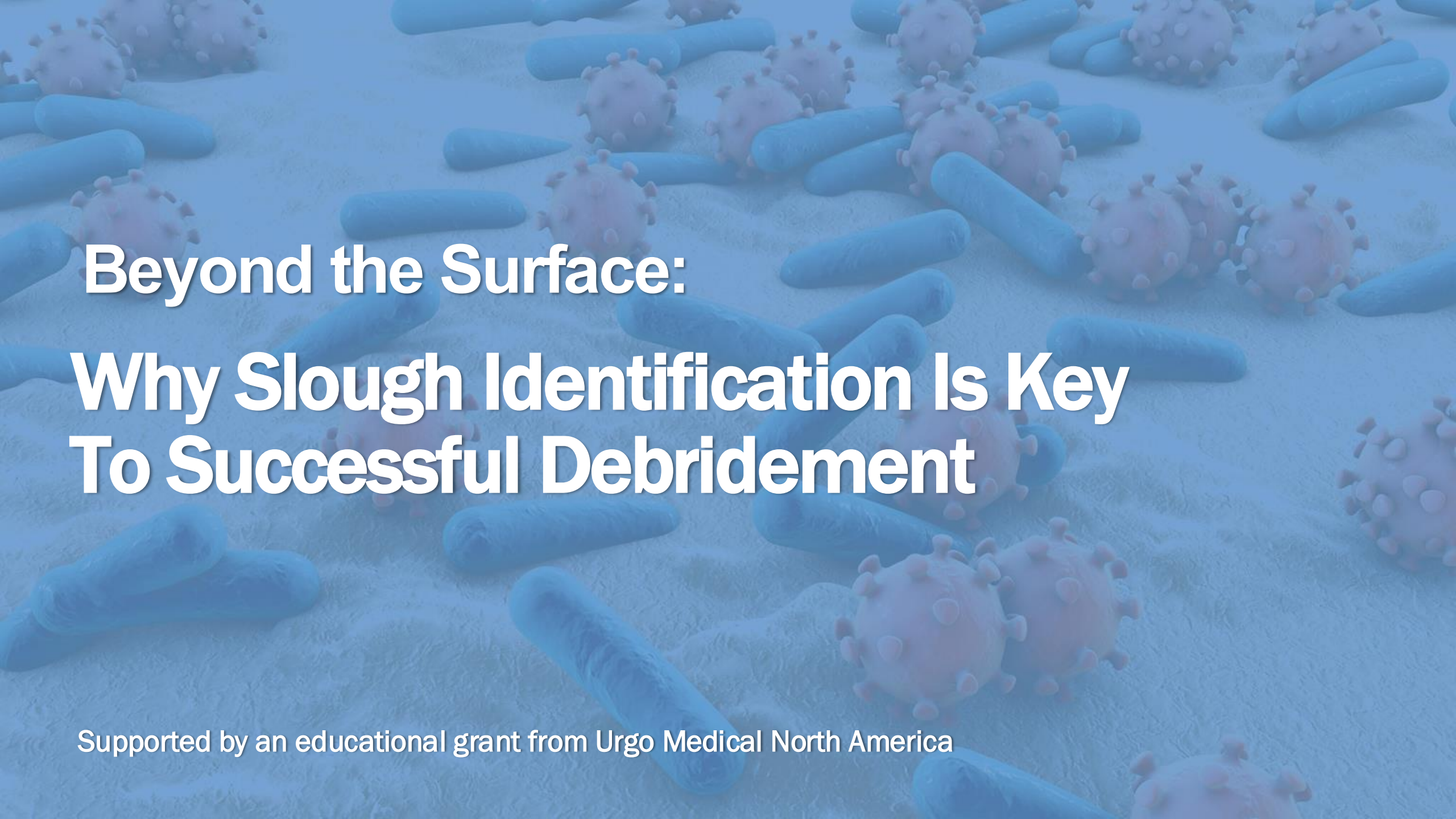


Beyond the Surface:

Why Slough Identification Is Key To Successful Debridement

Supported by an educational grant from Urgo Medical North America

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  Consultant: Urgo Medical North America; Urgo Medical France; Ethos CRO

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

Learning Objectives

- Describe the composition of slough and necrotic matter and explain their role in increasing microbial burden and impairment of wound healing
- Compare traditional and emerging debridement support technologies, including engineered fiber dressings and hypochlorous acid-based solutions and gels, with respect to their advantages, limitations, evidence base, and clinical applications
- Evaluate the role of wound surface microacidification in optimizing desloughing and wound bed preparation and promoting a healable wound environment
- Explore evidence-based strategies for achieving a healable wound bed, including the roles of debridement, microacidification, and combination therapies in optimizing wound healing outcomes

Submit questions at any time via the Question Box



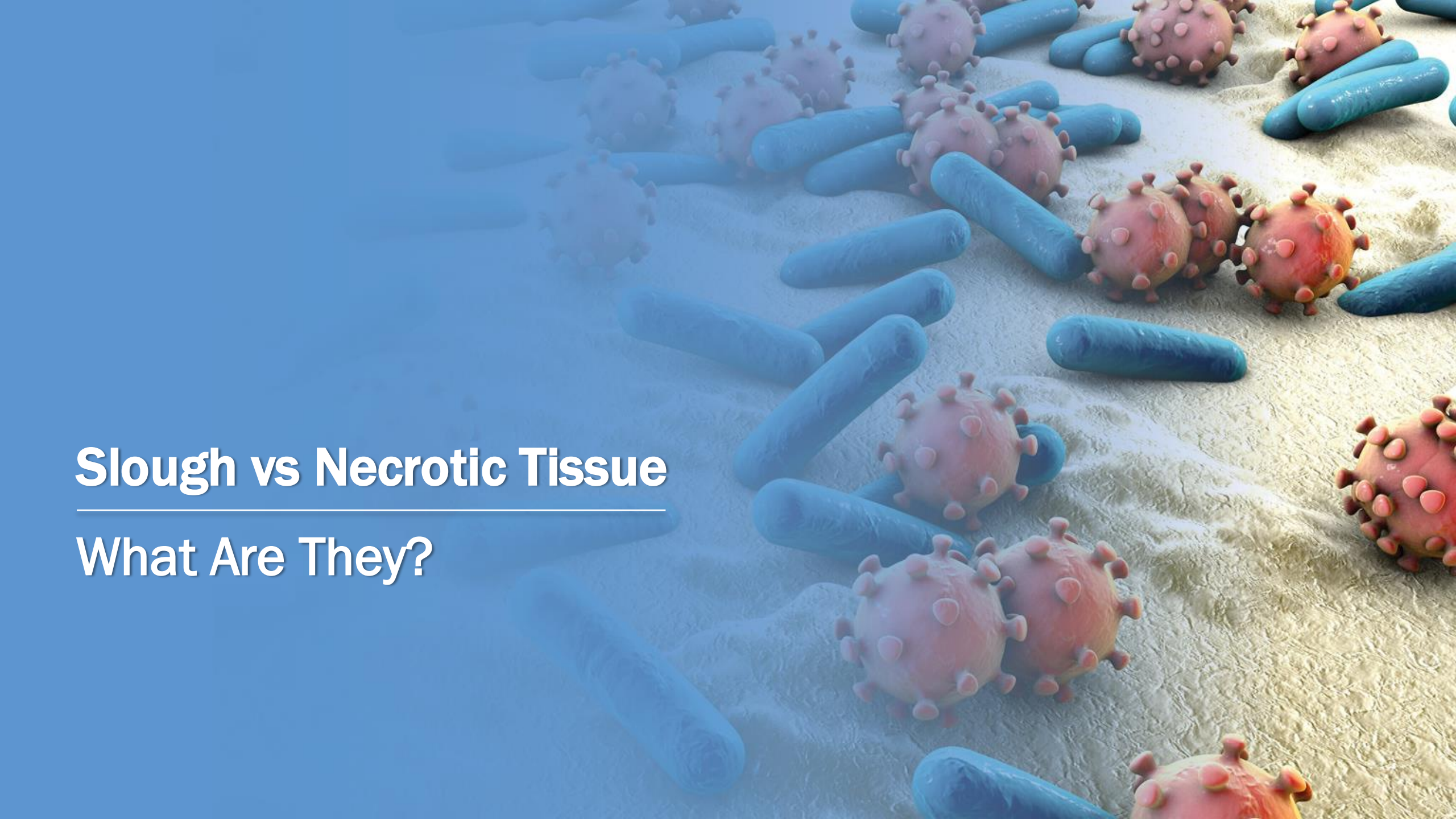
Science and Technology of Slough

Daniel J. Gibson, PhD
Assistant Professor
University of Alabama
Tuscaloosa, AL



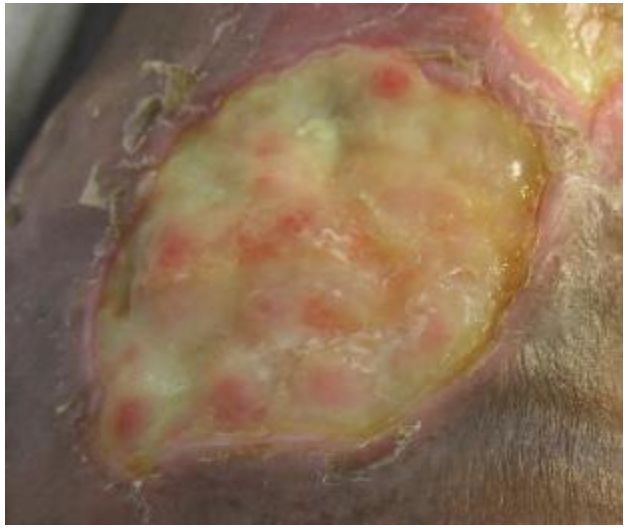
Slough vs Necrotic Tissue

What Are They?



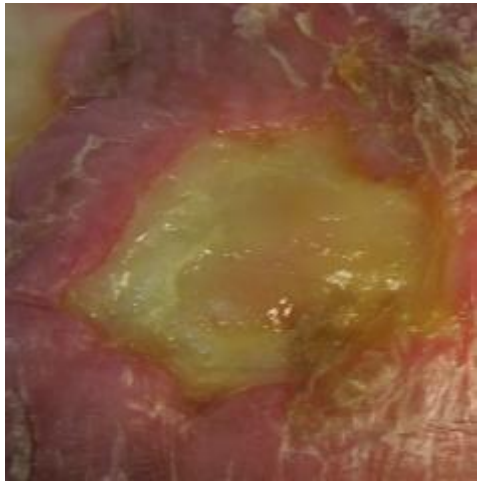
Slough: Loosely Attached







Proteinaceous
Gelatinous
Coagulum





Firmly Attached Slough: Cut It Off*



*If the patient is a candidate for sharp debridement

Can use other forms of debridement

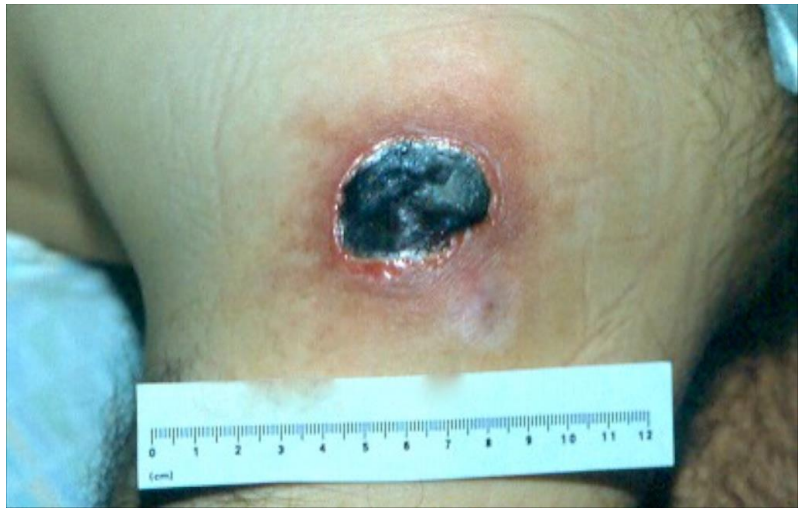


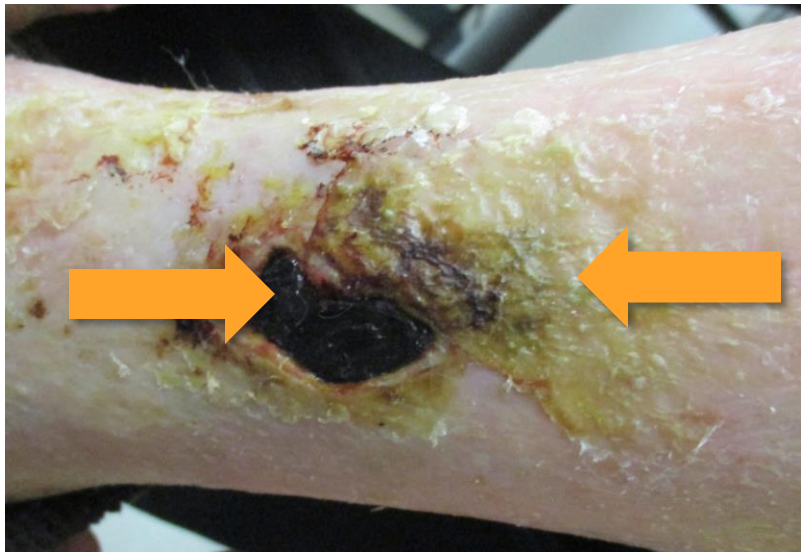


Cannot be curetted, scrubbed, or peeled off

Necrotic Tissue









Mixed Slough and Necrotic Tissue











Slough vs Necrotic Tissue: Source

- Slough is…
  - Coagulated serum and immune-derived proteins
    - “Dead” exudate (Kutting, 2003)
  - Some cells (leukocytes/neutrophils; Hadfield, 1963)
  - Formed in weepy wounds
- Necrotic tissue is…
  - Dead tissue extracellular matrix (ECM) (Thomas, et al. 1999; Nurlybayeva, et al. 2026)
  - Leukocytes (Thomas, et al. 1999)
  - Ischemic wounds
- ***Both are composed of biomolecules and can harbor microbes as a growth matrix***

ECM = extracellular matrix.

International Wound Infection Institute (IWII). *Wound Infection in Clinical Practice: Principles of Best Practice*. 2022. Accessed July 2026. https://woundinfection-institute.com/resources/wound-infection-in-clinical-practice-principles-of-best-practice. Mayer DO, et al. *J Wound Care.* 2024;33(Suppl 6b):S1-S32. Kutting. *Br J Community Nurs*. 2003;8(Sup3):S4-S9. Nurlybayeva, et al. *Vasc Dis*. 2026;51(1):29. Hadfield. *Br J Surg*. 1963;50(224):649-661. Thomas AML, et al. *J Wound Care*. 1999;8(6):285-287.

The Slough Project



- Pilot study to describe human and microbial components of slough
- Slough collected from wounds of various etiologies
- Findings
  - Slough is highly polymicrobial
    - Assessed by both quantitative cultures and qPCR
      - $1.0x10^2$ - $8.0x10^7$ CFU/inch^2 wound via culture
      - $4.2x10^3$ - $4.6x10^8$ CFU/inch^2 wound via qPCR
    - Most common taxa: *Corynebacterium* spp., *Pseudomonas* spp., and *Staphylococcus* spp.
  - Slough exhibits signatures associated with both wound etiology and location
  - Protein profiles from healing wounds are significantly different from non-healing wounds

Kalan L, et al. *Wounds International.* Published May 2023. Accessed July 2026. Available: https://woundinfection-institute.com/resources/slough-composition-analysis-and-effect-on-healing. Townsend EC, et al. *Wound Repair Regen.* 2024;32(6):783-798. Brinkmann V, et al. *Science.* 2004;303(5663):1532-1535.

A Closer Look at Slough Biomolecules

An Example Using Fibrinogen



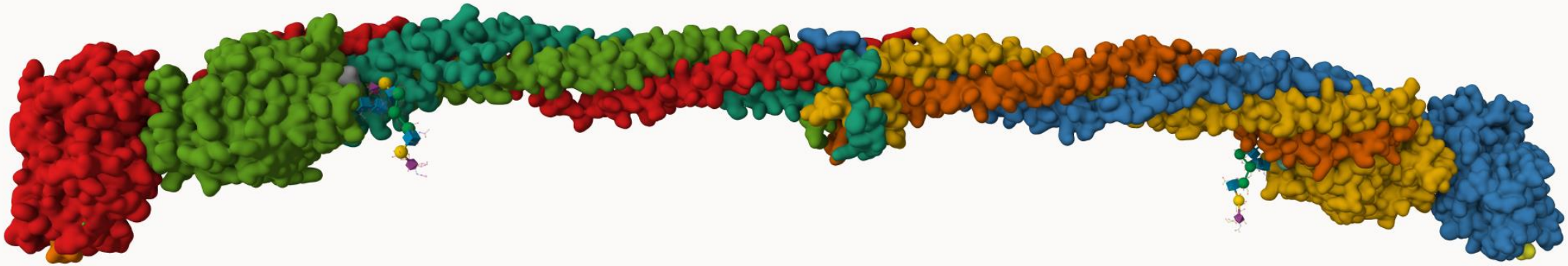
Biomolecular Response to Cleansing Agents

- Slough is primarily protein
  - Some evidence of neutrophil extracellular traps (NETs) — DNA, antimicrobial peptides (AMPs), and proteins
- Protein behavior is based on protein side chains
- Side chains respond to pH and can be modified by antimicrobial agents

NET = neutrophil extracellular trap; AMP = antimicrobial peptide.

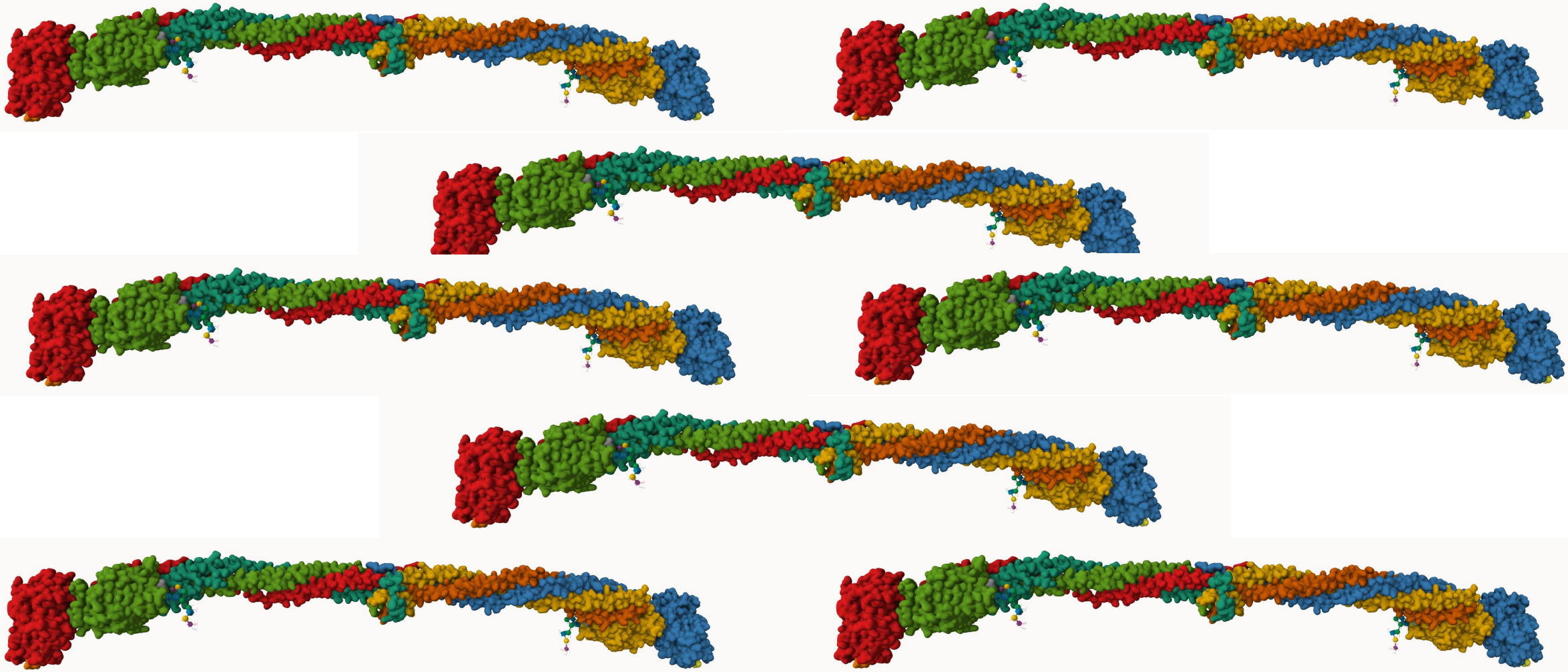
Kalan L, et al. *Wounds International.* Published May 2023. Accessed July 2026. Available: https://woundinfection-institute.com/resources/slough-composition-analysis-and-effect-on-healing. Townsend EC, et al. *Wound Repair Regen.* 2024;32(6):783-798. Brinkmann V, et al. *Science.* 2004;303(5663):1532-1535.

Slough at the Molecular Level: Fibrin



Kollman JM, et al. *Biochemistry*. 2009;48(18):3877-3886.

Slough at the Molecular Level: Fibrin Polymerization

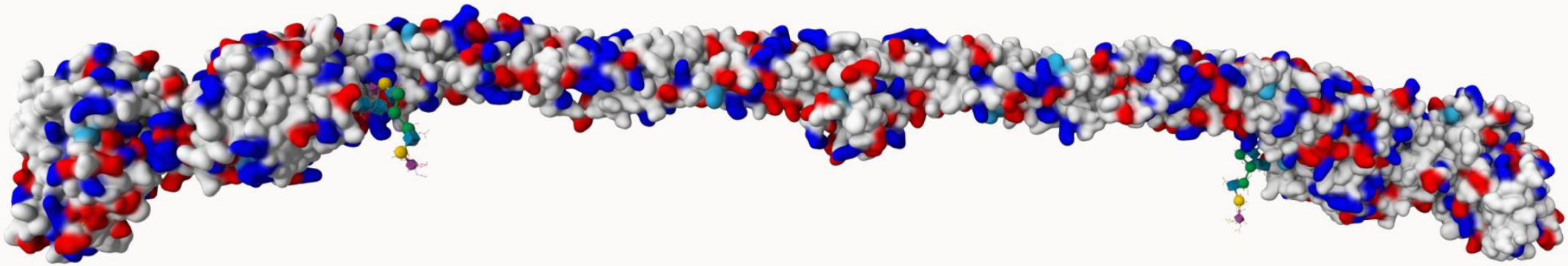


Kollman JM, et al. *Biochemistry*. 2009;48(18):3877-3886. Weisel JW, et al. *Blood*. 2013;121(10):1712-1719.

Slough at the Molecular Level: Fibrin Charge and pH

NEUTRAL | **POS (Lys, Arg)** | **Weak POS (His)** | **NEG (Asp, Glu)**

pI ≈5.8



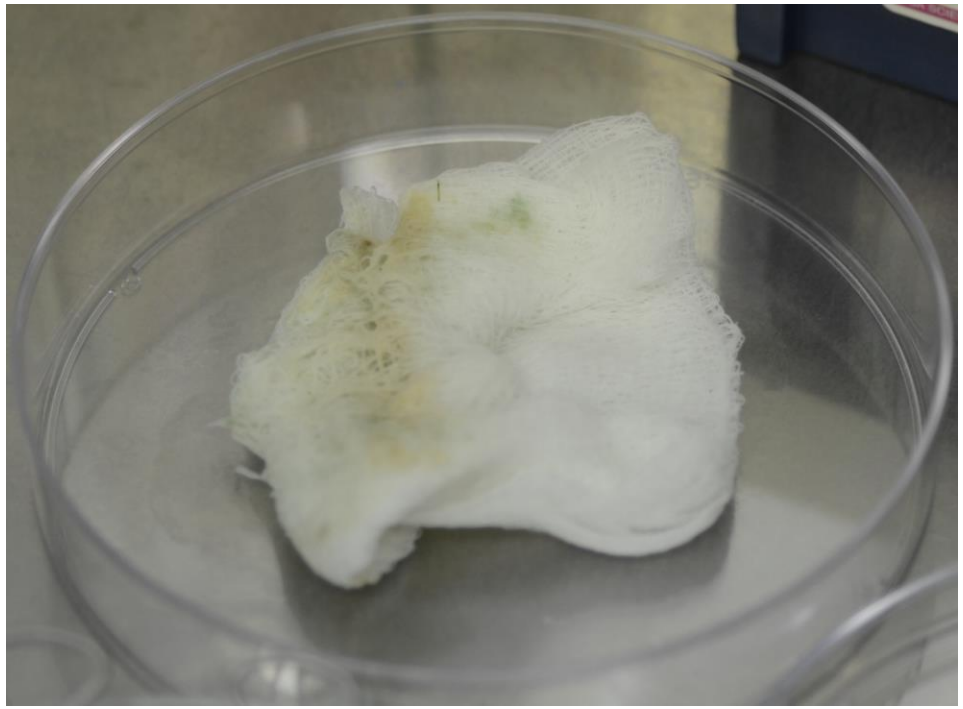
Henderson-Hasselbalch Approximation

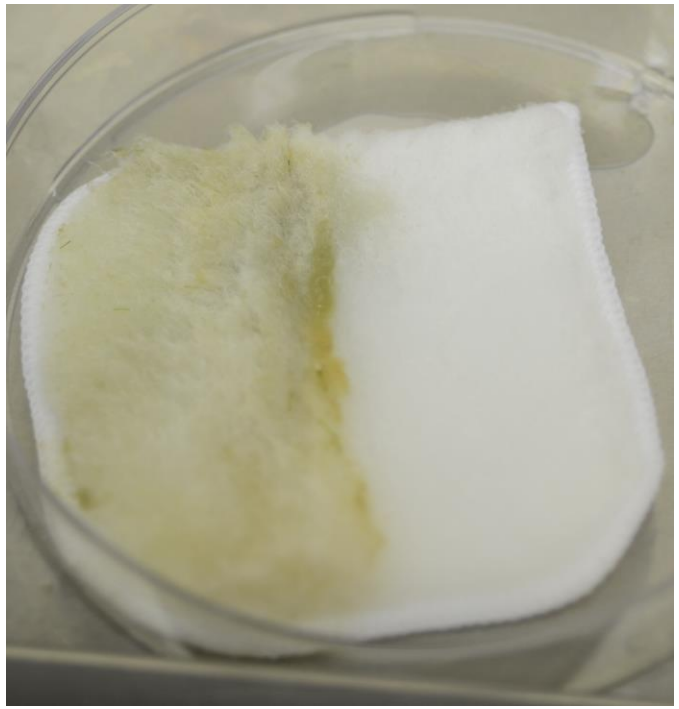
$$pH \approx pK_a + \log_{10} \frac{[A^-]}{[HA]}$$

Side Chains	pH 6.0	pH 7.0	pH 8.0
Acids	105:1	1,055:1	10,550:1
Histidine	1:1	1:9	1:90
Bases	146,000:1	14,600:1	1,460:1

Kollman JM, et al. *Biochemistry*. 2009;48(18):3877-3886. Żeliszewska P, et al. *Langmuir*. 2014;30(37):11165–11174. LibreTexts Chemistry. Physical & Theoretical Chemistry. Henderson-Hasselbalch Approximation. Accessed Oct 2026. https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Acids_and_Bases/Buffers/Henderson-Hasselbalch_Approximation

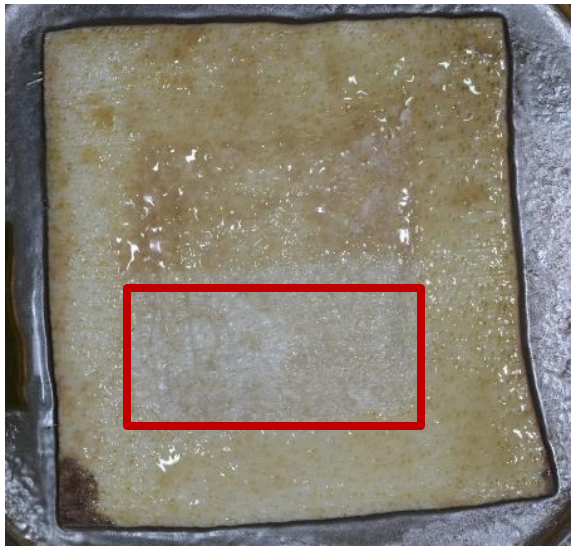
Traditional Removal: Wiping or Cutting



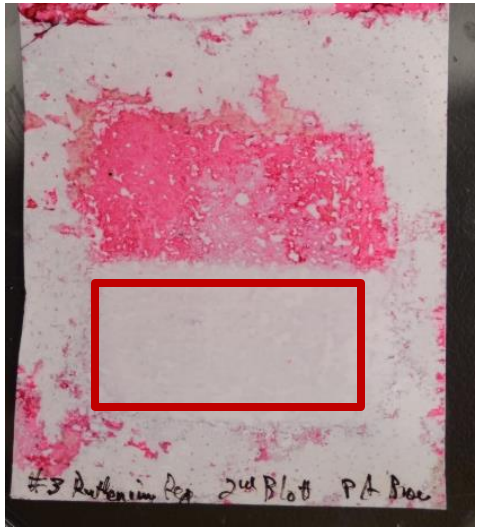




Novel Removal: Charged Membranes or Dressings

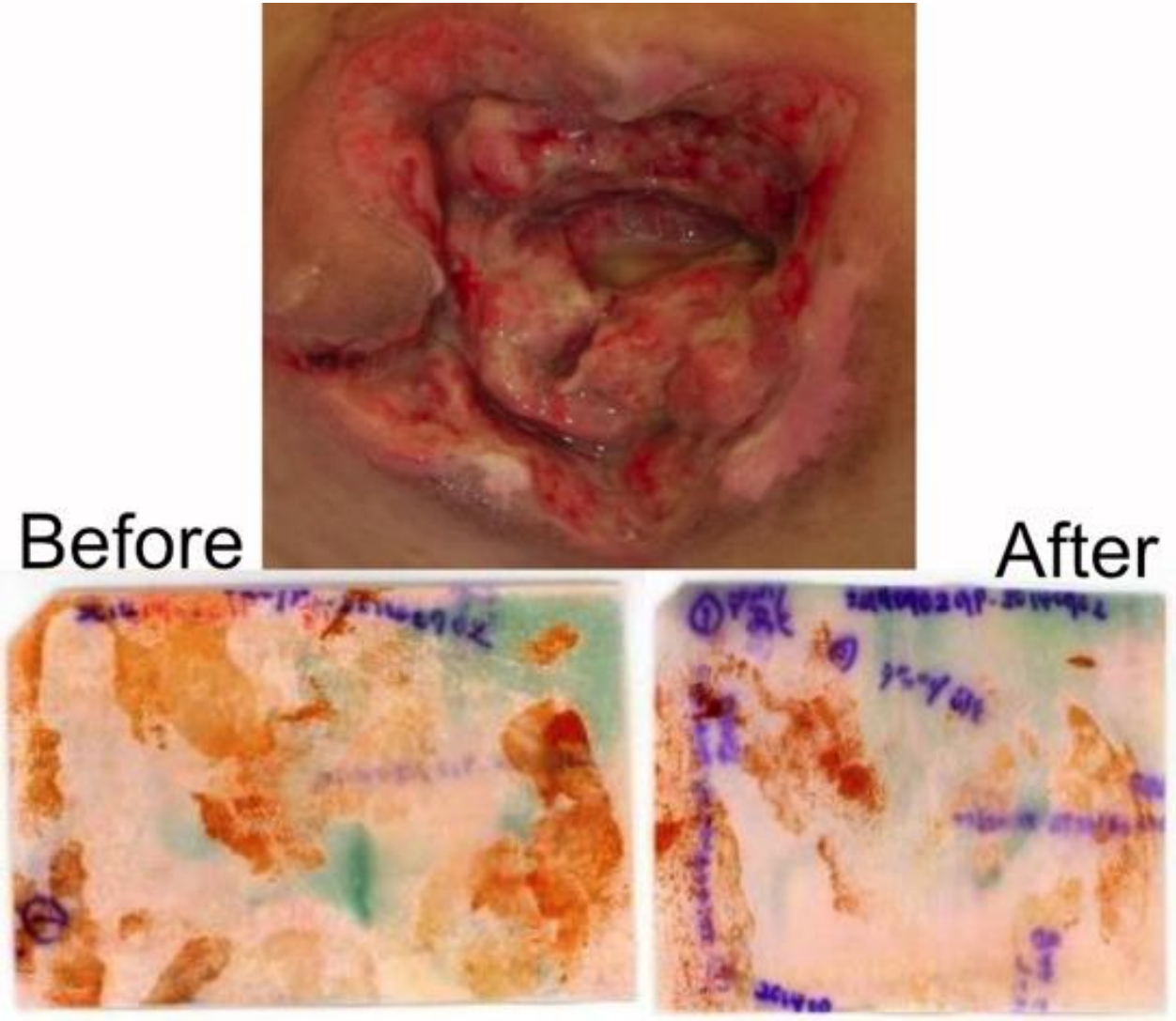


Ex vivo porcine skin biofilm



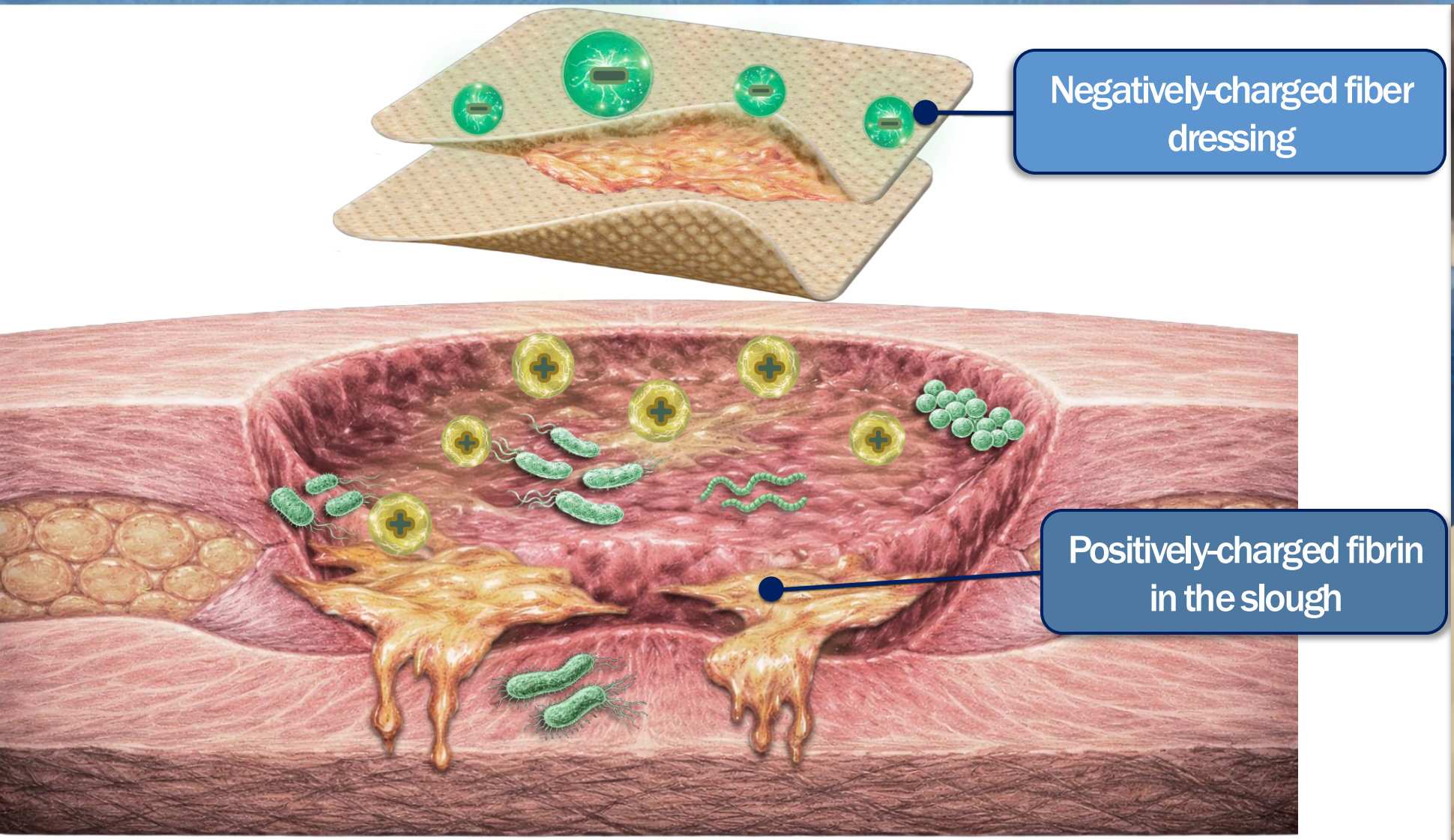
Stained blot

Preclinical Data with Cationic Membranes



Nakagami G, et al. *Wound Rep Regen.* 2017;25(1):131-138.

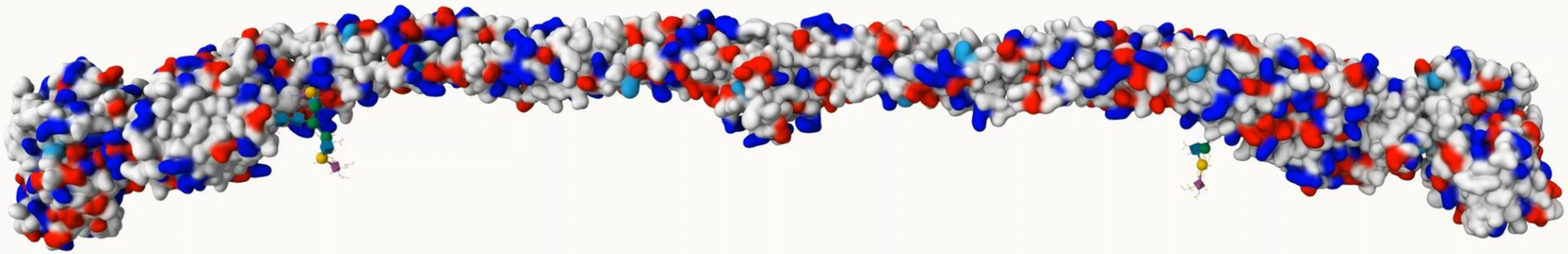
Novel Removal: Charged Membranes or Dressings





Slough at the Molecular Level: Plenty of Charges to Grab

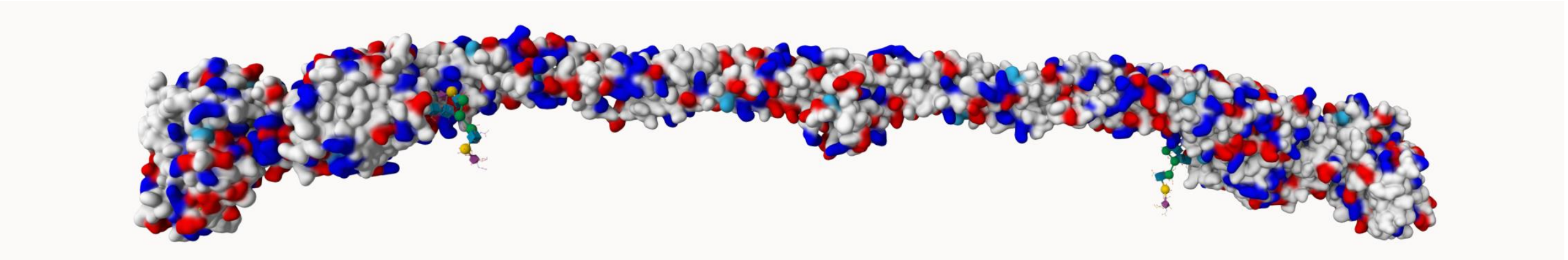
NEUTRAL | **POS (Lys, Arg)** | **Weak POS (His)** | **NEG (Asp, Glu)**



Kollman JM, et al. *Biochemistry*. 2009;48(18):3877-3886.

Slough at the Molecular Level: Other Modifications

NEUTRAL	POS (Lys, Arg)	Weak POS (His)	NEG (Asp, Glu)



- Iodination of tyrosine and histidine
- HOCl oxidation of tyrosine
- HOCl chlorination of lysine, histidine, arginine → + chloramines
- HOCl reacts with several other amino acids as well as cell membrane lipids
- Met > Cys >> His ≈ alpha amino > Trp > Lys >> Tyr ≈ Arg > backbone > Gln ≈ Asn

Kollman JM, et al. *Biochemistry*. 2009;48(18):3877-86. Pattison DI, et al. *Biochemistry* 2007;46(34):9853-64. Pattison DI, Davies MJ. *Chem Res Toxicol*. 2001;14(10):1453-64.



Capturing Slough:
What a Negatively-Charged Fiber Dressing Actually Removes from the Wound Bed

Yadwinder Dhillon, MD
AZ Wound and Hyperbaric Medicine
Associate Professor, University of Arizona
School of Medicine
Phoenix, AZ

Slough Is Protein, and It Is Polymicrobial

- Slough is nonviable tissue of varying color, loosely or firmly attached — dead cells, exudate, proteins, and multiple microbial species
- IWII: slough is a complex mixture of proteins and is polymicrobial; chronic wound slough carries a high concentration of pro-inflammatory proteins
- Devitalized tissue is a nutrient-rich, hypoxic niche that shelters microbes from host defenses and physically blocks cell migration
- **If slough is fundamentally protein, then a dressing that desloughs must, mechanically, be a protein-binding device**

The Slough Project (Kalan, et al.)

Polymicrobial
Confirmed by both quantitative culture and qPCR

10^2–10^8 CFU/in²
Bioburden range measured within slough

Corynebacterium, Pseudomonas, Staphylococcus
Most common taxa recovered

Etiology and site signatures
Protein profiles of healing wounds differ significantly from those of non-healing wounds

IWII. Wound Infection in Clinical Practice. 2022. Kalan L, et al. *Wounds Int*. 2023. Townsend EC, et al. *Wound Repair Regen*. 2024;32(6):783-798.

The Problem: 24-Hour Therapeutic Window

- The cleanest a wound ever looks is immediately after sharp debridement — that is the therapeutic window
- Slough and microbial colonies begin to re-form within ≈24 hrs; most patients are seen again in 7 days
- Standard dressings target exudate and bacteria; few actively target slough between visits
- **Slough re-accumulates faster than episodic debridement can keep up with**

What Happens Between Visits

Day 0	Sharp debridement — clean wound bed
Day 1	Slough and microbial colonies begin re-forming
Days 2-6	Re-accumulation continues unaddressed
Day 7	Next visit — debride again, repeat the cycle

Mayer DO, et al. *J Wound Care.* 2024;33(Suppl C):S2–S29.

Integral Debridement: Extending the Window

Integral debridement: the combined use of different but complementary methods of debridement on the same wound — an aggressive primary technique followed by adjunctive, continuous debridement

- Consensus recognition that wounds are not debrided often enough and that adjunctive methods must carry the interval between visits
- Shifts wound bed preparation from episodic intervention to continuous management
- Bridges scope-of-practice limits — not every setting or clinician can sharp debride

Effective

Continuously removes slough as it forms and mitigates microbial re-colonization post-debridement

Accessible

Usable across clinic, hospital, and home settings; not limited by scope of practice; reimbursed

Easy and Comfortable

Simple for staff, well tolerated by patients because consistency is what makes it work

How Charged Fibers Remove Slough



Property 1: High Density of Negative Charges

- Many dressings carry negative charges — alginate and carboxymethylcellulose (CMC) both do
- What differs is spacing; in alginate and CMC, charged sites sit ≈8-10 atoms apart, so charge density is low
- In the negatively-charged fiber (NCF) dressing, charges are ≈3 atoms apart — densely packed along the polymer
- **Measured charge density is ≈16x that of CMC gelling-fiber dressing**

Dressing fiber type	Negative charge (mmol / 10×10cm)
Negatively-charged fiber dressing	**4.30**
CMC gel dressing	0.26
Polyvinyl alcohol (PVA) dressing	0.16
Alginate dressing A	0.09
Alginate dressing B	0.07

16x **higher charge density than the CMC comparator — more binding sites per square inch of dressing**

CMC = carboxymethylcellulose; NCF = negatively-charged fiber; PVA = polyvinyl alcohol.
Morozkina S, et al. *Polymers (Basel).* 2022;14(17):3604. ·

Property 2: Local Microacidification at the Interface

- Healthy skin surface pH is 4.5–5.5; chronic wounds run alkaline at ≈7.15–8.9 as the acid mantle is lost and protein breakdown yields alkaline byproducts
- When the fibers contact high-pH exudate, carboxyl groups release H^+ ions, dropping pH locally at the dressing–wound interface
- Microacidification is the targeted reduction of pH at the wound surface — local, not systemic
- **That local pH drop increases the number of positively-charged groups on slough proteins, which is what enables electrostatic binding**

Dressing tested in pH 9 buffer	Resulting pH
Polyabsorbent fiber rope dressing	**7.42**
Polyabsorbent fiber dressing	**7.64**
Silver-containing polyabsorbent fiber	**7.64**
Silver-containing hydrofiber dressing	8.36
Calcium-alginate dressing	8.31
CMC-based gelling fiber dressing	8.61

Polyabsorbent fibers produced a pH drop ≈2.5x greater than the comparators

Sim P, et al. *Int J Mol Sci*. 2022;23:13655. Percival SL, et al. *Wound Repair Regen*. 2014;22:174-186.

Putting It Together: Why Slough Sticks to the Fiber

1

ALKALINE WOUND

Chronic wound pH ≈7.15–8.9. At that pH, slough proteins carry net negative charge — poorly attracted to a negative fiber.

>

2

H^+ RELEASE

Fiber carboxyl groups release H^+ on contact with exudate, acidifying the interface locally.

>

3

CHARGE FLIP

As local pH falls, amino-acid side chains and fibrin become protonated — positive charges increase on the slough proteins.

>

4

ELECTROSTATIC CAPTURE

Densely packed negative fiber charges bind the now positively-charged protein — the strong, distinctive force.

>

5

LIFT & REMOVE

Bound slough, exudate, and bacterial residues leave with the dressing. TLC-Ag gel keeps removal atraumatic.

Hydrophilic interaction and hydrogen bonding are common to all absorbent dressings. The electrostatic step is what distinguishes this one — it is a physical attraction: no bonds are broken, unlike enzymatic debridement.

TLC-Ag = technology lipido-colloid with silver ions.

Rahmani V, et al. *Eur J Pharm Biopharm*. 2017;117:232-243.

Mode of Action and Candidate Wounds

Charged Fibers

Bind, trap, and remove slough, exudate, bacterial residues, and other wound debris continuously throughout wear time

TLC-Ag Matrix

The silver-containing lipido-colloid matrix forms a bio-friendly gel that supports autolytic debridement, provides an antimicrobial barrier, and ensures atraumatic, pain-free removal

Who Benefits

Sloughy wounds

Visible slough on the wound bed, any etiology

Post-sharp-debridement wounds

Extends the therapeutic window between visits

Wounds that cannot be sharp debrided

Patient intolerance, anticoagulation, setting, or scope of practice

Clinical Evidence: Slough Down, Granulation Up

1,558

patients in a large real-world observational study

60% → 10%

median proportion of slough, initial visit to final visit

20% → 80%

median granulation tissue over the same period

Reported symptom improvement

Malodor, local infection, maceration, and spontaneous pain all improved substantially across the cohort (approximately 60%-87%, depending on the symptom assessed)

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

What Actually Comes Off?

The mechanism predicts that a charged fiber matrix should bind protein-rich slough. Until now, that prediction has been supported by clinical appearance rather than by molecular identification of the captured material.



Study Design: Let the Dressing Report What It Removed

Apply

UrgoClean Ag (TLC-Ag) applied to chronic wounds with visible slough

>

Wear

1 wk of wear on the wound bed

>

Remove

Dressing lifted with material bound to it

>

Analyze

Dressing-bound material processed for proteomics — not a wound biopsy

>

Identify

DIA LC-MS/MS: unbiased identification and quantification of every captured protein

10	7	3	1 wk
dressings analyzed	from venous leg ulcers (VLU)	from non-VLU chronic wounds	wear time before removal

DIA LC-MS = data-independent acquisition liquid chromatography-tandem mass spectrometry; MS = mass spectrometry; VLU = venous leg ulcer.

Analytical Pipeline (DIA Quantitative Proteomics)

Protein recovery

Proteins extracted from dressing-bound material (8 M urea lysis); BCA quantification; SDS-PAGE integrity check.

LC-MS/MS

Vanquish Neo nanoLC, 120-minute gradient into an Orbitrap Exploris 480 in data-independent acquisition mode.

Databases

Homo sapiens PLUS 6 wound pathogens: *S. aureus, S. epidermidis, S. pyogenes, P. aeruginosa, C. tetani, C. albicans.*

Digestion

Reduction/alkylation (DTT/IAM), single-pot SP3 bead cleanup, sequencing-grade trypsin (1:50, 37° C overnight), C18 desalting.

Identification

DIA-NN search; 20 ppm precursor and fragment tolerance; carbamidomethyl (C) fixed; oxidation (M) and N-term acetyl variable.

Statistics

Median normalization and imputation; PCA and PLS-DA; DEPs at fold change ≥2 with $p<.05$ (t-test); GO and KEGG enrichment.

Key Result

The dressing captured an entire wound proteome.

4,683

proteins identified
from material bound to the removed dressings

39,951

peptides identified
high-confidence, database-matched sequences

10/10

dressings productive
thousands of proteins recovered from every sample

Every one of these proteins was physically retained by the fiber matrix through a week of wear and through dressing removal — direct evidence of binding affinity for wound bed material.

Consistent, High-Yield Dressing Capture from Every Dressing

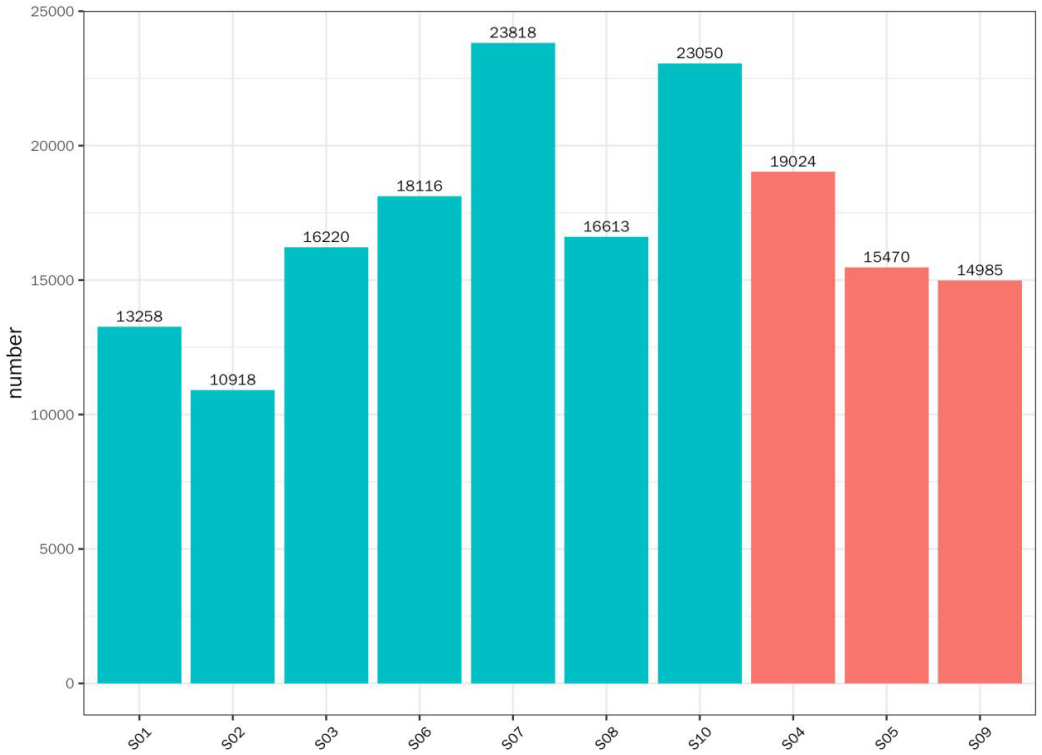


Fig. 4 — Peptides identified per dressing (teal = VLU, salmon = non-VLU)

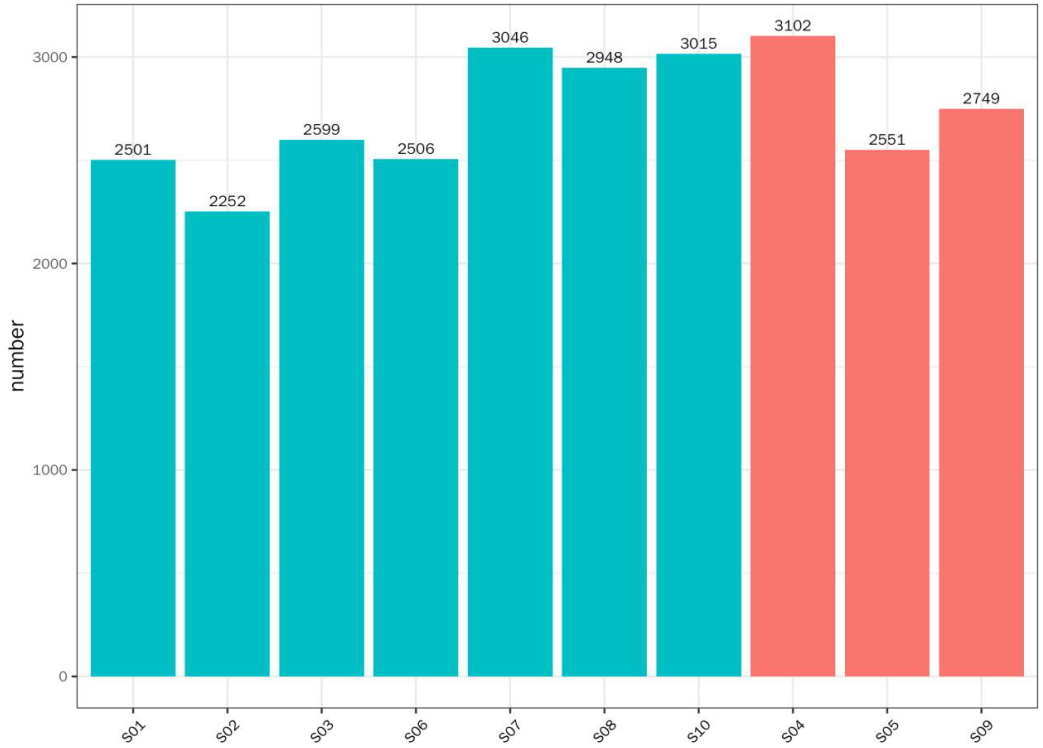


Fig. 5 — Proteins identified per dressing

10,918–23,818 peptides and 2,252–3,102 proteins per dressing — capture was reproducible across patients and wound types, not an occasional event.

The Fibers Bound Intact Protein, Not Degraded Debris

- Tryptic peptides from the dressing follow the canonical 7-30 amino-acid distribution expected of well-preserved protein
- No excess of very short fragments — the captured proteome was not simply proteolytic soup, which matters in a wound full of MMPs and bacterial proteases
- Peptide identification scores clustered at high confidence, supporting data quality
- **The fiber matrix binds and holds structurally intact protein from the slough layer**

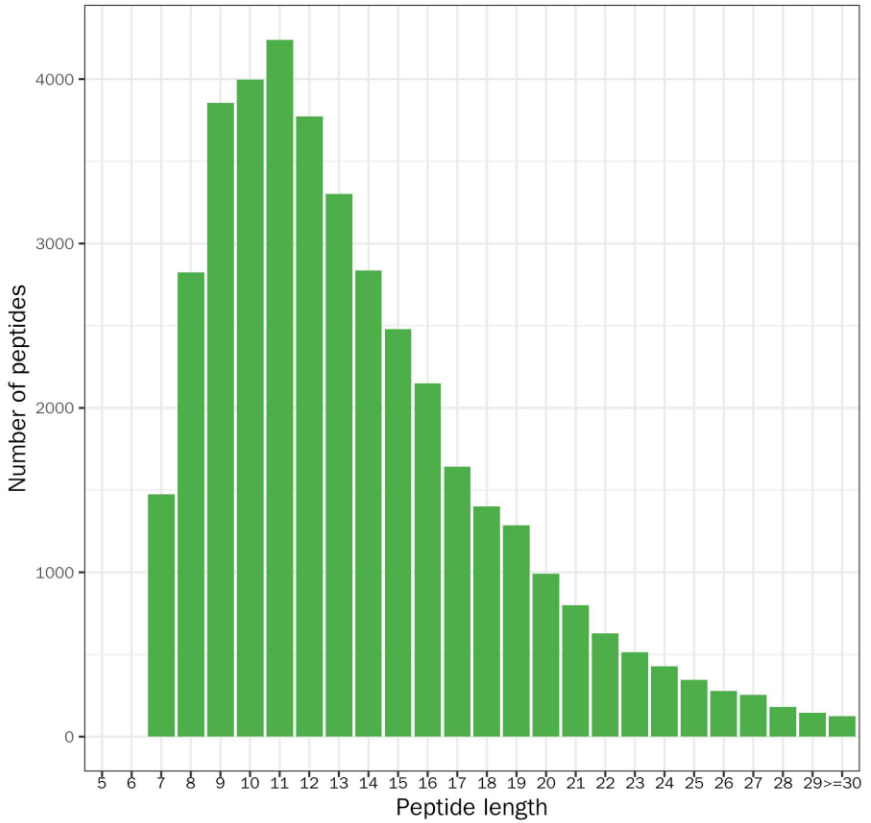


Fig. 3. Peptide length distribution of captured material

MMP = matrix metalloproteinases.

What the Fibers Bound: Charges Host-Defense Proteins

- The highest-intensity captured proteins are immunoglobulin variable-region chains — kappa, lambda, heavy — the signature of an antibody-saturated inflammatory exudate
- Immunoglobulins are large, charge-dense glycoproteins; at the microacidified interface, many carry net positive charge, making them prime targets for a densely negative fiber
- **This is the predicted catch, observed: the mechanism says charged protein, and charged protein is what dominated the dressing**

Protein	Description	Intensity
KVD29_HUMAN	Ig kappa variable 2D-29	1.63e9
LV310_HUMAN	Ig lambda variable 3-10	2.33e8
LV39_HUMAN	Ig lambda variable 3-9	8.99e7
A0A075B7B8	Ig heavy variable 3/OR16-12	8.31e7
KV37_HUMAN	Ig kappa variable 3-7	6.56e7
A0A075B7B6	Ig heavy variable 4/OR15-8	3.34e7
HV364_HUMAN	Ig heavy variable 3-64	2.28e7

Tab. 2 (excerpt). Highest-intensity proteins identified on the dressing

A Core Slough Proteome, Shared across Etiologies

3,565 proteins captured from BOTH wound types — a conserved core of slough constituents the fibers bind regardless of etiology

738 additional proteins unique to VLU dressings

380 additional proteins unique to non-VLU dressings

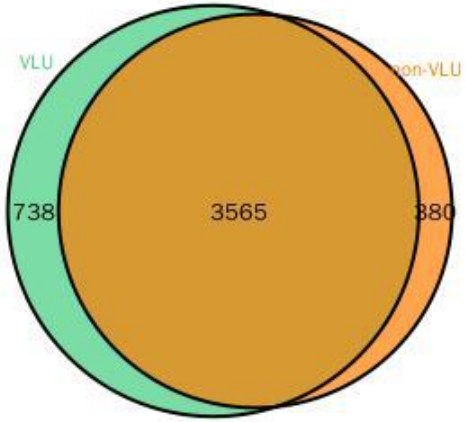


Fig. 7. Proteins captured: VLU vs non-VLU dressings

Affinity in Action: Claim vs Evidence

Mechanistic Claim	Proteomic Evidence
Densely charged fibers bind slough protein	4,683 proteins retained through a week of wear and removal; highest-abundance species are charge-dense immunoglobulins.
Binding is robust and reproducible	Every dressing (10/10) yielded 2,252–3,102 proteins; intact tryptic peptide profile, not degraded residue.
Capture reflects true slough composition	Core proteome of 3,565 proteins shared across etiologies; immune, adhesion, and matrix functions enriched.
The dressing removes bioburden components	Multi-species search identified bacterial proteins; *S. aureus* infection pathway enriched among captured DEPs.

Clinical Implications

Continuous integral debridement

Molecular confirmation that the dressing keeps working between visits — the adjunctive half of integral debridement, not just a cover

Inflammation offloading

Sequestering immunoglobulins, complement, and leukocyte proteins may help de-escalate the chronic inflammatory loop of the stalled wound

Bioburden removal plus silver

Bacterial material is removed with the dressing, while the TLC-Ag layer exerts antimicrobial action within it

Wound bed preparation

Fits the T of the TIME framework — tissue management — now with objective molecular evidence of what is being removed

Limitations and Next Steps

- Descriptive capture study: the proteomics shows what the dressing bound and removed; charge-mediated affinity is the mechanistic rationale, demonstrated here by outcome rather than by a direct binding assay
- No paired wound bed biopsies and no comparator dressing in this dataset — relative capture efficiency vs other dressings is not yet quantified
- Small, unbalanced cohort (7 VLU / 3 non-VLU) and a single 1-wk timepoint
- Protein abundance on the dressing reflects both wound supply and fiber affinity; the two are not fully separable without controls
- Charge-density and pH-drop comparisons cited here are manufacturer data on file, not peer-reviewed

References

- Mayer DO, et al. Wound debridement: consensus document. *J Wound Care*. 2024;33(Suppl C):S2–S29.
- International Wound Infection Institute (IWII). Wound Infection in Clinical Practice: Principles of Best Practice. 2022.
- Kalan L, et al. Slough composition, analysis and effect on healing. *Wounds Int*. 2023.
- Townsend EC, et al. *Wound Repair Regen*. 2024;32(6):783–798.
- Reinboldt-Jockenhöfer F, et al. *J Wound Care*. 2025;34(4):261–270.
- Percival SL, et al. *Wound Repair Regen*. 2014;22(2):174–186.
- Sim P, et al. *Int J Mol Sci*. 2022;23(21):13655.
- Rahmani V, et al. *Eur J Pharm Biopharm*. 2017;117:232–243.
- Morozkina S, et al. *Polymers* (Basel). 2022;14(17):3604.
- Meaume S, et al. *J Wound Care*. 2014;23(3):105–116.
- Proteomic analysis report: MtoZ Biolabs, Project MtoZ-MZJL0212202602, commissioned by Ethos CRO, July 2026.
- Charge-density and pH-drop comparisons: manufacturer data on file.

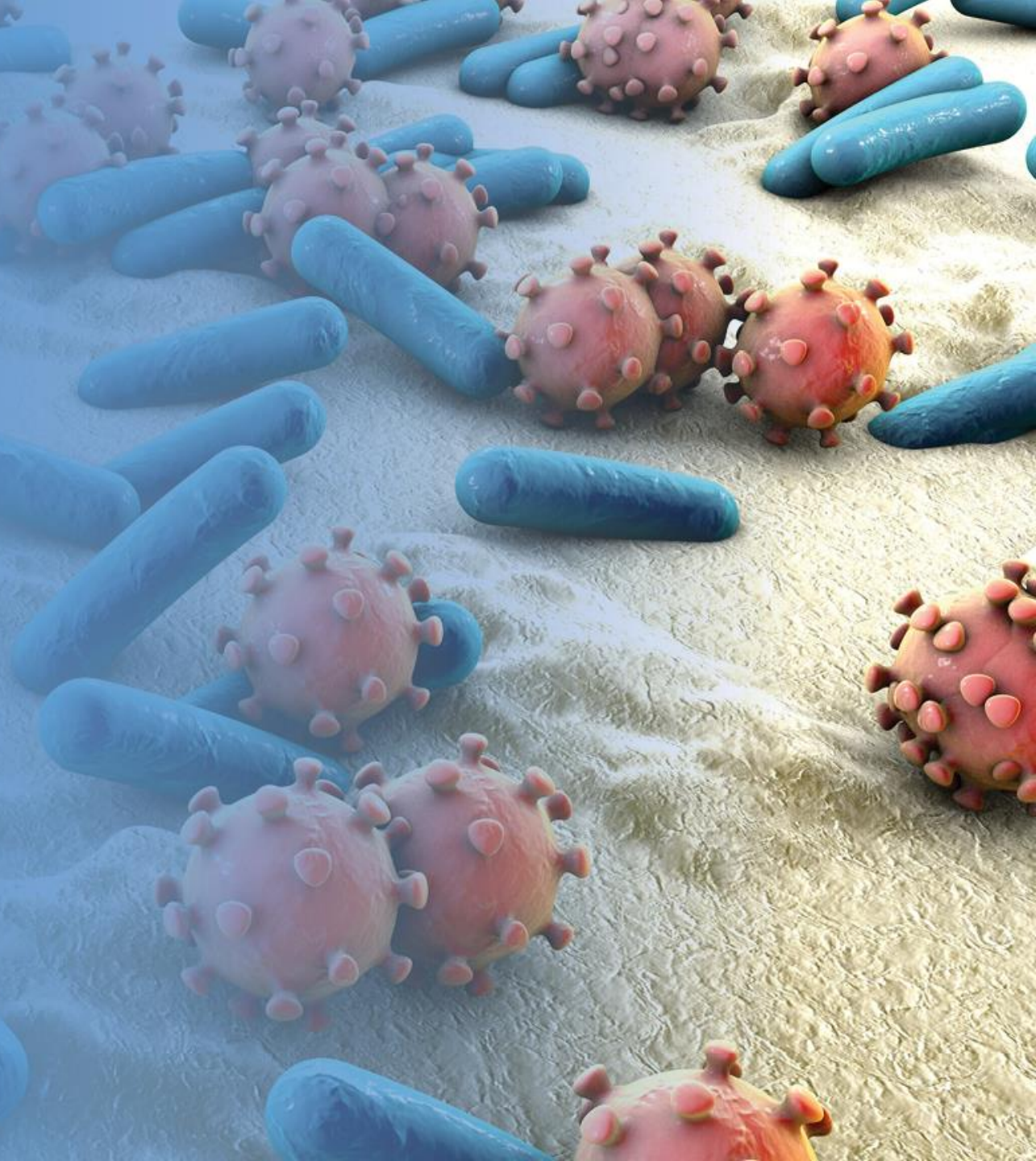


Combining Therapies to Optimize Clinical Outcomes

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Plastic and Reconstructive Surgery, Wound Care, Hyperbaric Medicine
Abrazo Arrowhead Hospital and Wound Clinic
Glendale, AZ

Definition: Slough is a layer of soft, dead tissue that forms over a wound. It looks yellow, tan, gray, or white and often feels wet or stringy. It is made of dead cells, white blood cells, and protein. Slough stops a wound from healing and can trap germs. Doctors often remove it to help new skin grow.
(AI-generated)

Clinical importance: Distinguishing between “stuff,” not slough.....



Debridement: An Essential Component of Wound Bed Preparation

Sharp vs other...



Types of Debridement





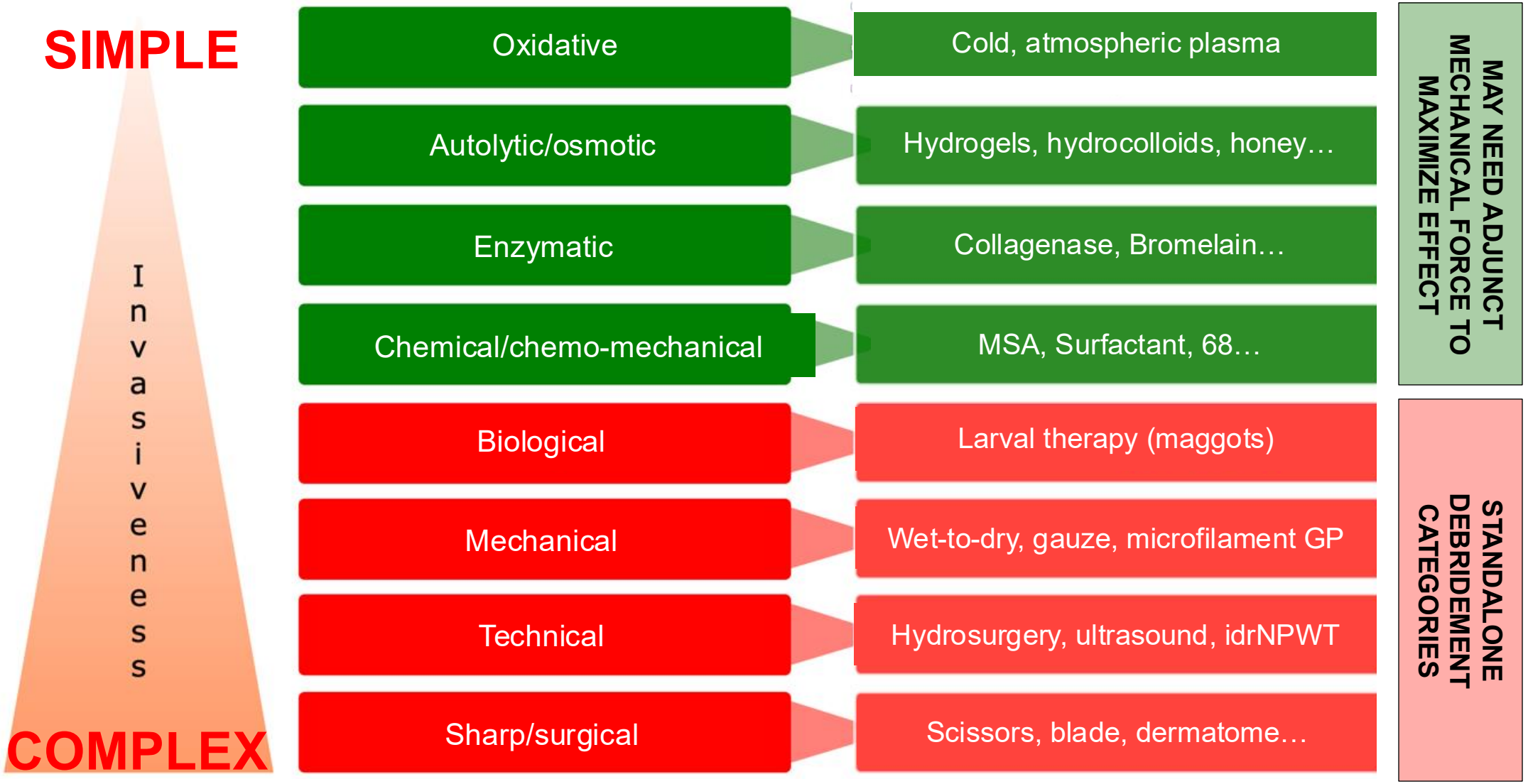








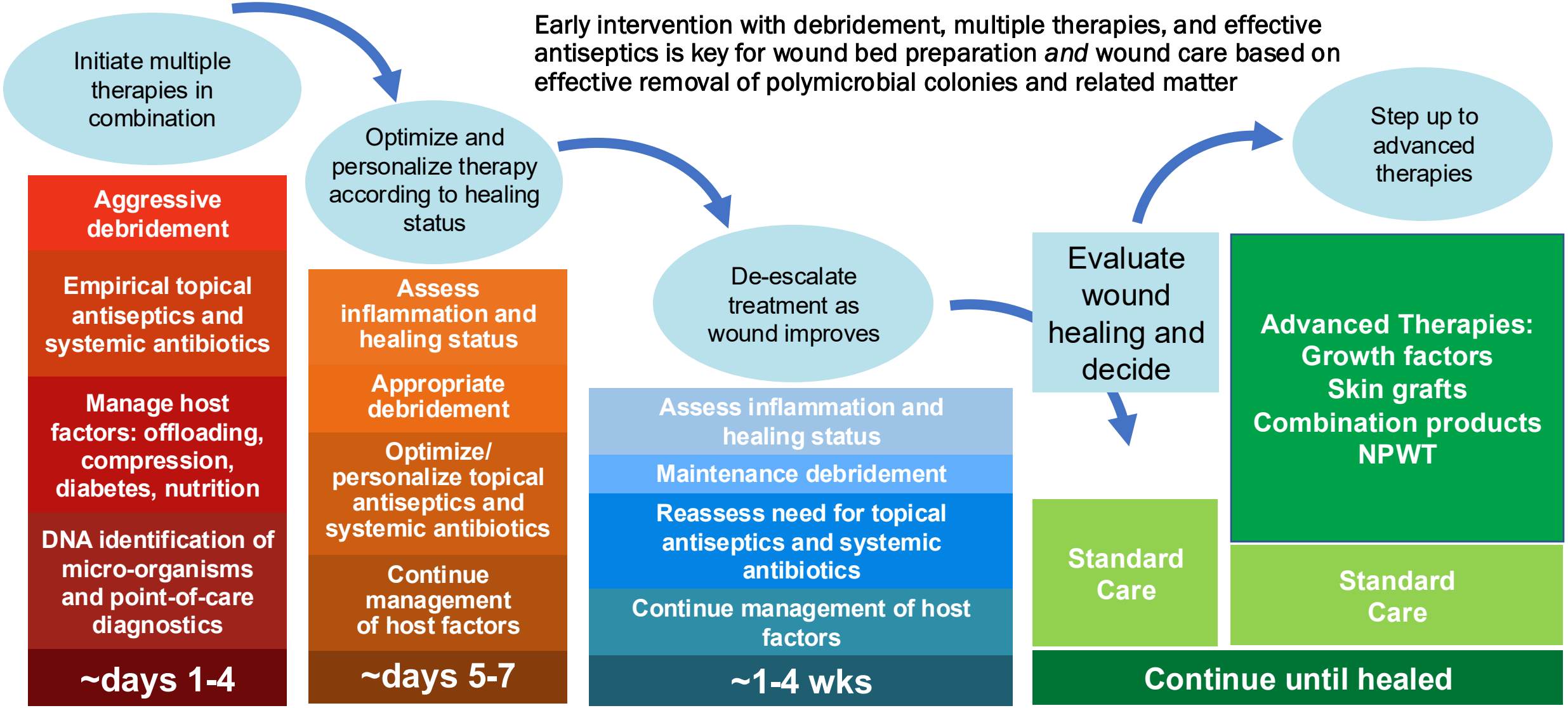
Complexity of Wound Debridement Procedures



Mayer D, et al. *J Wound Care*. 2024;33(Supp6b).

Step-Down then Step-Up Treatment Strategy

Early intervention with debridement, multiple therapies, and effective antiseptics is key for wound bed preparation *and* wound care based on effective removal of polymicrobial colonies and related matter



Schultz G, et al. *Wound Repair Regen*. 2017;25(5):744-757.

The Need for Debridement Options

Current State

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

Clinician Wants

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

Market

Evolutionary

vs

Revolutionary

Microbial Colonies and Associated Debris Begin to Re-Form 24 Hours after Debridement

- “Slough or necrotic tissue can promote bacterial growth…[and] prevent the formation of granulation tissue, and subsequent re-epithelialisation, and interfere with wound contraction” (IWII)
- “More frequent debridement was associated with improved healing. Wounds that were debrided weekly or more frequently were over four times more likely to heal than wounds receiving debridement less often than weekly” (EPUAP, NPIAP, PPPIA)
- “Autolytic debridement… is insufficient to meet the debridement requirements of wound hygiene, as it takes a long time to occur, requires numerous dressing changes and can increase the risk of infection in hard-to-heal wounds” (JWC International Consensus Document)



Schultz G, et al. *Wound Repair Regen*. 2017;25:744-757.

Continuous Debridement of Slough Is Needed

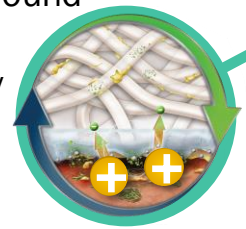
1. **Must be effective**
   Continuously remove slough and wound debris and mitigate re-formation of microbial colonies post-sharp debridement

2. **Must be accessible**
   All caregivers can incorporate sharp debridement throughout the continuum of care

3. **Must be easy and comfortable**
   Easy to use by healthcare providers and well tolerated by patients

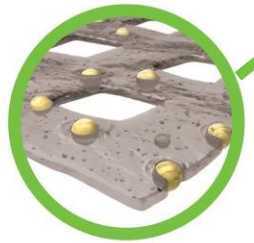
Charged fibers support the continuous debridement of slough

- 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



Antimicrobial

- Fast, broad-spectrum, antimicrobial-barrier efficacy
- Antimicrobial layers impregnated with silver (TLC-Ag healing matrix) promote healing and atraumatic, pain-free removal





Lazareth I, et al. *Wounds.* 2008;20(6):158-166. Dissemond J, et al. *J Wound Care.* 2020;29(3):162-173. Desroche N, et al. Characterization of the antimicrobial spectrum and anti-biofilm activity of a new silver-containing dressing with poly-absorbent fibres and antimicrobial silver matrix. Poster EWMA, May 2016. Percival SL, et al. *J WoundCare.* 2015;24(11):498, 500-503, 506-510.

How Do Charged Fibers Work?

Biomaterials behave in predictable ways within complex tissue environments

- Steric exclusion
- Hydrophobic interactions
- Hydrogen bonds
- Fibers have a high attraction to positively-charged fibers
- Electrostatic interactions



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

Current Debridement Options Have Limits



Sharp Debridement: "The Gold Standard"

- Painful, may require anesthesia
- No tissue selectivity; cannot remove everything
- Limited in scope; not all wounds qualify
- Stops at the scalpel

"Wounds… debrided weekly or more frequently were over 4x more likely to heal than wounds receiving debridement less often than weekly"

Traditional Autolytic Debridement (alginates, hydrocolloids, and similar)

- Slow-acting, requires frequent changing
- Depends on healthy immune system and moisture balance
- Increased risk of infection and/or maceration
- Can damage healthy tissue and be painful

Mechanical Debridement

- Non-selective
- Benefits are only during removal or manipulation
- Can be painful

Enzymatic Debridement

- Requires frequent application
- Requires prescription
- Can be costly

Despite multiple debridement options, slough and microbial colonies are outperforming current debridement options

- Remove slough and necrotic tissue
- Reduce signs of local infection
- Promote healthy granulation tissue
- Improve vascularization



Post-sharp debridement



Next appointment

Consensus Guidelines Agree:
Standalone Debridement Is Not Enough

Microbial colonies and associated debris begin to re-form within 24 hrs after debridement

- "Slough or necrotic tissue can promote bacterial growth…[and] prevent the formation of granulation tissue, and subsequent re-epithelialisation, and interfere with wound contraction" (IWII)
- "Many patients have issues with reoccurring slough and require ongoing debridement to promote healing… it may be necessary to use more than one method of debridement"
- "International guidelines now recommend *integral debridement*, which combines complementary methods of debridement"



Approximately 60% of patient wounds are <u>not debrided enough</u>

Schultz G, et al. *Wound Repair Regen*. 2017;25:744-757.

Integral Debridement



1. It takes a **holistic** and **complete** approach
2. It also allows for a **tailored** and **patient-centric** approach to wound care that highlights the need to **consider patient comfort** and preferences when selecting a debridement method
3. This concept can **help bridge limitations** in the **health professional's scope of practice** and knowledge base, potentially enabling **more effective outcomes**

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

Why Do We Care so Much about Slough?

Think of devitalized tissue and slough like weeds in a garden

- Just as weeds take up space and nutrients, preventing healthy plants from growing, devitalized tissue harbors bacteria and microbial colonies, blocking healthy tissue from forming
- Weeds attract pests and disease, just like devitalized tissue supports microbial adhesion and infection
- Regularly removing weeds helps plants thrive, just as continuous debridement of slough promotes wound healing by creating a clean environment for new tissue to grow
- In both cases, removing the unwanted material is key to fostering healthy growth



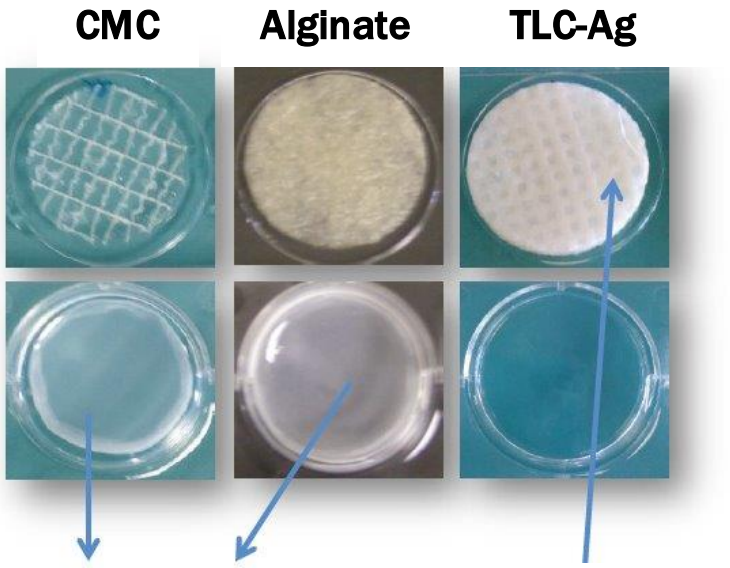
How Strong Is the Charge

Dressing fiber type	Negative charge (mmol / 10×10cm)
Negatively-charged fiber dressing	**4.30**
CMC gel dressing	0.26
Polyvinyl alcohol (PVA) dressing	0.16
Alginate dressing A	0.09
Alginate dressing B	0.07

16x **higher charge density than the CMC comparator — more binding sites per square inch of dressing**

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. SAWC Spring 2024, May 14-17, 2024, in Orlando, FL.

TLC-Ag's Adherence to Slough

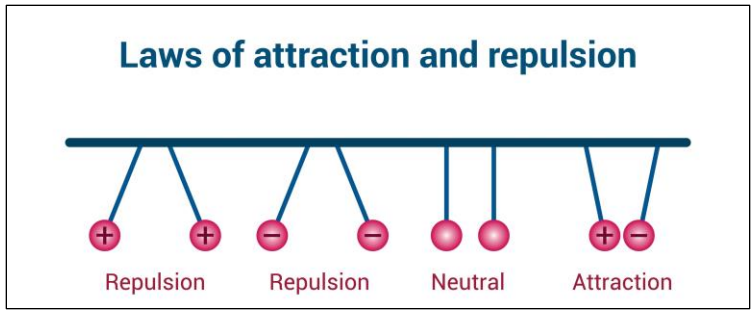


Study	Product	Sloughy Tissue, Day 0	Relative Slough Reduction, Wk 2	Relative Slough Reduction, Wk 4	Wound Surface, Day 0	Duration, Day 0	Year
Thetis Ag N=36	UrgoClean Ag	68%	-38%	-62%	8.1 cm^2	6 months	2013
Earth N=74	Aquacel	80%	-25%	-35%	7 cm^2	11 months	2011
Clouds N=28	Aquacel Extra	70%	-23%	-46%	9 cm^2	7 months	2011

Mechanism of Action

Charged Fibers

Binds, traps, and removes slough, exudate, bacterial residues, and other wound debris



TLC-Ag Matrix

In contact with the wound, the TLC-Ag dressing matrix forms a ***biofriendly*** gel ***which supports*** debridement ***while*** ensuring atraumatic, pain-free removal.

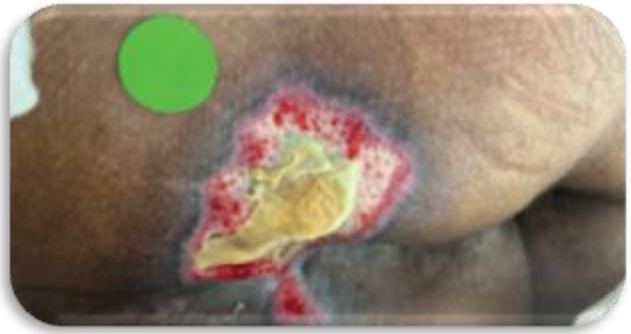


When to Use Negatively-Charged Fiber Dressings

- Post sharp debridement wounds



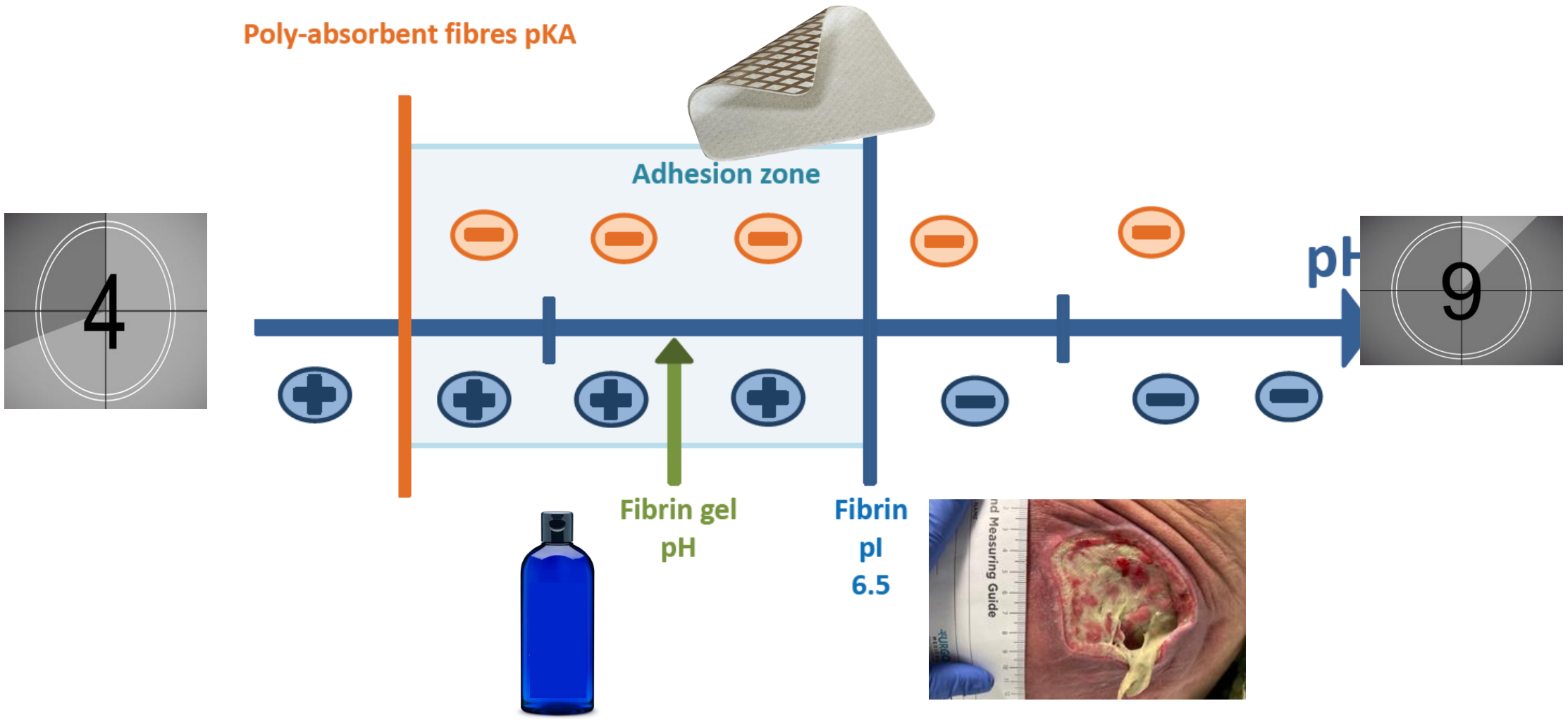
- Sloughy wounds



- Wounds that cannot be sharply debrided



Synergy between HOCl and Negative Fibers



Clinical Experience



Case: Skin Necrosis Following IV Infiltration

68y Female with multiple comorbidities, including DM, HTN, ESRD ,admitted with sepsis;
IV infiltration of norepinephrine bitartrate resulting in deep partial-thickness skin necrosis



Day 1



Day 5



Day 10

DM = diabetes mellitus; HTN = hypertension; ESRD = end-stage renal disease.

Case Summary

- 59y Male with longstanding venous stasis ulcers declined surgical intervention; requires continuous debridement to allow for wound progression
- Medical history: Obesity, HTN
- Treatment:
  - Excisional debridement in office
  - Negatively-charged dense fibers initiated to expedite debridement
  - Transitioned to NPWT followed by CAMPs application

NPWT = negative pressure wound therapy; CAMPs = cellular, acellular, and matrix-like products.

Venous Stasis Ulcers (Day 1)





LLE venous ulcer with slough and heavy exudate

LLE = left lower extremity.

Venous Stasis Ulcers (3 Months)





LLE venous ulcer reduced in size, slough, and exudate

Venous Stasis Ulcers (6 Months)





LLE venous ulcer with increased re-epithelialization

Case Summary: Right Hip Ulcer, Stage 4

- 77y Female with spina bifida who is ambulatory with a walker presents with a right hip ulcer from soft-tissue trauma; patient prefers non-surgical intervention
- Medical history: No CAD, DM, HTN
- Social History: Lives at home with husband
- Treatment:
  - Excisional debridement performed
  - Negatively-charged dense fibers initiated to expedite debridement

CAD = coronary artery disease.

Right Hip Ulcer, Stage 4 (Day 1)





Right Hip Ulcer, Stage 4 (Day 1)







Right Hip Ulcer, Stage 4 (1 Wk)





Right Hip Ulcer, Stage 4 (3 Wks)





Right Hip Ulcer, Stage 4 (3 Wks)





- Pressure ulcer with sufficient reduction slough and exudate
- Excisional debridement performed prior to adipose matrix grafting

Case Summary: Scalp Reconstruction

- 79y Male, h/o SCCA scalp s/p XRT 2 months ago; admitted with acute infection and bone exposed
- Medical history: No CAD, DM, HTN
- Treatment:
  - Admitted to hospital for acute infection
  - IV antibiotics and bedside debridements performed
  - Negatively-charged dense fibers initiated to expedite debridement
  - Taken to OR for debridement and reconstruction
  - Placental allograft placed to optimize and assist healing
  - Synthetic electrospun fiber matrix (SEFM) allograft placed as soft-tissue scaffolding over exposed bone
  - NPWT initiated immediately following matrix placement
- Outcome: Treatment ongoing; healing secondarily

SCCA = squamous cell cancer; XRT = external beam radiation therapy; SEFM = synthetic electrospun fiber matrix.

Scalp Reconstruction (Day 0)





Scalp Reconstruction (Day 0)





Scalp Reconstruction (Day 0)





Scalp Reconstruction (Day 1)





Scalp Reconstruction (Day 1)





Scalp Reconstruction (Day 1)





Scalp Reconstruction (Day 1)





Scalp Reconstruction (Day 1)





Scalp Reconstruction (1 Wk)





Scalp Reconstruction (2 Wks)





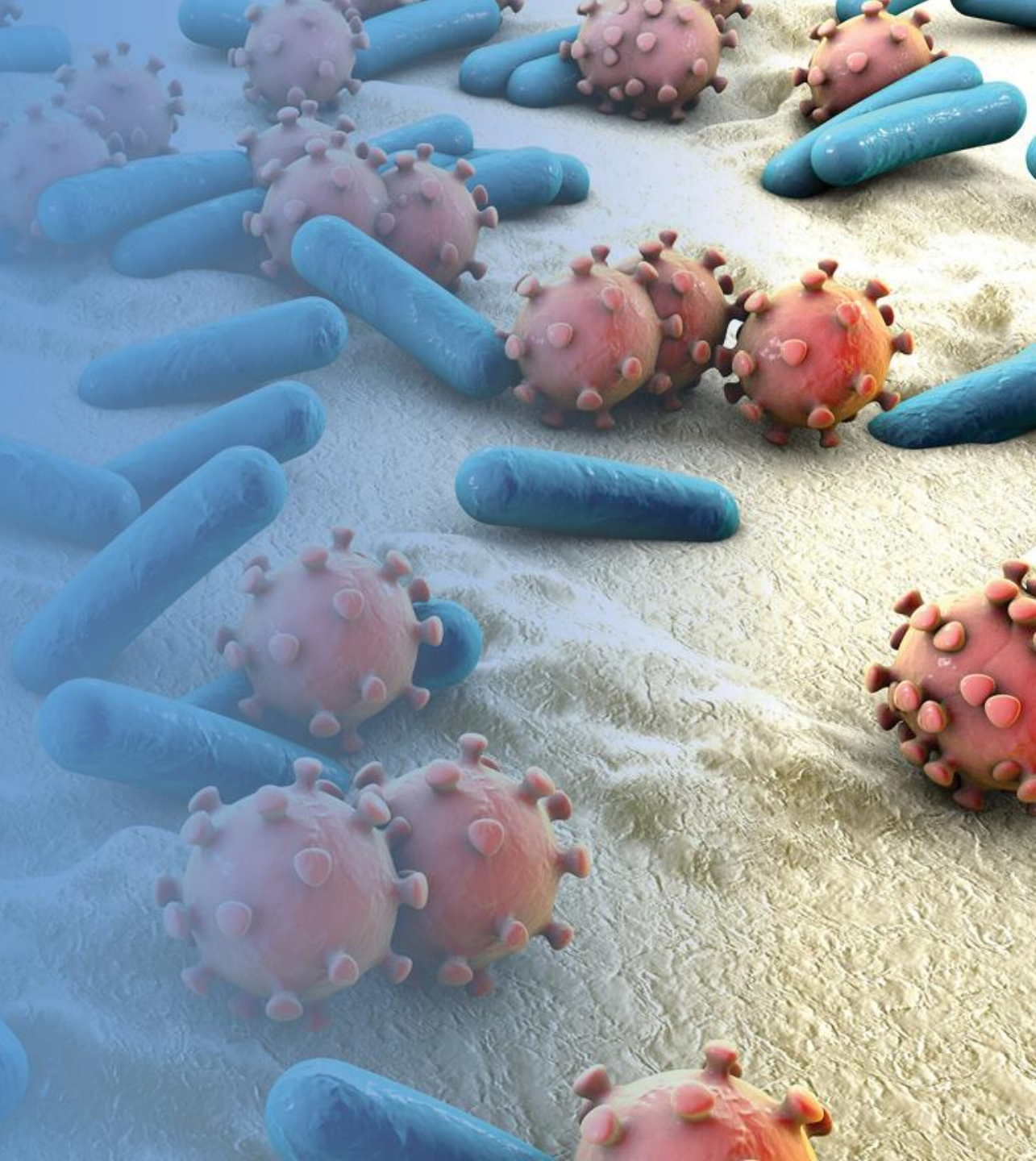
Scalp Reconstruction (3 Wks)





Definition: Slough is a layer of soft, dead tissue that forms over a wound. It looks yellow, tan, gray, or white and often feels wet or stringy. It is made of dead cells, white blood cells, and protein. Slough stops a wound from healing and can trap germs. Doctors often remove it to help new skin grow.
(AI-generated)

Clinical importance: Distinguishing between “stuff,” not slough.....



Scalp Reconstruction (4 Wks)





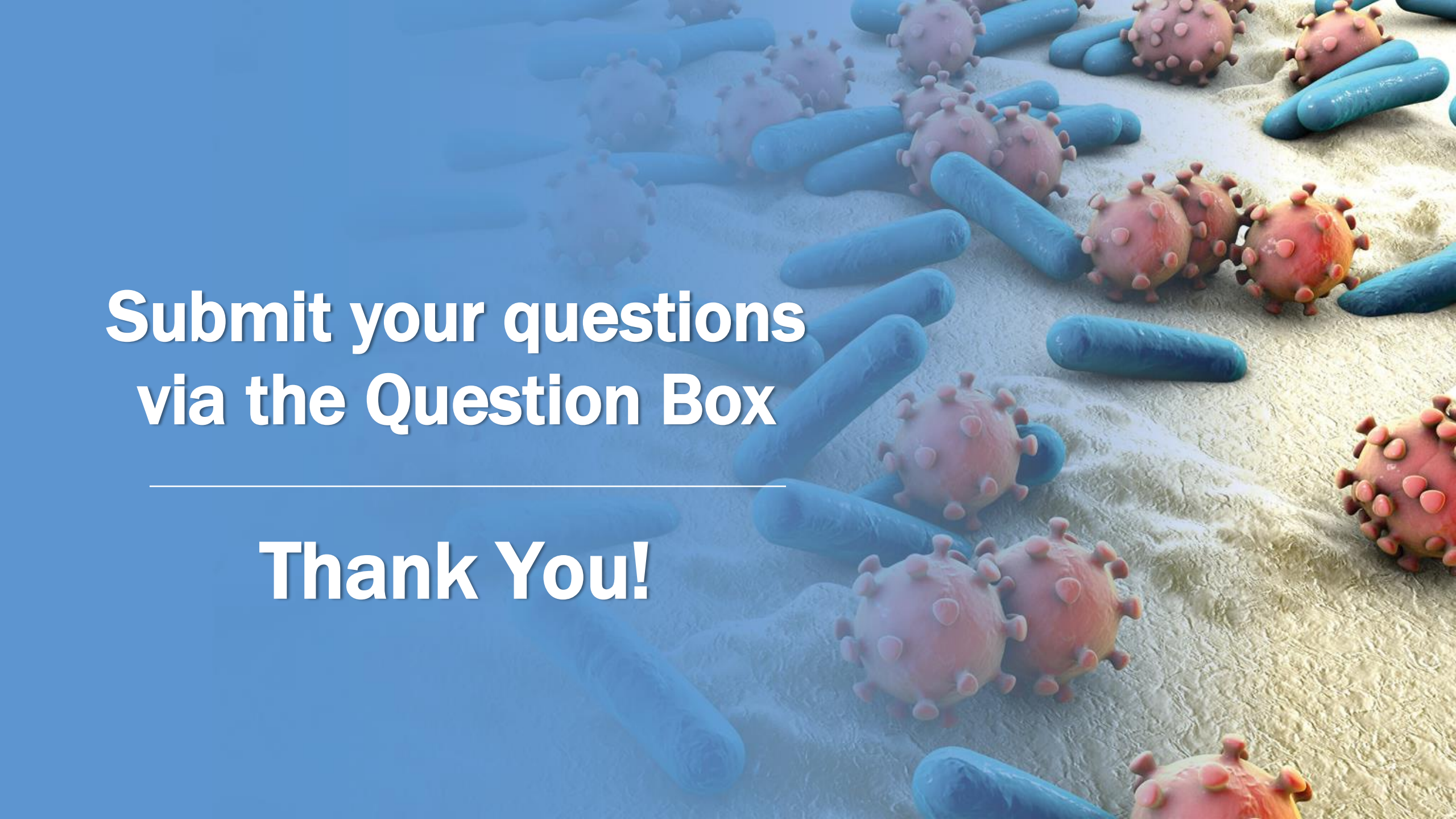
Scalp Reconstruction (6 Wks)





Summary

- Debridement is the cornerstone for wound bed preparation and reduction of bacterial burden to allow for wound healing
- There is a role for integral debridement with a variety of techniques to optimize patient outcome
- Negatively-charged fibers may assist in the removal of slough, bioburden, necrotic tissue, and associated debris that may lead to infection free in highly complex wounds/patients
- Combining technologies may lead to faster wound bed preparation in anticipation of surgical closure and or expedite healing secondarily



Submit your questions via the Question Box

Thank You!