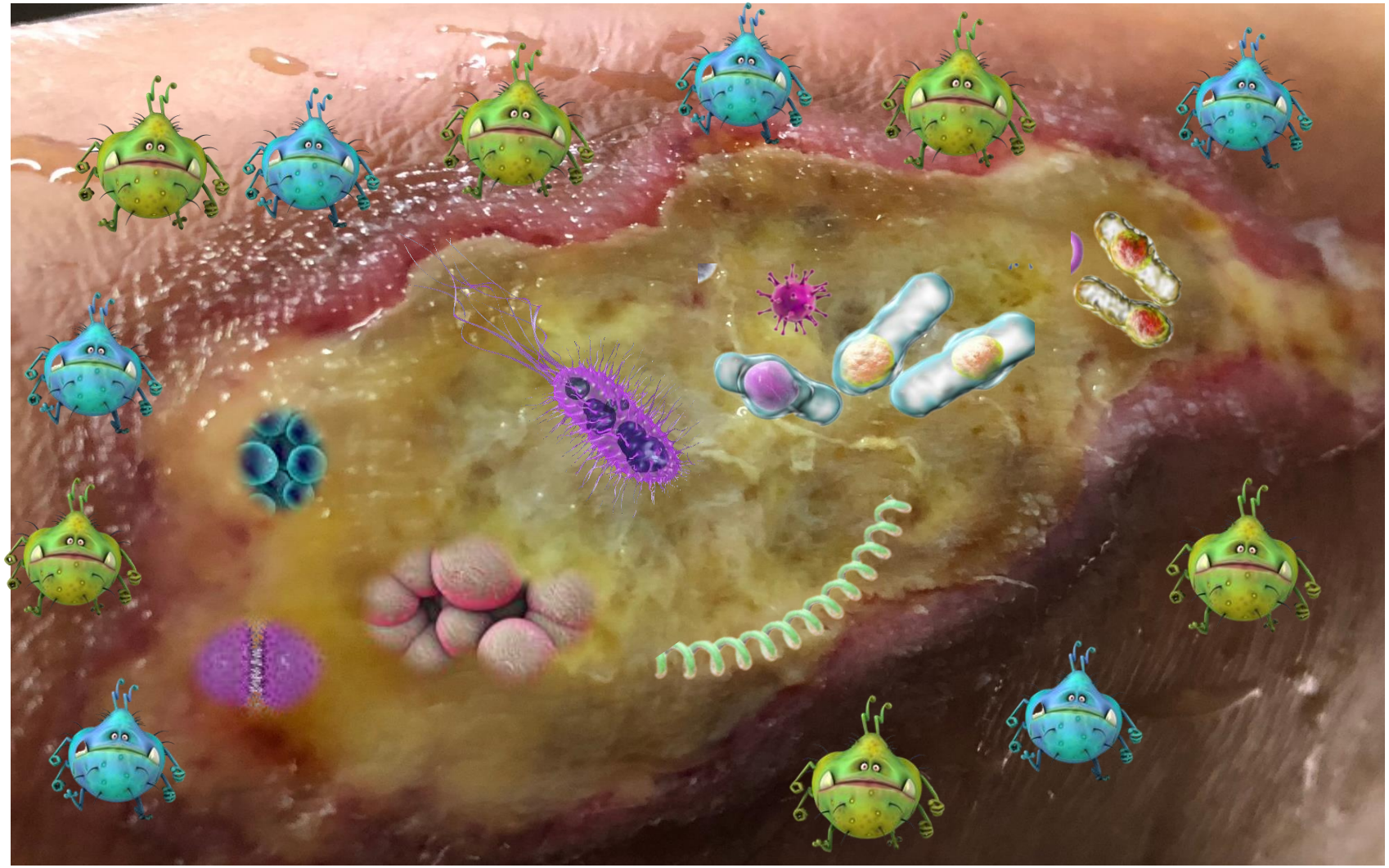
Clinician, Holland Hospital Wound and Hyperbaric Medicine
Consultant/Educator
Holland, MI

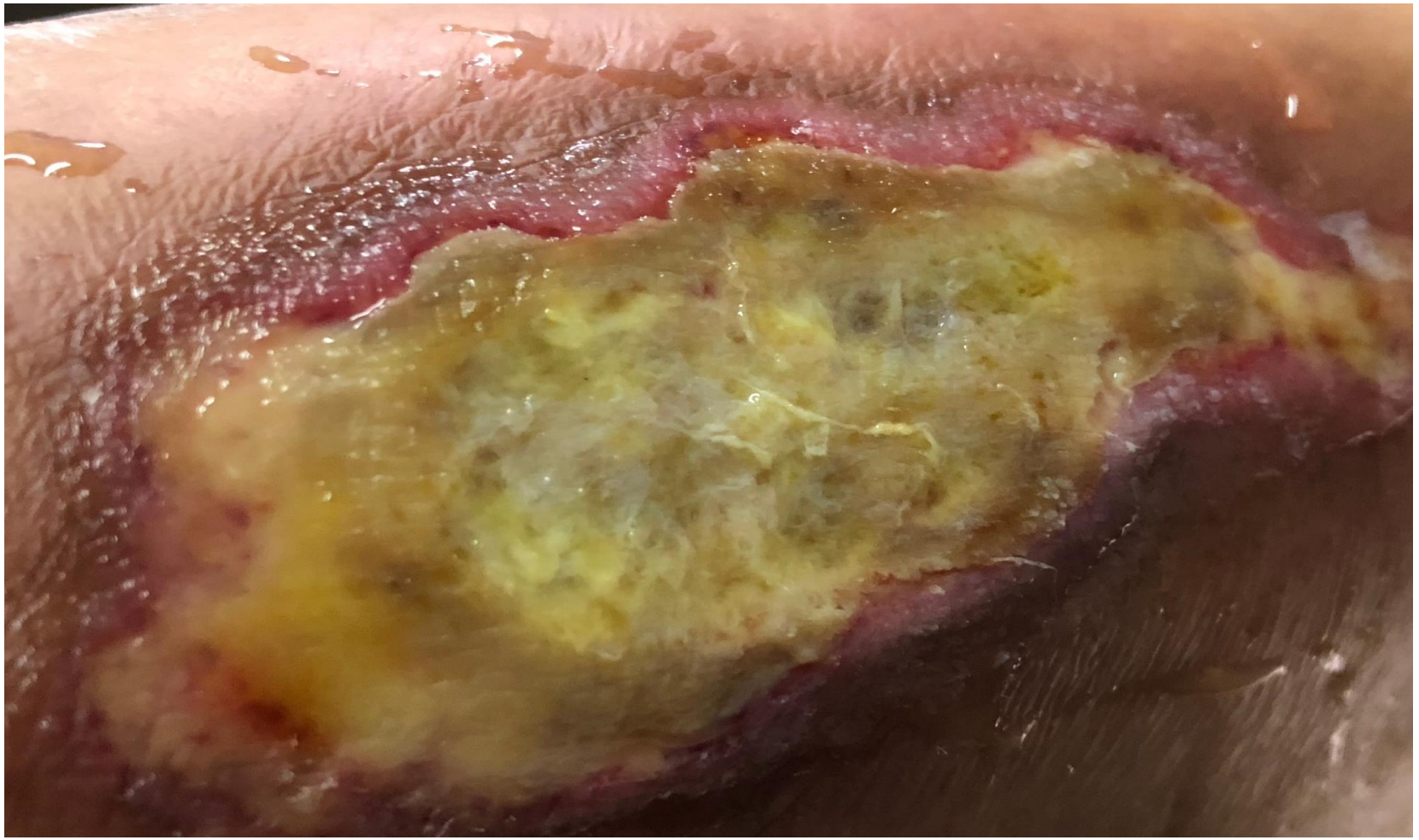
Wounds Are a Buffet for Bacteria



Let's back up:
What Do You Call This "Yellow Stuff?"

Slough?

Is that a noun or verb?

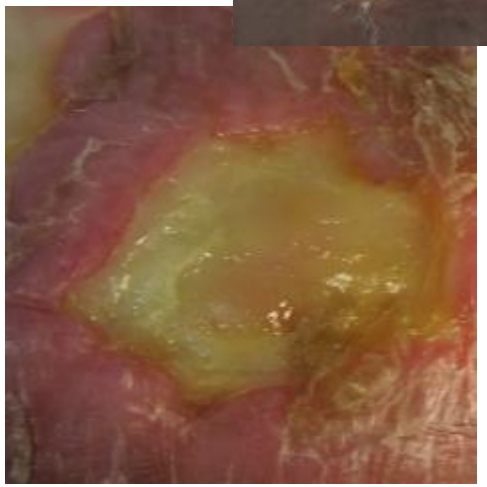


Is it dead?

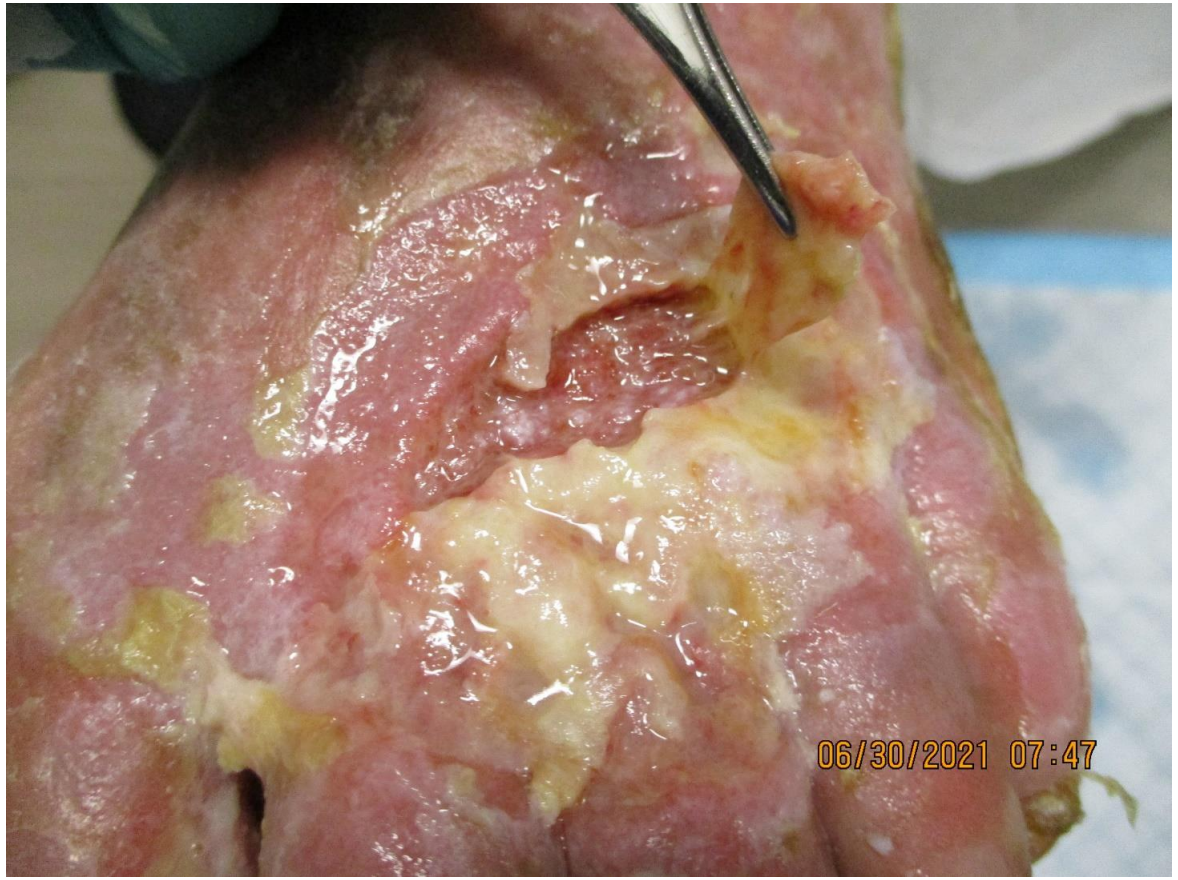
Is it attached to live?

Material “Sloughing” out of Wounds

What about Other “Yellow Stuff?”



Is It Necrotic if You Can Peel It Off?



Or Just Cleanse It Off?

Yellow material formed in the presence of perfectly adequate perfusion; with or without obvious infection / inflammation?

Proteinaceous, Mucilaginous, or Coagulum

International Wound Infection Institute (IWII) Therapeutic wound and skin cleansing: Clinical evidence and recommendations. *Wounds International.* 2025

Lastly, Is It Biofilm?

Kalan L, Schultz G, Malone M, et al (2023) Slough: Composition, analysis and effect on healing. *Wounds International.*

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We have been focused on biofilm-based wound care.

We should focus on slough-based wound care.

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Wound Repair and Regeneration — WILEY

ORIGINAL ARTICLE-BASIC SCIENCE

What is slough? Defining the proteomic and microbial composition of slough and its implications for wound healing

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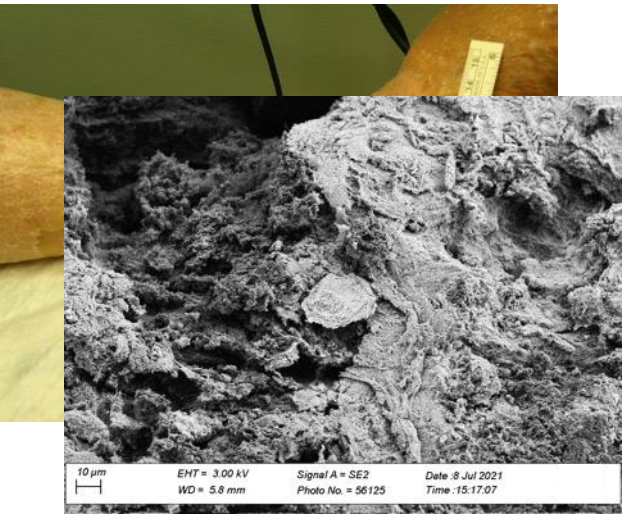
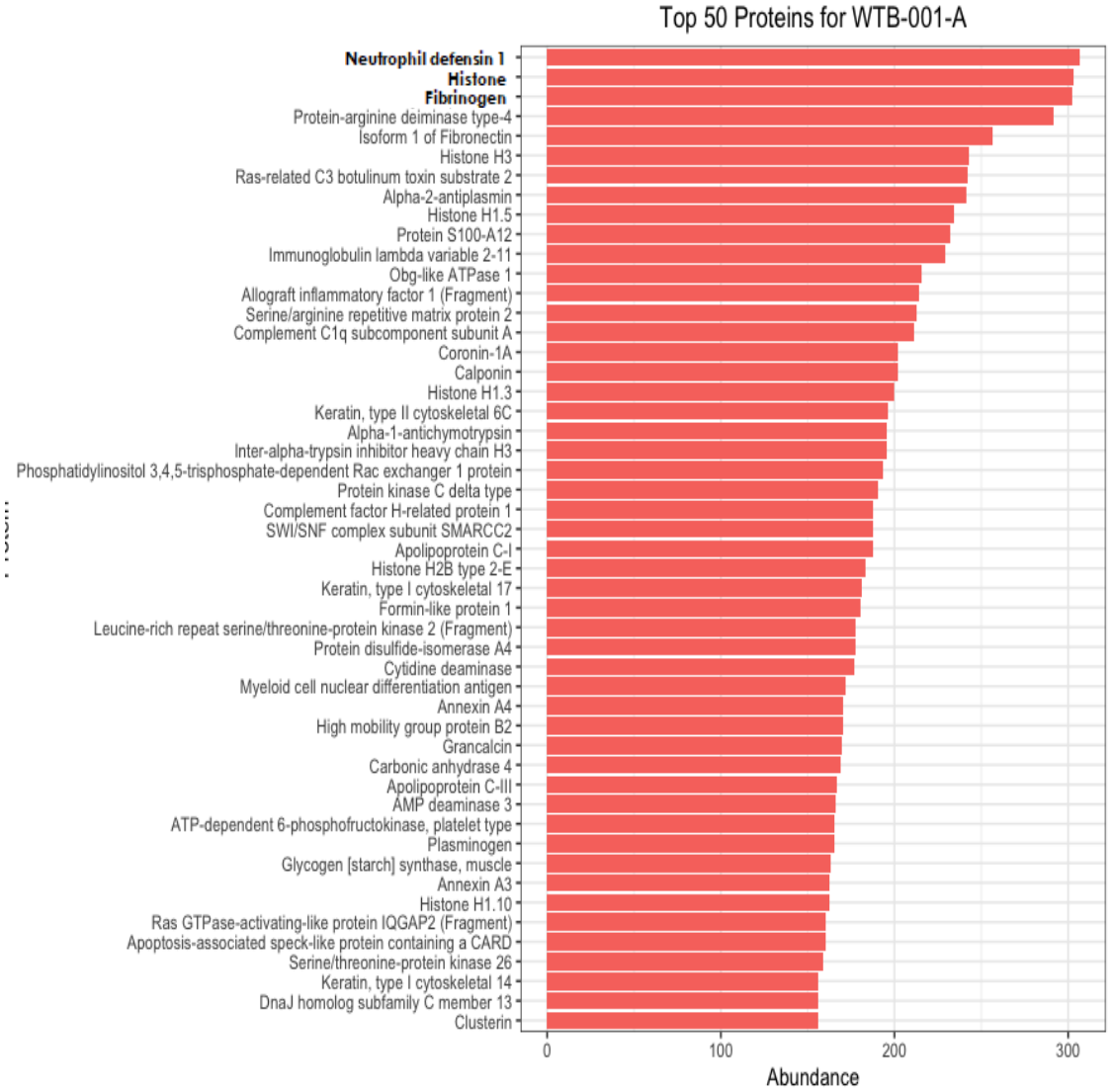
Townsend EC, et al. *Wound Repair Regen*. 2024;32(6):783-798.

Patient 1

Side	Location	Etiology	Wound Age	Length(cm)	Width(cm)	cm^2	Shape	CFUs
Left	Medial Ankle	Lymphedema	15	8.5	4	34	Irregular; Round Oval	1.3×10^7



- Loosely adherent yellow slough
- High bioburden 1.3×10^7 CFU
- Polymicrobial (4+ by culture)
- No obvious biofilm by SEM
- Amorphous material

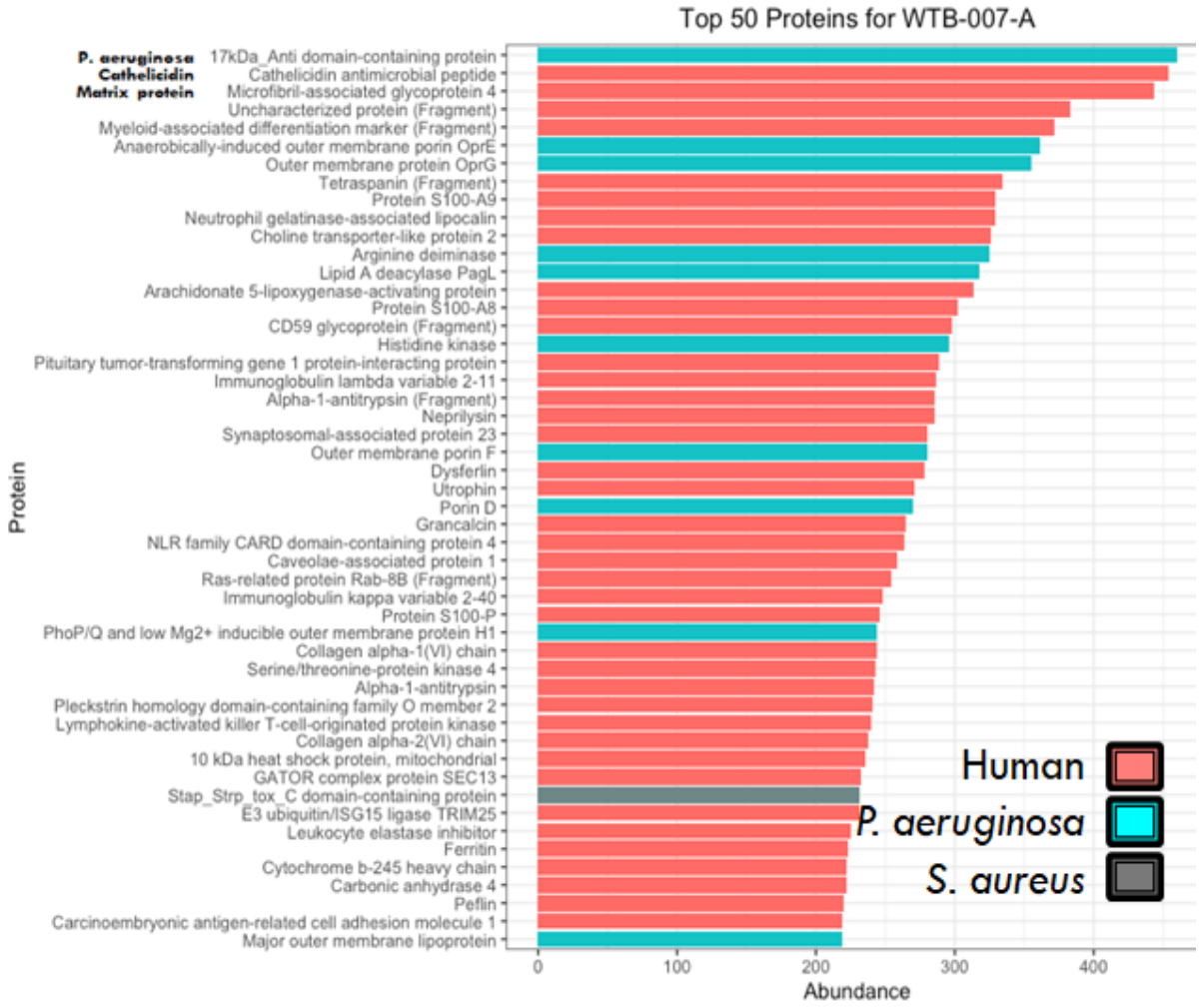


Kalan L, et al. (2023) Slough: Composition, analysis and effect on healing. *Wounds International.*

Patient 7

Side	Location	Etiology	Wound Age	Length(cm)	Width(cm)	cm^2	Shape	CFUs
Right	Lateral Ankle	Surgical wound	1.25	8	10.4	93.6	Irregular	8×10^7

- Adherent
- High bioburden
- *Pseudomonas aeruginosa* cultured
- No obvious biofilm by SEM
- Proteomics identifies *P. aeruginosa* and *S. aureus*
- 16S sequencing is pending



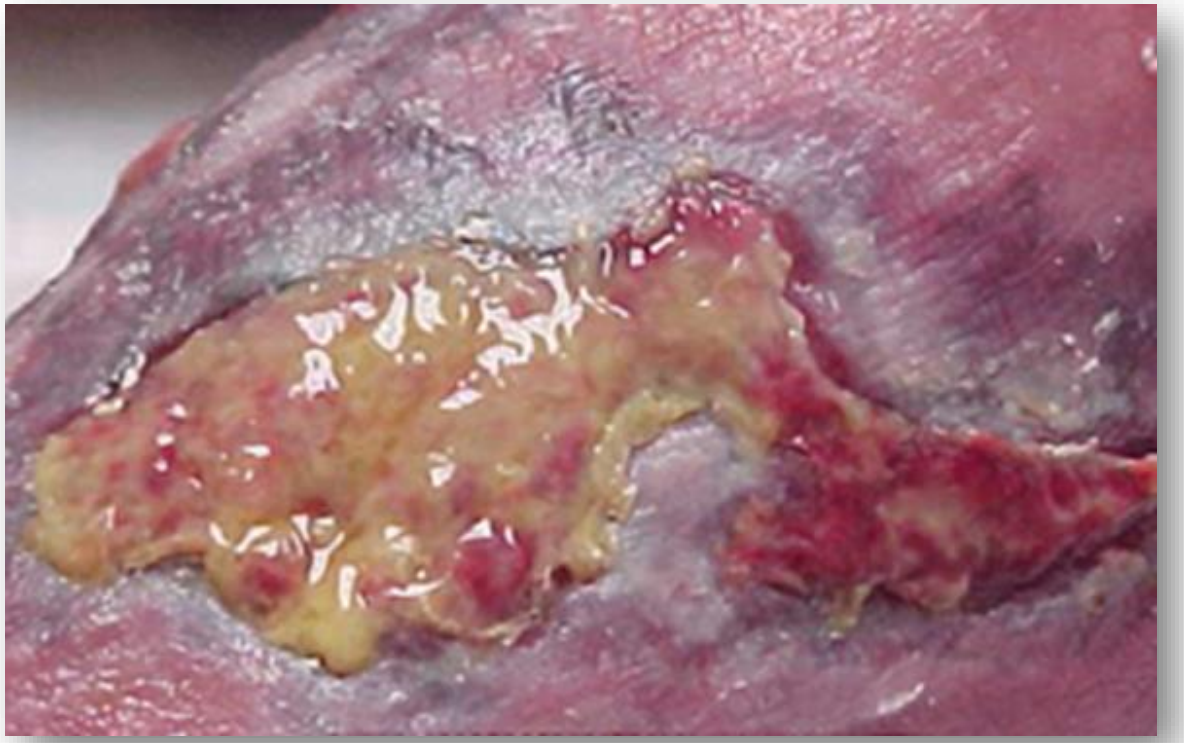
SEM = sub-epidermal moisture.

Kalan L, et al. (2023) Slough: Composition, analysis and effect on healing. *Wounds International.*

Bottom Line: Slough Is Rotten Tissue

It can be solid:

Or liquid:



Synergy

- A mutually advantageous conjunction or compatibility of different and distinct elements (such as resources or efforts)
- The combined power of a group of things when they are working together that is greater than the total power achieved by each working separately
- The creation of a whole that is greater than the sum of its parts

Dressing concept: Negatively-Charged Fiber (NCF) Technology

- Absorbent fiber dressing with TLC-Ag matrix
  - Lipido-colloid technology with silver salts
- Cleaning action plus antimicrobial protection
- Charged fibers support the continuous debridement of slough
  - Fibrin, microorganisms, and wound residue attach to negatively-charged fibers to continuously clean the wound bed
  - Fibers form a gel to promote moist wound healing

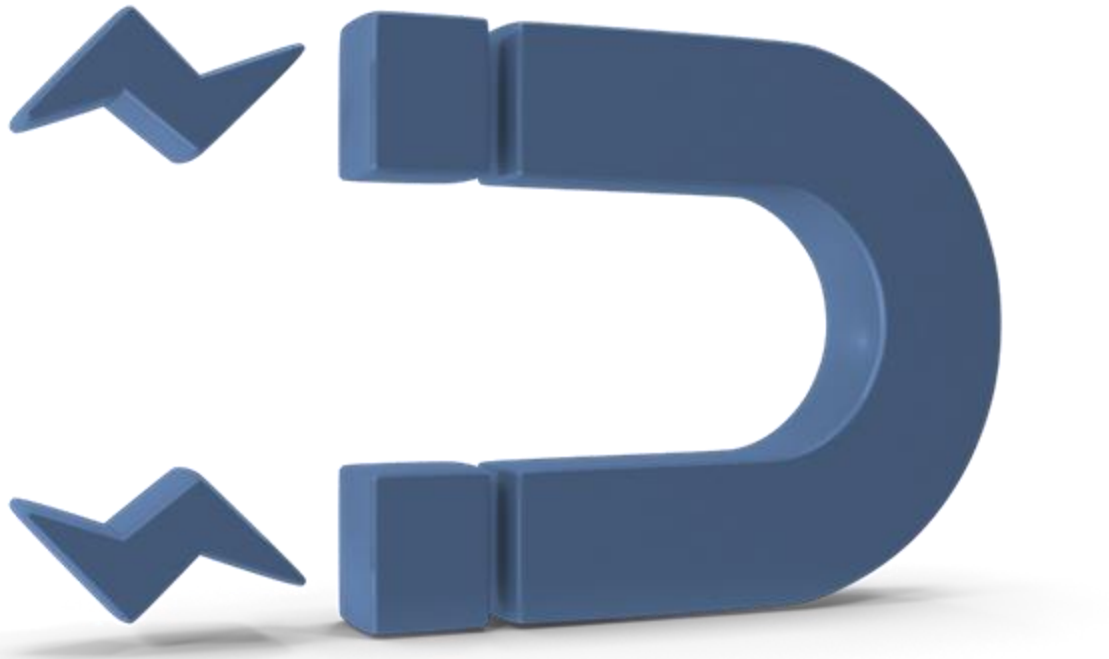
Example of gel formation

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

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

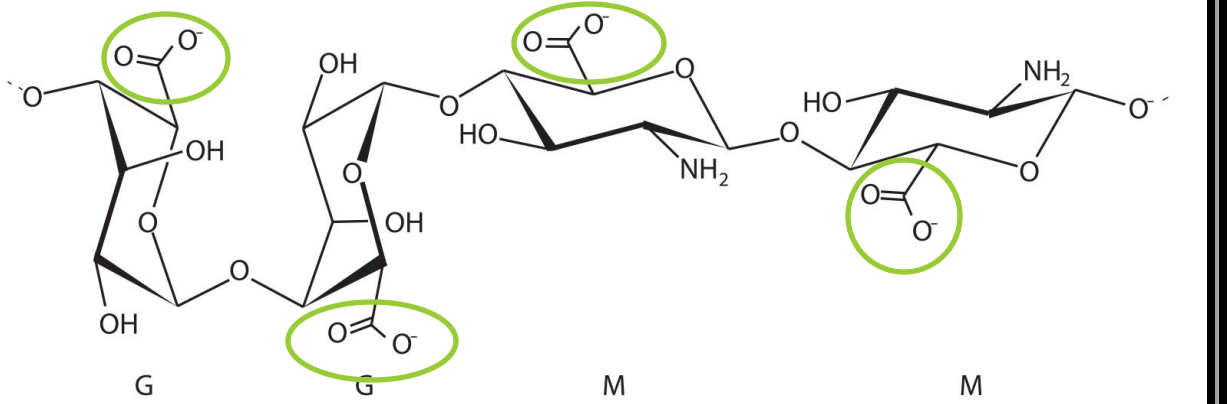


During autolytic debridement, negatively-charged fibers are highly attracted to positively-charged fibers in slough

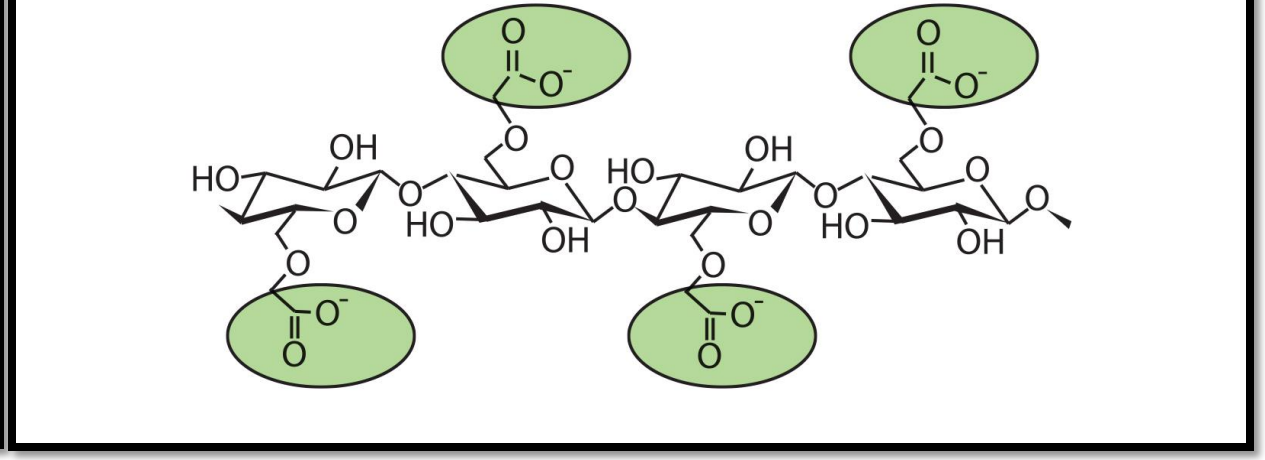
Meaume S, et al. *J Wound Care*. 2014;23(3):105-116.

Other Dressings with Negatively-Charged Fibers

Alginate:
Negative charges are far apart

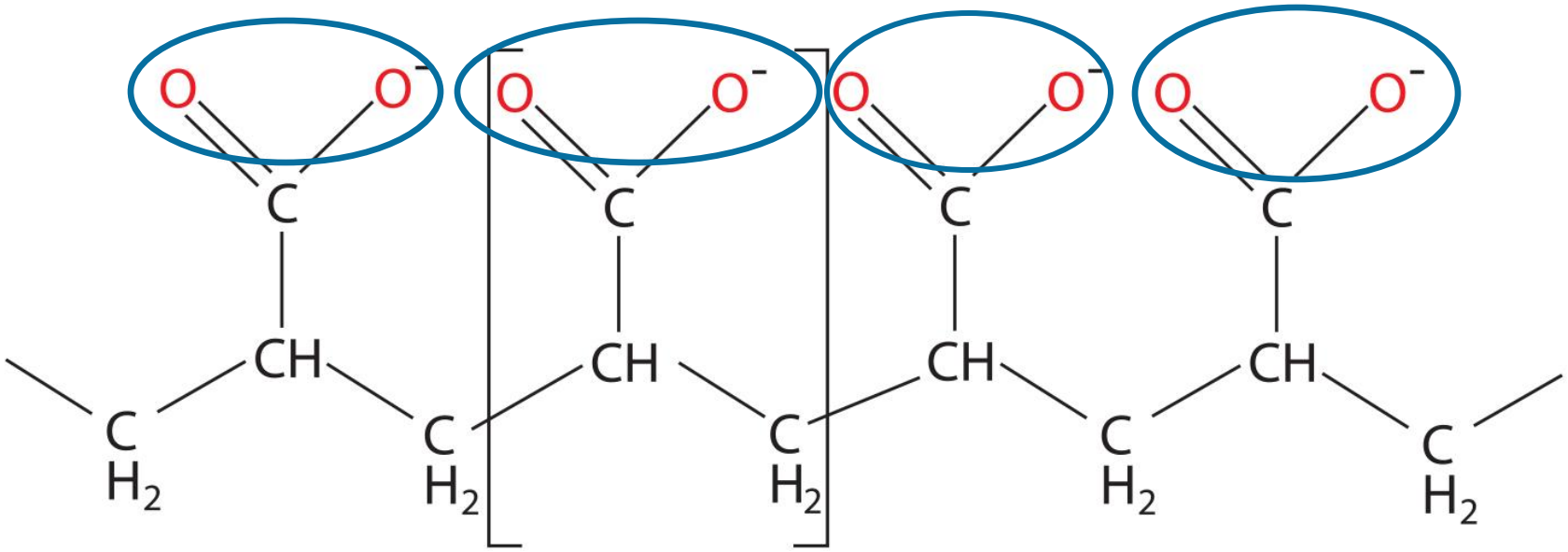


Carboxymethylcellulose (CMC):
Negative charges are far apart



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

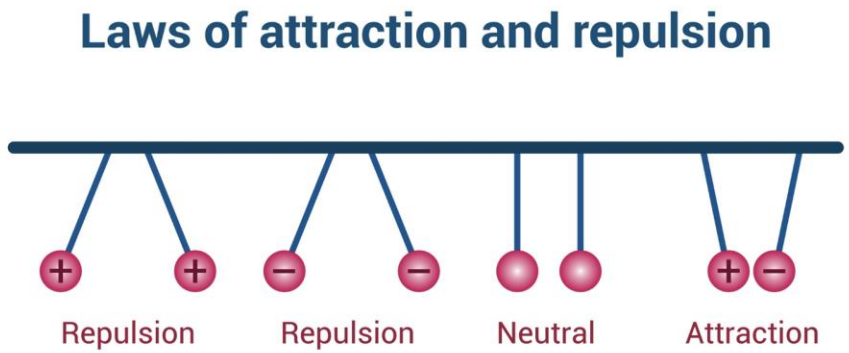
NCF Dressings Negative Charges are ***VERY CLOSE***



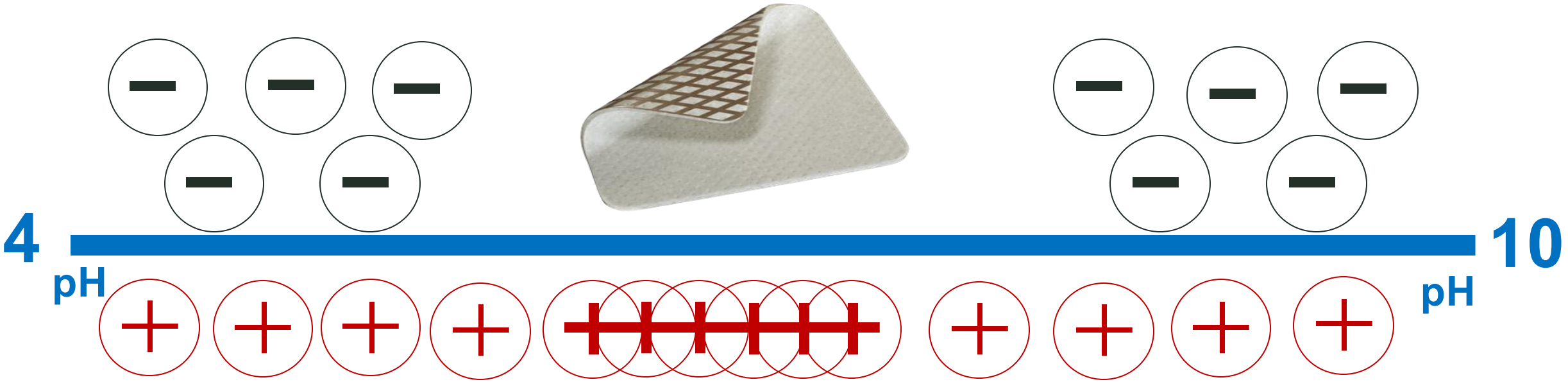
Negatively-Charged Fiber (NCF) Technology Dressing

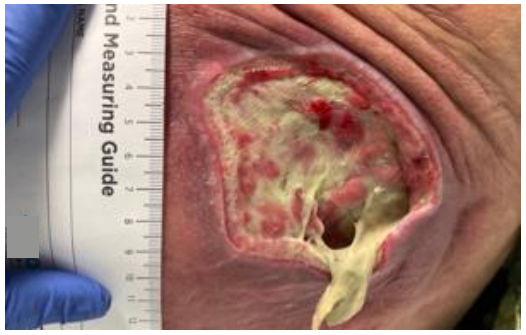
- Absorbent fiber dressing with TLC-Ag matrix
- Lipido-colloid technology with silver salts
- Cleaning action plus antimicrobial barrier protection

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



How pH and Charge Play into Slough Removal





Skin/Wound pH

- Normal intact skin pH is between 4.5-5.3 increasing deeper in the stratum corneum (6.8)
- pH of wounds is naturally more alkaline as trauma disturbs acidic milieu
  - Exposes underlying tissues with pH of 7.4
- Studies report the pH of a chronic wound in a range of 7.4-8.9
- Surface pH plays an important part in wound healing
  - Helps control infection
  - Increases antimicrobial activity, oxygen release, angiogenesis, protease activity, and bacterial toxicity
  - High pH selects for pathogenic organisms

Sim P, et al. *Int J Mol Sci*. 2022;23(21):13655.

A look at the evidence

Strength of the Charge

Product	Negative Charge in mmole units per 10 cm x 10 cm dressing
Negatively Charged Fiber Dressing	1,25
Alginate Dressing A	0,17
Alginate Dressing B	0,07
Carboxymethyl Celluluse gelling dressing	0,21
Polyurethane dressing	0,13
Poly Vinyl Alcohol, PVA dressing	0,03

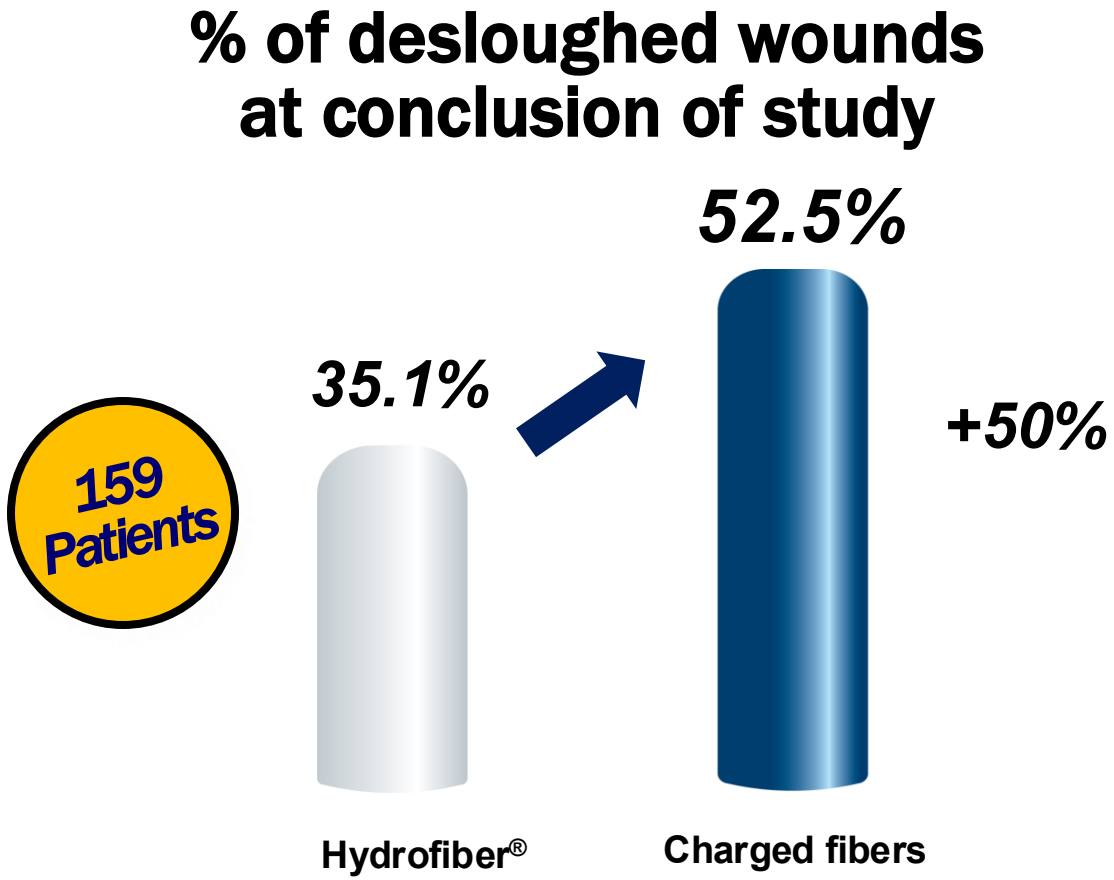
7X

Chakravarthy D. The engineered structure-based ability of a highly charged absorbent (polyacrylate) dressing* to adhere to slough like material in a preferential way compared to other absorbent fibers found in advanced dressings. Poster LR-011: SAWC Spring 2024. Orlando, FL, USA.

Proven Efficacy

In a randomized controlled trial:

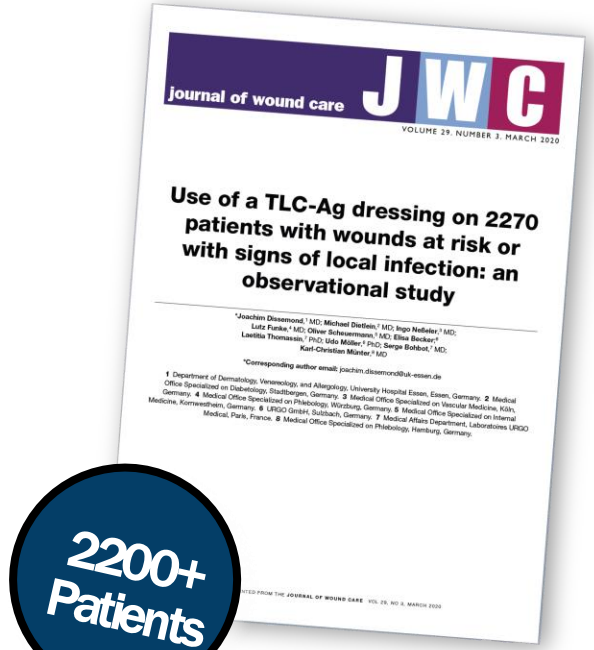
Negatively-charged fiber technology showed greater reduction of slough compared to Hydrofiber® technology



Meaume S, et al *J Wound Care.* 2014;23(3):105-6,108-11, 114-6.

The Largest Observational Study Ever Conducted on a Silver Dressing

- 2270 patients, including 77 under the age of 18 yrs
- After only 2 wks, 90.6% of the wounds treated demonstrated improvement of the healing process
- NCF dressing effectively reduced exudate level by 70%
- Over 3 wks, there was a 79% increase in healthy granulation tissue and a significant reduction in slough and necrotic tissue
- No intolerance to the dressing was documented



SAWC Fall
POSTER RIBBON AWARD RECIPIENT

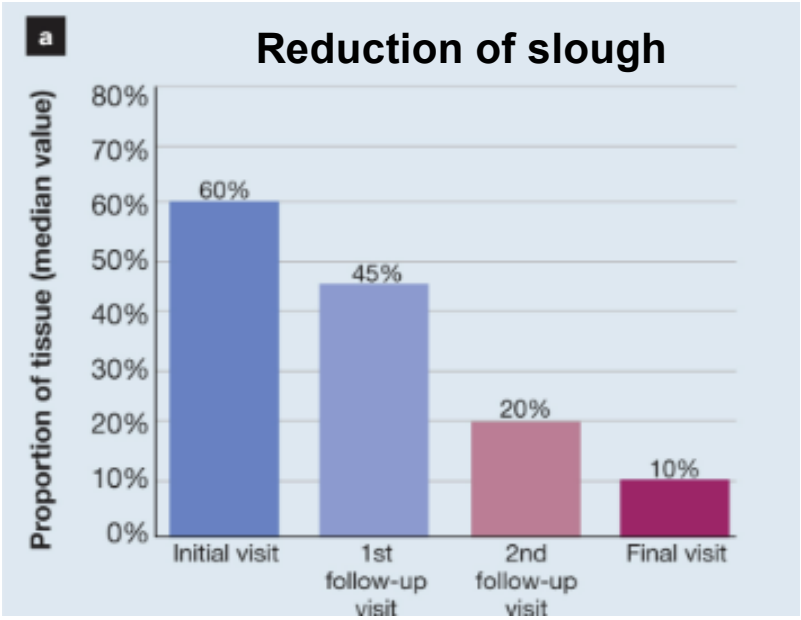
Dissemond J, et al. *J Wound Care.* 2020;29(3):162-173.

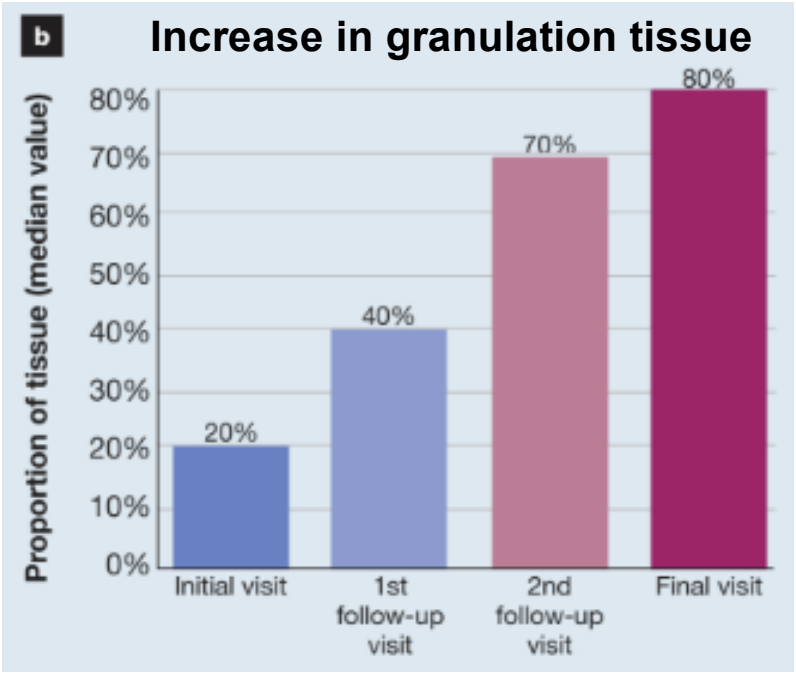
4-Week Observational Study

NCF technology showed

- Reduction of slough from 60% to 10%
- Increase in granulation tissue from 20% at initial visit to 80% at final visit
- Improvement was also associated with reduction in
  - Infection rates by 87.3%
  - Malodor by 86.7%
  - Maceration by 65.6%
  - Spontaneous pain by 60.4%

1,558 Patients





Reinboldt-Jockenhöfer F, et al. *J Wound Care*. 2025;34(4):261-270.

What Do You See?

- 63y Male, severe PAD, HTN, CKD
- Day 0 burn from defibrillator pad

3 days daily dressings with HOCl cleanser soaks, NCF dressing

Dressing removed 3rd day

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

PAD = peripheral artery disease; HTN = hypertension; CKD = chronic kidney disease.

56y Female: Pyoderma Gangrenosum

- 56y Female
- Pyoderma gangrenosum
- Slough area at top of a larger wound
- Dressing changed wkly x2 wks with compression wrap after 10-20min pHA cleanser soak

Venous Leg Ulcer

Day 0: Application of NCF dressing

Day 7: Tissue softer

Day 14

Day 28

Day 35

Day 42

Recalcitrant Venous Leg Ulcer

- Recurring presence of slough
- Fairly painful
- Soaked with HOCl
- Applied NCF dressing with 2-layer compression bandage

1 Week

A-Line Extravasation

Debrided, began NCF dressing

Week 1

Week 3

Heating pad burn to breast – Difficult to debride in clinic
5min soak with HOCl, NCF dressing applied

1 Week of NCF Dressing

2 Weeks

Clinical Pearls

- Wounds have multiple needs
- Removal of slough is essential
- The ideal management plan is one that is simple, safe, and effective (cost and otherwise)

Questions?

Thank You!