Wound Infection Day:

From Guidelines to Frontlines of Infection Management

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Faculty Disclosures

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Consultant, Speakers Bureau: Integra LifeSciences; Organogenesis Inc.; Reapplix; Solventum, Medical Surgical Business; Urgo Medical NA

Sujay Dutta, MD, MS
Nothing to disclose in relation to this activity

Dot Weir, RN, CWON, CWS
Advisory Board: Urgo Medical NA; Consultant: Solventum, Medical Surgical Business; Speakers Bureau: LifeNet Health; Mölnlycke; Solventum, Medical Surgical Business; Urgo Medical NA; Other: Secretary, International Wound Infection Institute; Co-Chair, Symposium on Advanced Wound Care

Disclosures

Faculty have been informed of the 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 US Food and Drug Administration)

- Applicable CME staff have no relationships to disclose relating to the subject matter of this activity
- This activity has been independently reviewed for balance

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Learning Objectives

- Explain the patient-centric drivers of wound infection today
- Determine if there are gradations of contamination that can be agreed upon, categorize the levels of microbes in the wound, and differentiate modes of treatment for wounds contaminated at various levels
- Assess current techniques, in both inpatient and outpatient settings, to determine levels of contamination and identify which method to use and when
- Determine the relationship between slough removal and infection control
- Explain the role of antimicrobial agents and how to critically assess their efficacy in the management of bioburden
- Examine new and emerging technologies for slough/debris/microbe removal, including hypochlorous acid-based cleansers and charged fiber technology for physical removal of slough
- Explore illustrative case studies on wound infection/slough management and apply current strategies

Drivers of Wound Infection

Sujay Dutta, MD, MS
Center for Advanced Wound Healing
Thousand Oaks, CA

Part I: Elements that contribute to wound infection

Part II: Analysis and interpretation of wound culture results

Promoters of Wound Infection: Host Factors

1) Age
2) Diabetes mellitus: Multiple levels of effect, especially with poor glycemic control; measure and record hemoglobin A1c
3) Immunocompromised state: HIV infection, malnutrition, chemotherapy, medications (especially biologics)
4) Impaired circulation
5) Cigarette smoking

Wolny D, et al. *J Clin Med*. 2024;13(4):1003.

Promoters of Wound Infection:

Biofilms

Biofilms: 90% Chronic Wounds

- Complex communities of extracellular polymeric substances (EPS) provide protection from immune system and antibiotics
- Bacteria: Planktonic and active biofilm
- Fungi and bacteria
- Induce chronic inflammation
- Antibiotic-resistant phenotypes
- Regular debridement of chronic wounds restores healthier microbiome and stimulates acute inflammation

EPS = extracellular polymeric substances.

Cavallo I, et al. *Biology*. 2024;13(2):109. Attinger C, Wolcott R. *Adv Wound Care*. 2012;1(3):127-132.

Antibiotic Resistance

Challenging problem due to overuse of antibiotics

Biofilms promote antibiotic-resistant phenotypes

Complex relationship between different bacteria

Normal skin flora (eg, *Staph epidermitis*, anaerobes vs pathogenic bacteria, *Staph aureus, Pseudomonas*, etc)

Debridement of chronic wounds helps to restore healthier balance, at least temporarily

Use systemic antibiotics judiciously – risk vs benefits

Wound Culture vs PCR

- Wound culture is the classic method and still the standard
- Biopsy of tissue more valuable than swab
- Both can be sent for culture: Aerobic, anaerobic, fungal, and AFB (in the proper clinical setting)
- Culture results take up to 5 days (for routine bacterial), 4 wks for fungal cultures, and up to 6 wks for AFB (mycobacterial)
- Tissue biopsy can also be sent for pathology: Stains can be done by pathologist for the above

AFB = acid-fast bacilli.

Miller JM, et al. *Clin Infect Dis*. 2024 Mar 5:ciae104.

PCR Testing of Acute and Chronic Wounds

- PCR (polymerase chain reaction) employs primers of specific organism, which bind to DNA and are amplified and identified
- Can detect organisms at lower concentration than culture
- Results can be available within 24 hrs
- Quantitation is also available
- Less common organisms may not be detected as their primers were not in the test

Reddy M, et al. *JAMA*. 2012;307(6):605-611.

Wound Infection vs Colonization

Colonization: Organisms present and multiplying in wound without causing inflammatory response or tissue invasion

Local infection: Organisms multiplying and causing tissue invasion and inflammatory response from host

10^5 or greater organisms/gram of tissue = Infection

Variable host inflammatory response — clinician may not see signs of infection at this level

Look for increasing pain, periwound erythema, or stalled wound

Common Pathogens in Chronic Wounds

- Gram-positive shifts to gram-negative as wounds become more chronic
- *Staph aureus* (MSSA, MRSA), *Strep* species (especially group A or B) are very pathogenic — can lead to systemic infection and sepsis
- *Pseudomonas*, *Enterobacteriales* (*E. coli, Proteus, Klebsiella*, etc.) are common pathogens
- Chronic wounds are often polymicrobial — biofilms
- Bacteria within biofilms may have more resistant phenotypes
- Ideal sampling: Cleanse and debride, then obtain tissue

Clinical Pearls

- Obtain culture (or PCR) if signs of infection (including stalled wound healing)
- Chronic infection promotes chronic inflammatory state, prevents healing
- Obtain history about medications, including infectables and other immune suppressing or modulating medications
- Be aware of hardware or surgical material beneath chronic wounds
- Consider testing for anaerobes, AFB, and fungi
- Work as a team with fellow clinicians and laboratory staff

Addressing The Wound Environment

Dot Weir, RN, CWON, CWS
Holland Hospital Wound and Ostomy Clinic
Holland, MI

Defining Bioburden / Microbial Burden

- Microbial burden: Microbial burden is the number of microorganisms in a wound, the pathogenicity of which is influenced by microorganisms present (ie, species/strain), their growth, and their potential virulence mechanisms
- Degree of microbial contamination or microbial load; the number of microorganisms contaminating an object before sterilization
  - Assumed to be quantified relative to the object
- In wound management and wound healing, often a statement as to the presence of bacteria on a wound, as well as a qualitative descriptor of bacterial status of a wound
- As a result, it has also become a term used to document, and consequently rationalize and support, the use of various treatment alternatives

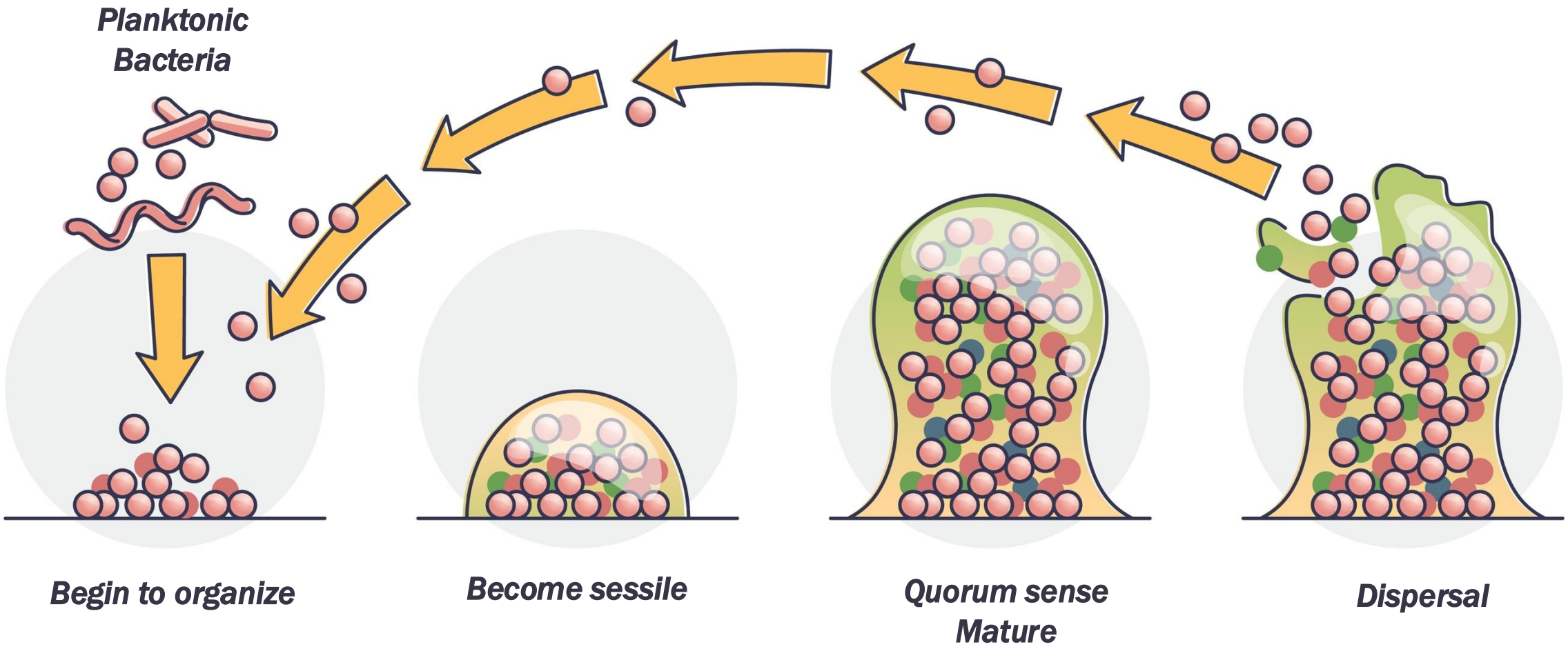
International Wound Infection Institute (IWII) Wound Infection in Clinical Practice. Wounds International. Published 2022. Accessed Sept 1, 2025. woundsinternational.com/consensus-documents/wound-infection-in-clinical-practice-principles-of-best-practice/ Stedman's Medical Dictionary. 28th Ed. 2013. Lippincott Williams & Wikins. Infection Control Today. Published May 22, 2024. Accessed Sept. 1, 2025. infectioncontroltoday.com/view/understanding-bioburden-critical-steps-ensuring-medical-device-safety Science Direct. Published 2016. Accessed Sept. 1, 2025. sciencedirect.com/topics/medicine-and-dentistry/bioburden

Bacteria and Biofilms

- Modes of bacterial growth
  - Planktonic
    - Free floating
    - Antibiotics and other antimicrobials can destroy more easily
    - Routine wound cultures reflect planktonic bacteria
  - Biofilms
    - Complex communities of microbes that adhere to solid surfaces
    - Embedded in an extracellular polymeric substance (EPS)

EPS = extracellular polymeric substance.

Biofilm Development



A paradigm to consider...

International Wound Infection Institute

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https://woundinfection-institute.com/agm/

WELCOME TO THE INTERNATIONAL WOUND INFECTION INSTITUTE

The International Wound Infection Institute is for health care professionals with an interest in wound infection

- Antiseptics – Susie Seamann
- Where does pathogenicity start & when do we commence topical treatment? – Trish Idensohn
- Biofilm update: New or paradigms and treatments – Thomas Bjarnsholt

Begins at 1:13:01 on video

Wound Healing Is Impeded By Metabolically Active Bacteria

- First longitudinal study characterizing presence of biofilm and rate of healing in chronic venous leg ulcers
- 117 patients
- No correlation of healing with biofilm score or bleach-tolerant bacteria
- Reduced healing with bleach-susceptible (metabolically active) bacteria

		p-value		
Parameter	Result	Healing slope	Healing versus non-healing	PAR
Biofilm microscopy score	No association in any test	0.25	0.15	0.19
Total viable bacteria	Less healing in 2 of 3 tests when more bacteria were present	0.94	0.012	0.012
Bleach-tolerant bacteria	No association in any test	0.053	0.97	0.69
Bleach-susceptible bacteria	Less healing in all tests when more bleach-susceptible bacteria were present	0.003	0.0012	0.004

Bleach = 0.1% sodium hypochlorite

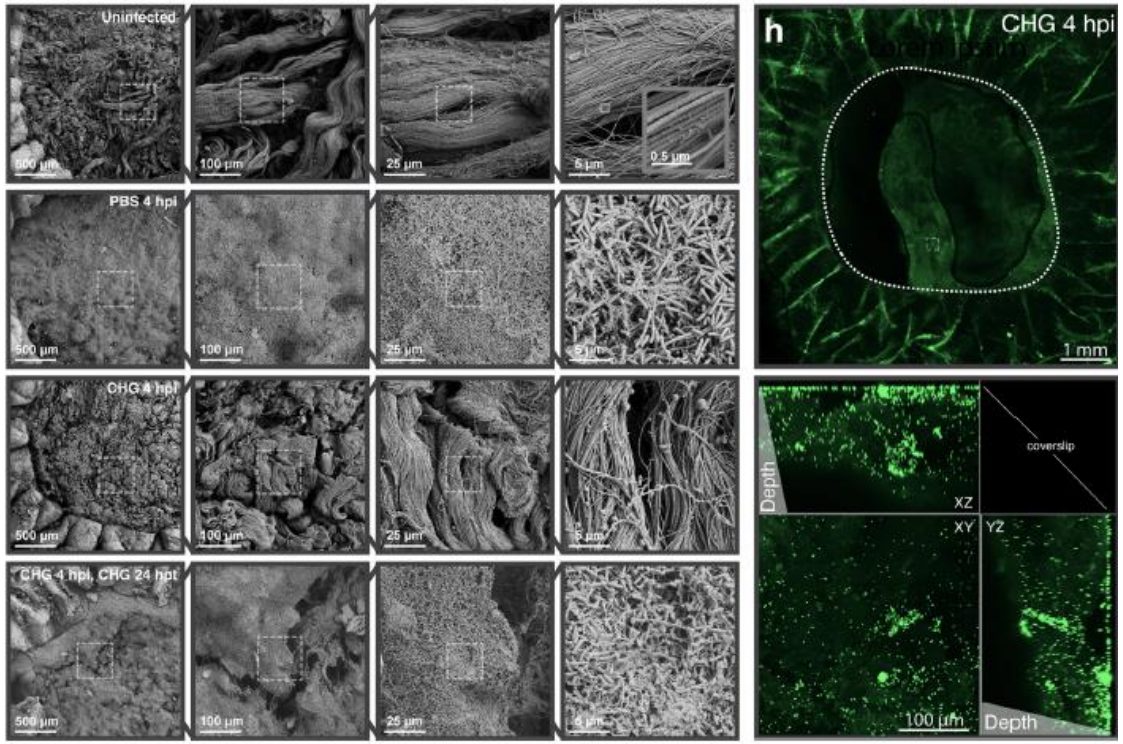
Stewart PS, et al. *Wound Repair Regen*. 2024;32(6):858-871.

Why Debridement Is Critical

WHS Fireside Chats

Scanning Electron Microscopy vs Confocal Laser Scanning Microscopy

Images compare different depths of infection

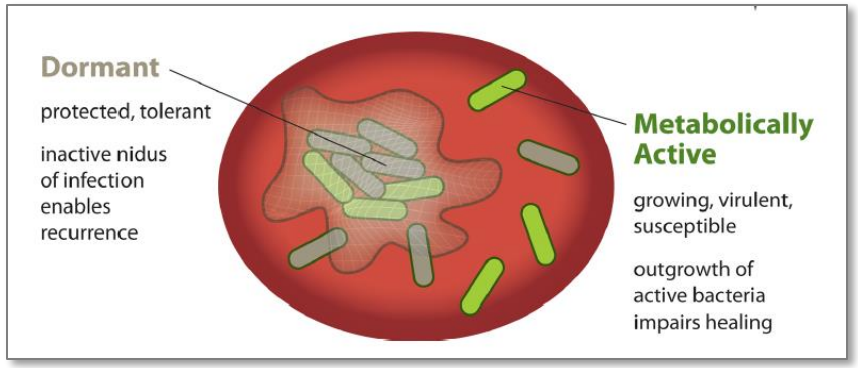


Identified reservoirs of *P. aeruginosa* in deep tissue not seen with SEM

Slide courtesy of Lisa Gould, MD, PhD
Cheong JZA, et al. *Wound Repair Regen*. 2022;30(5):573-584.

A Paradigm Shift and New Model: The Infectious Microenvironment

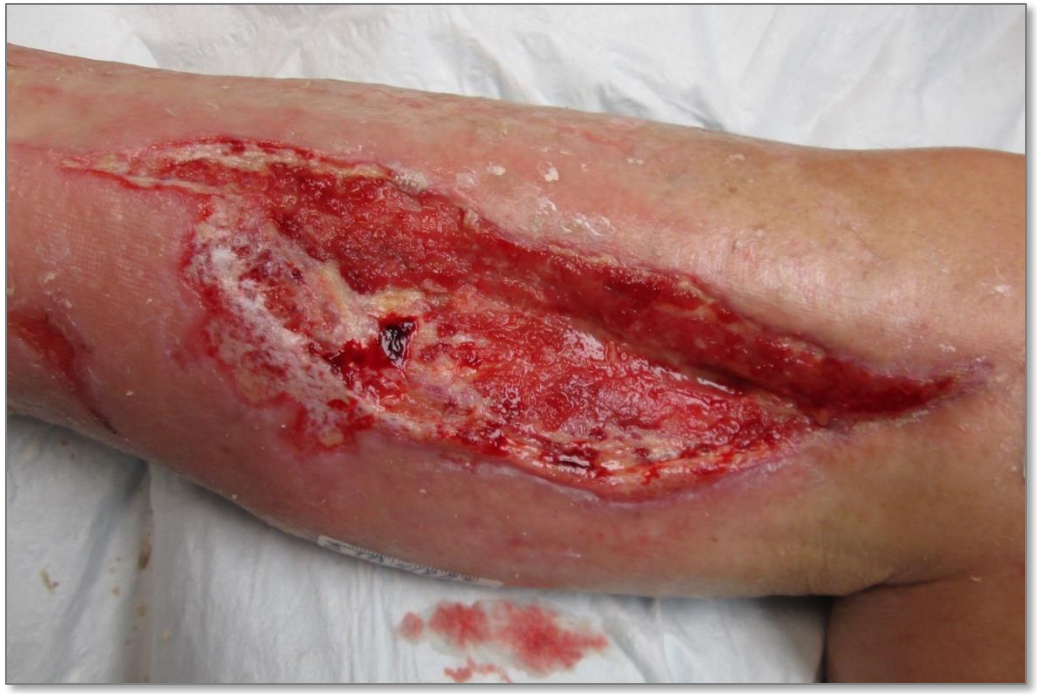
- Bacterial aggregation and biofilm is a phenotype, not the cause of bacterial persistence
  - Aggregate size can interfere with phagocytosis
- The trajectory of infections is controlled by the metabolism of the bacteria
- To understand wound infection, we must understand the infectious microenvironment
  - Bacterial metabolism
  - Inflammatory response
  - The metabolic signature of bacteria and host
- A new research goal is not to grow biofilms but to mimic the microenvironment



Stewart PS, et al. *Wound Repair Regen*. 2024;32(6):858-871.

Assessing Infection

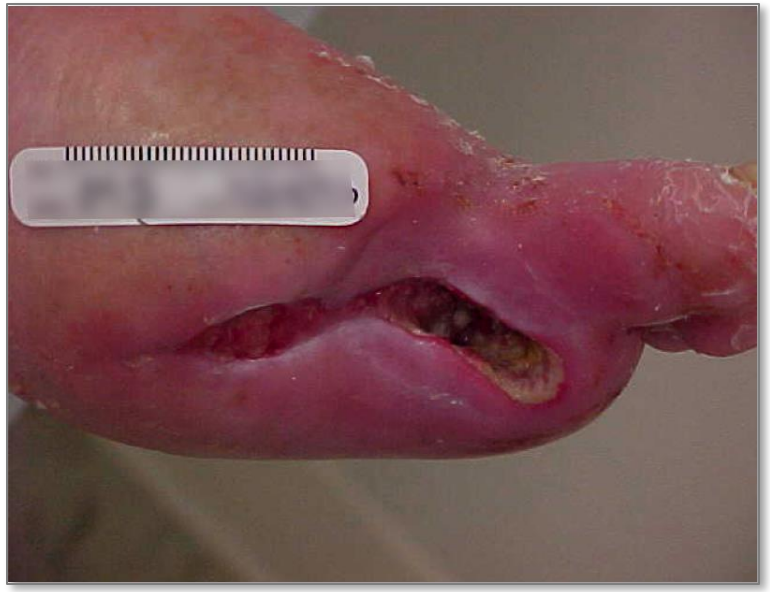
- The diagnosis of infection in a chronic wound is a clinical decision based on signs and symptoms of infection/prolonged non-healing
- The decision is made: antibiotics are prescribed empirically, and wound is debrided and cultured
- The wound culture then identifies the offending organism(s)



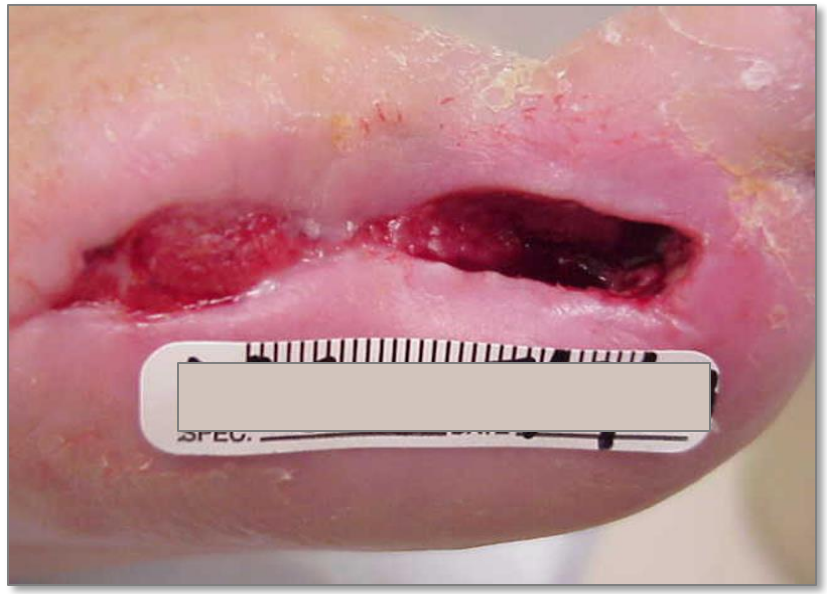
Stotts NA. Bioburden infection. In: Baranoski S, Ayello EA, eds. *Wound Care Essentials: Practice Principles*. 4th ed. Philadelphia, PA: Wolters Kluwer Health; 2015:93-119.

Infection: Clinical Picture

- Swelling
- Induration
- Erythema
- Warmth
- Pain
- Odor
- Increased drainage
- Listen to the patient….



5 days prior



IWII Wound Infection Continuum

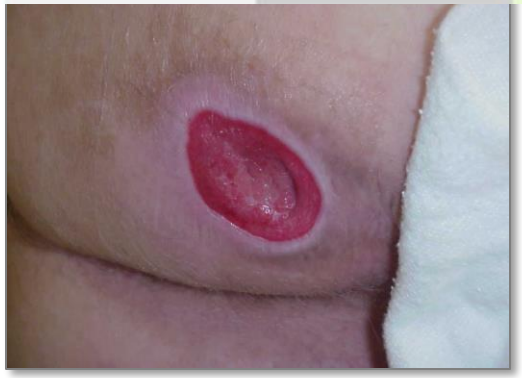
International Wound Infection Institute

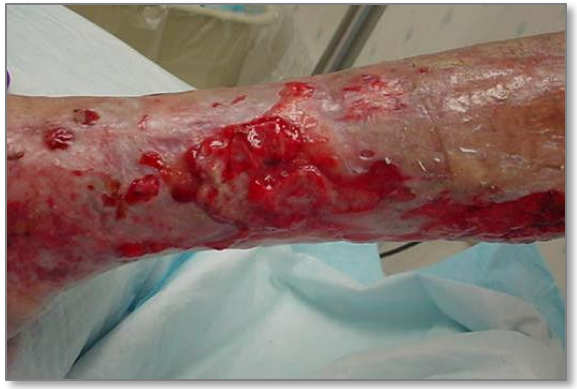
IWII WOUND INFECTION CONTINUUM AND MANAGEMENT GUIDE

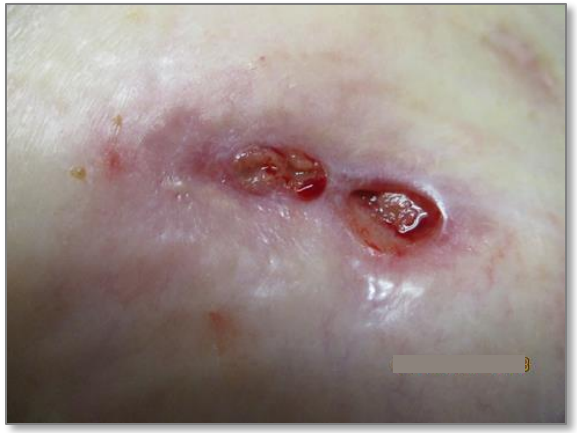
Increasing microbial burden in the wound

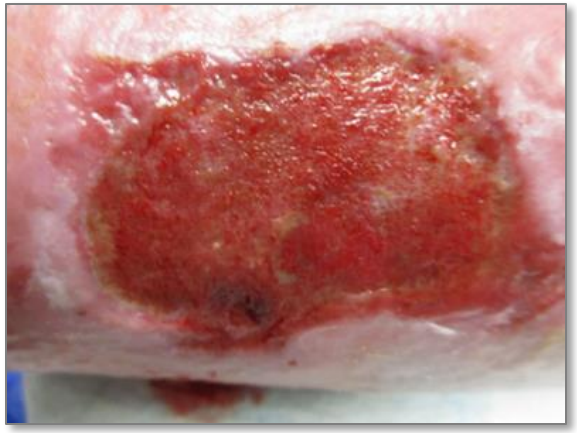
As the continuum green shading darkens, microbial burden increases

CONTAMINATION	COLONISATION	LOCAL WOUND INFECTION COVERT (subtle)	LOCAL WOUND INFECTION OVERT (classic)	SPREADING INFECTION	SYSTEMIC INFECTION
Assess for wound 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 • Lymphangitis • Crepitus • Wound breakdown/ dehiscence with or without satellite lesions • Inflammation, swelling of lymph glands	• Malaise • Lethargy or nonspecific general deterioration • Loss of appetite • Fever/pyrexia • Severe sepsis • Septic shock • Organ failure • Death









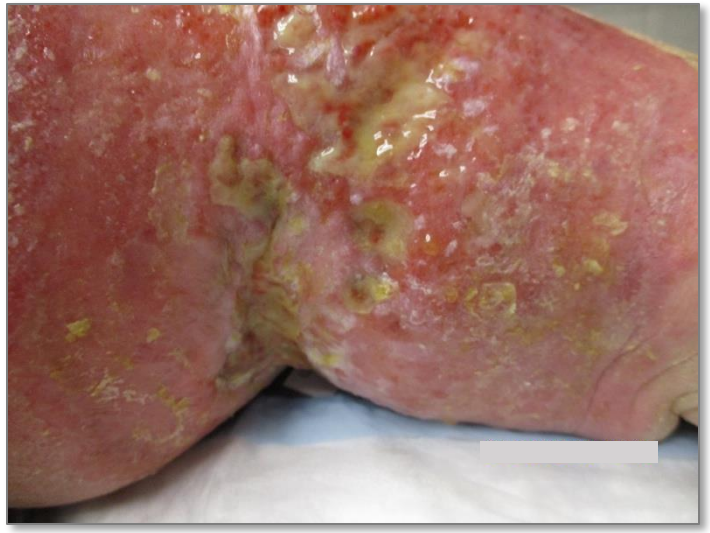
Signs of Covert/Local Infection

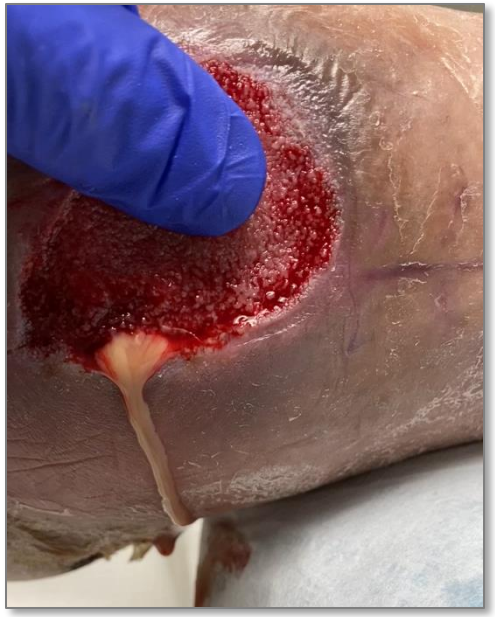
- Hypergranulation tissue
- Bleeding, friable granulation
- Epithelial bridging and pocketing in granulation tissue
- Wound breakdown and enlargement
- Delayed wound healing beyond expectations
- New or increasing pain
- Increasing odor

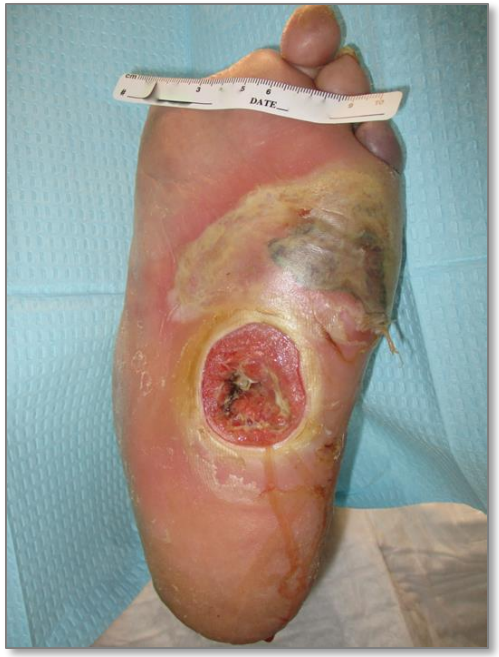
International Wound Infection Institute (IWII) Wound infection in clinical practice. *Wounds International*. 2022.

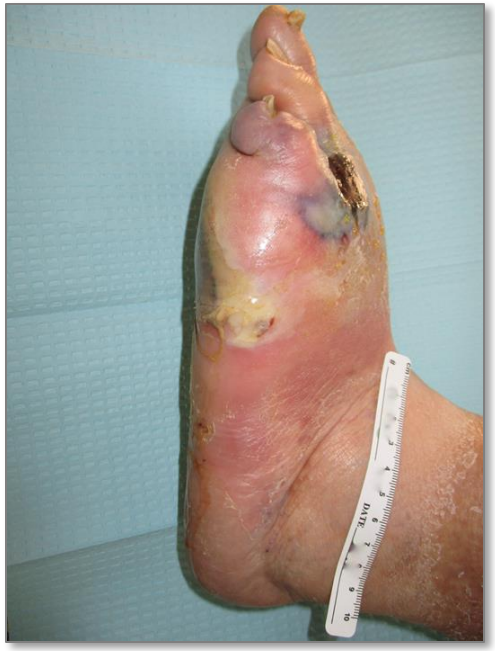
Signs of Overt Invasive Infection

- Erythema
- Local warmth
- Swelling
- Purulent +/or increasing drainage
- Delayed wound healing beyond expectations
- New or increasing pain
- Increasing malodor
- Cellulitis









International Wound Infection Institute (IWII) Wound infection in clinical practice. *Wounds International.* 2022.

CONTAMINATION	COLONISATION	LOCAL WOUND INFECTION COVERT (subtle) OVERT (classic)	SPREADING INFECTION	SYSTEMIC INFECTION
Initiate biofilm-based wound care when appropriate using step-down/step-up approach (see below)				
Perform therapeutic cleansing*				
• Select and use a wound cleansing solution based on resources and local policy • Use an inert cleansing solution prior to taking a wound sample • Cleanse the wound and periwound region				
			Confirm microorganisms and sensitivities	
			• Antibiotics as per culture sensitivities • Determine review dates	
		Debridement and post debridement care		
Debridement usually not required		• Use a topical antiseptic cleanser or surfactant soak • Initiation and method selected based on clinical need, goal, resources and local policy		
Apply a wound dressing				
• Select a wound dressing based on clinical assessment, goals of care, tissue type, exudate level, resources and local policy • Consider either a medicated/active wound dressing or a non-medicated wound dressing with antimicrobial action, consistent with local antimicrobial stewardship policy				
Following each review, document assessment and treatment, monitor progress and evaluate management				

International Wound Infection Institute

www.woundinfection-institute.

	HEALING	CONTAMINATION	COLONISATION	LOCAL WOUND INFECTION COVERT (subtle) OVERT (classic)	SPREADING INFECTION	SYSTEMIC INFECTION
PAIN	• Continual pain assessment: Remember the 3 As of pain management: Anticipate, Administer and Assess					
WOUND CLEANSING SOLUTION	• Inert solutions	• Inert solutions	• Inert solutions • High risk: surfactants and/or antiseptics	• Antiseptics • Surfactants • Inert solutions	• Antiseptics • Surfactants • Inert solutions	
WOUND CLEANSING INTENSITY	• Gentle	• Gentle to moderate	• Moderate/ rigorous	• Moderate to vigorous	• Vigorous	
WOUND CLEANSING TECHNIQUE	• Therapeutic cleansing • Irrigation • Soaks	• Therapeutic cleansing • Irrigation • Soaks • Compress • Swabbing • Scrubbing/mechanical action • Instillation • Hydroresponsive dressings				
CLEANSING EQUIPMENT	• Cleansing wipes/cloth • Irrigation equipment • Cleansing pad/microfilament pad • Gauze					
SKIN CLEANSING	• Mild skin cleanser with pH close to normal skin (4 to 5.5) • Cleansing wipes/cloths/gauze • Soaks, swabbing, scrubbing/mechanical action					

Therapeutic Wound Cleansing

Active removal of surface contaminants, loose debris, non-attached non-viable tissue, microorganisms, and/or remnants of previous dressings from the wound bed and periwound.

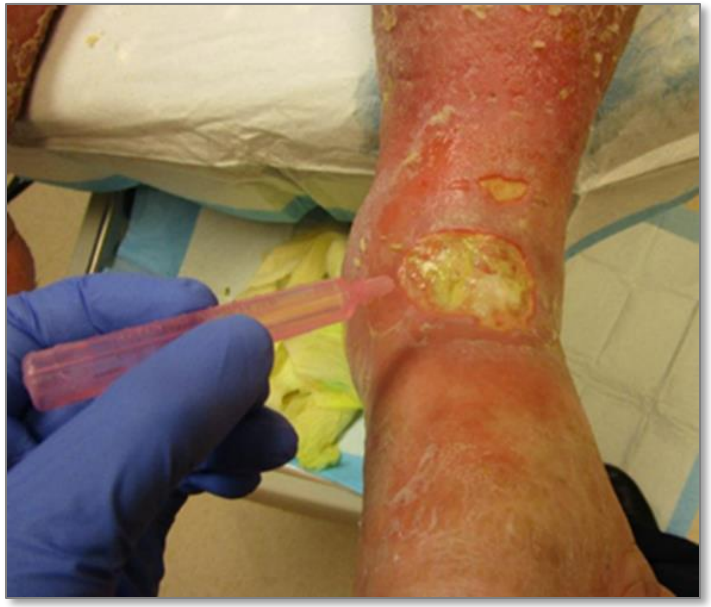
Therapeutically cleanse all wounds when the dressing is changed or removed.

*Underpinning evidence: modified Delphi process

Is There NON-Therapeutic Cleansing?

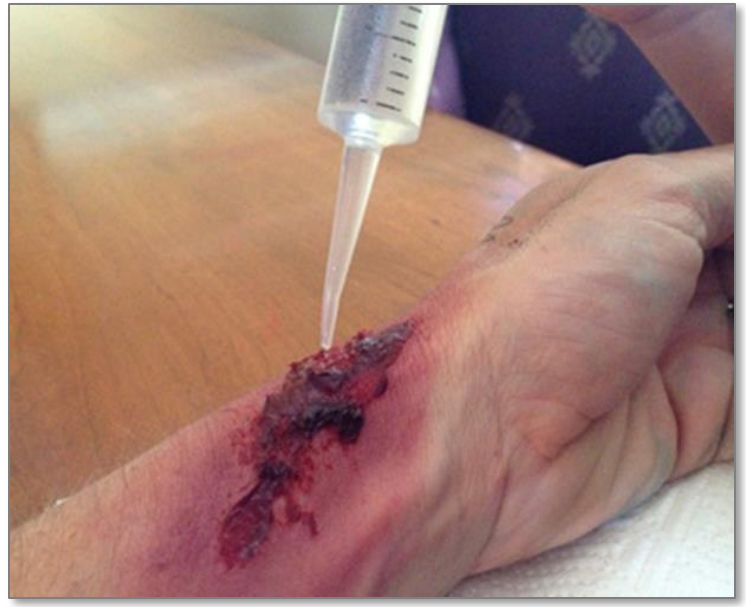
Emerging Evidence says

YES!



This is **not** cleansing.

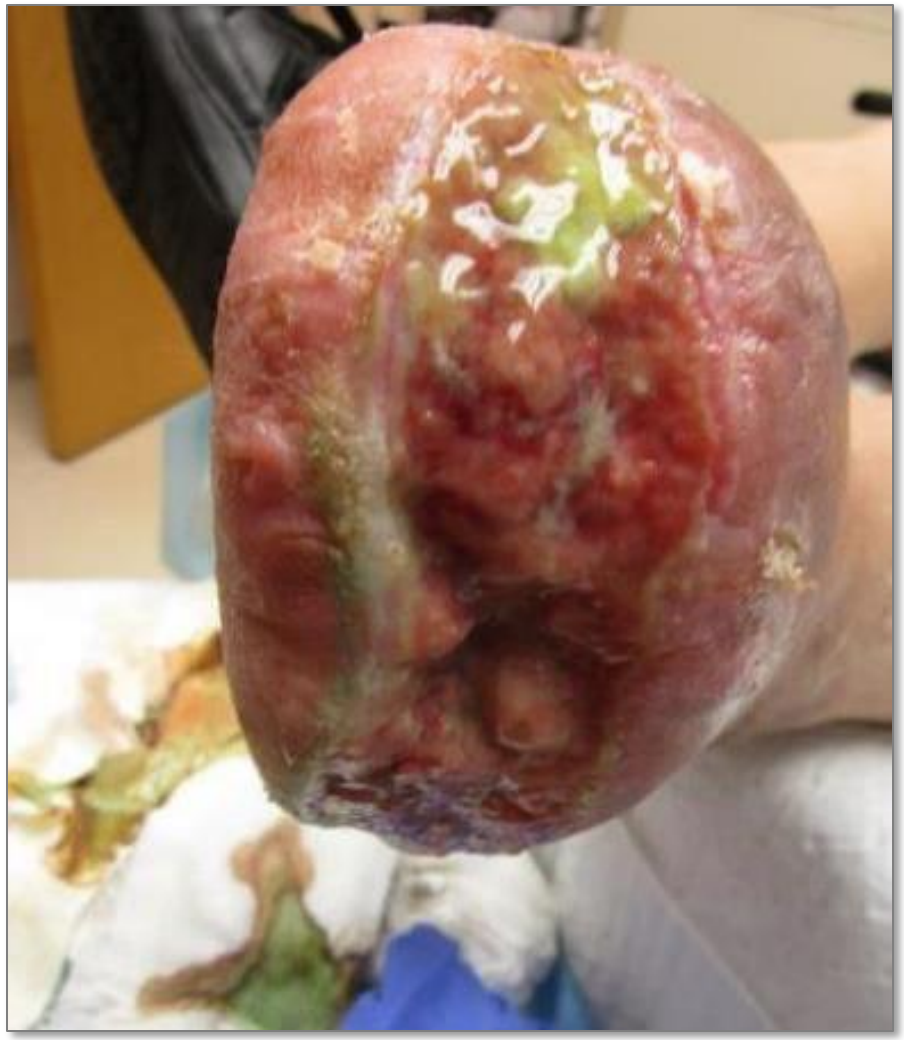
Anointing
Dabbling
Spritzing
Spraying



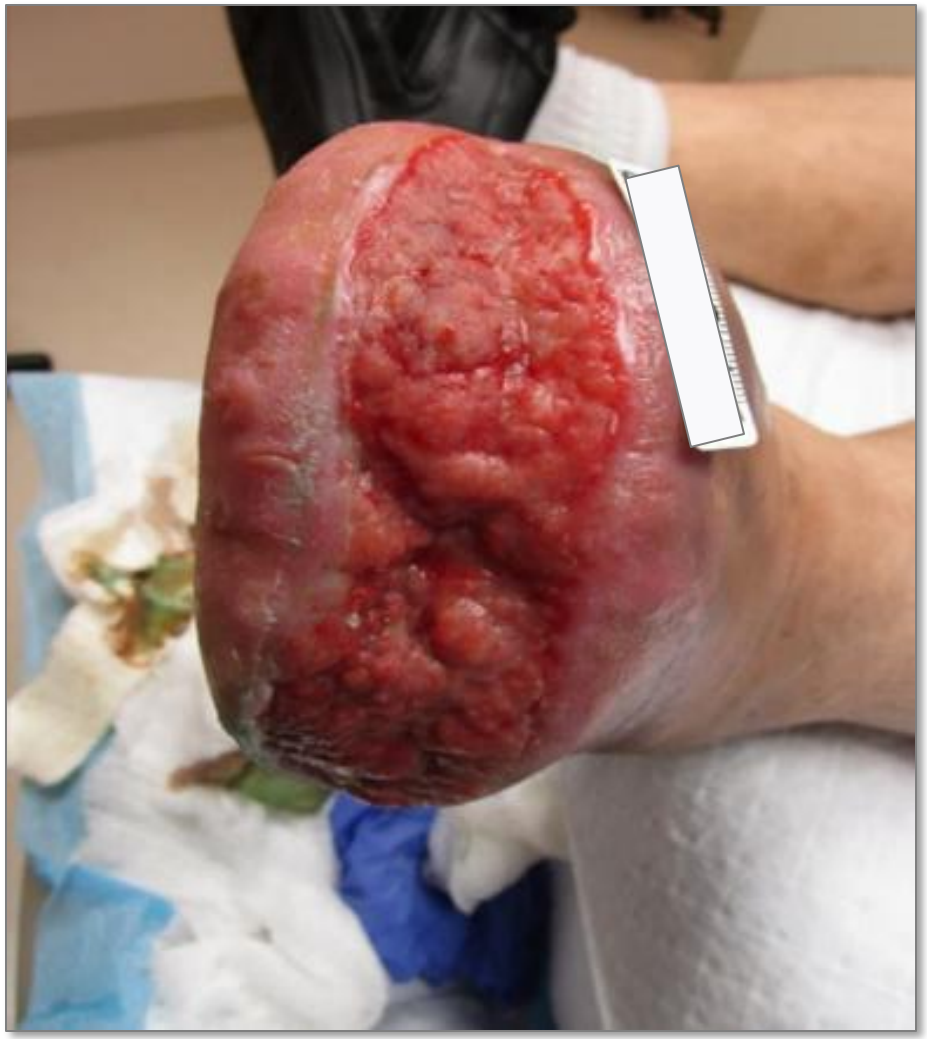
"Stop anointing wounds."
- Terry Swanson

"Clean it like you mean it."
- Dot Weir

Therapeutic Cleansing Is Visible

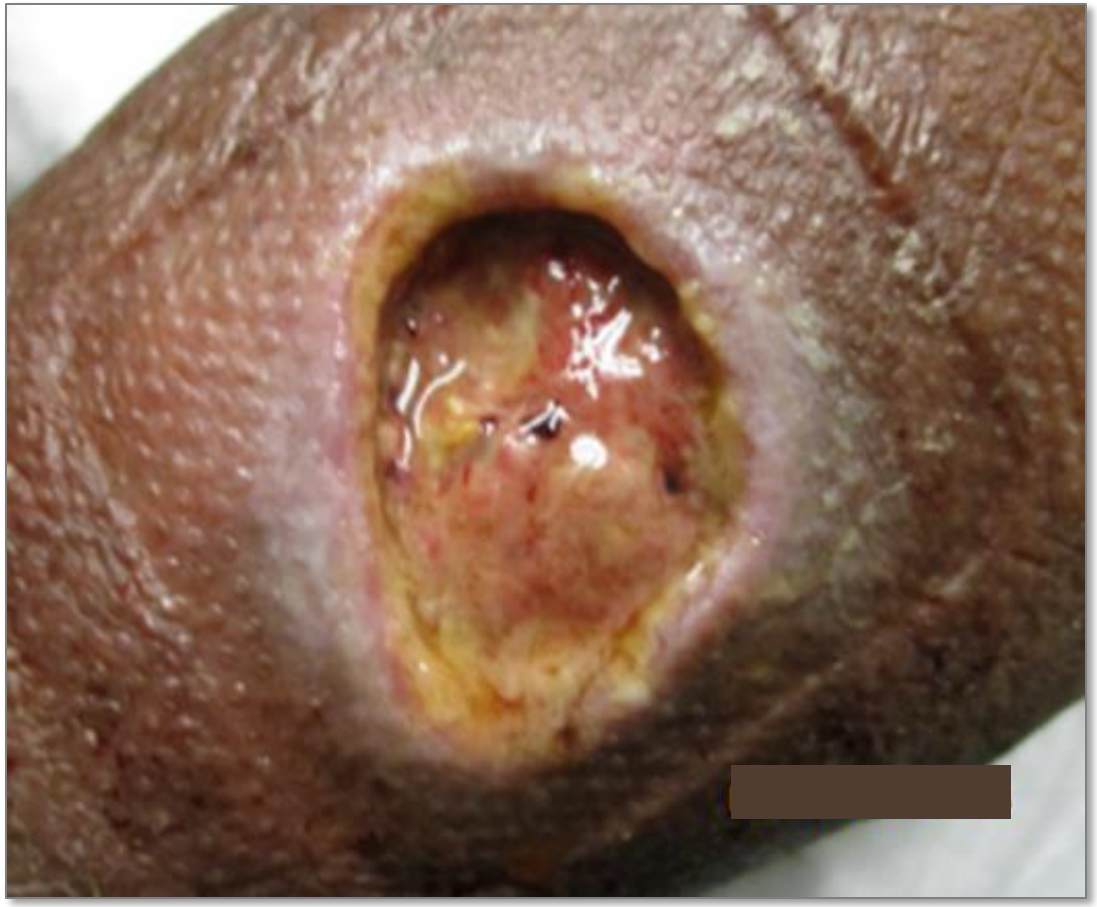


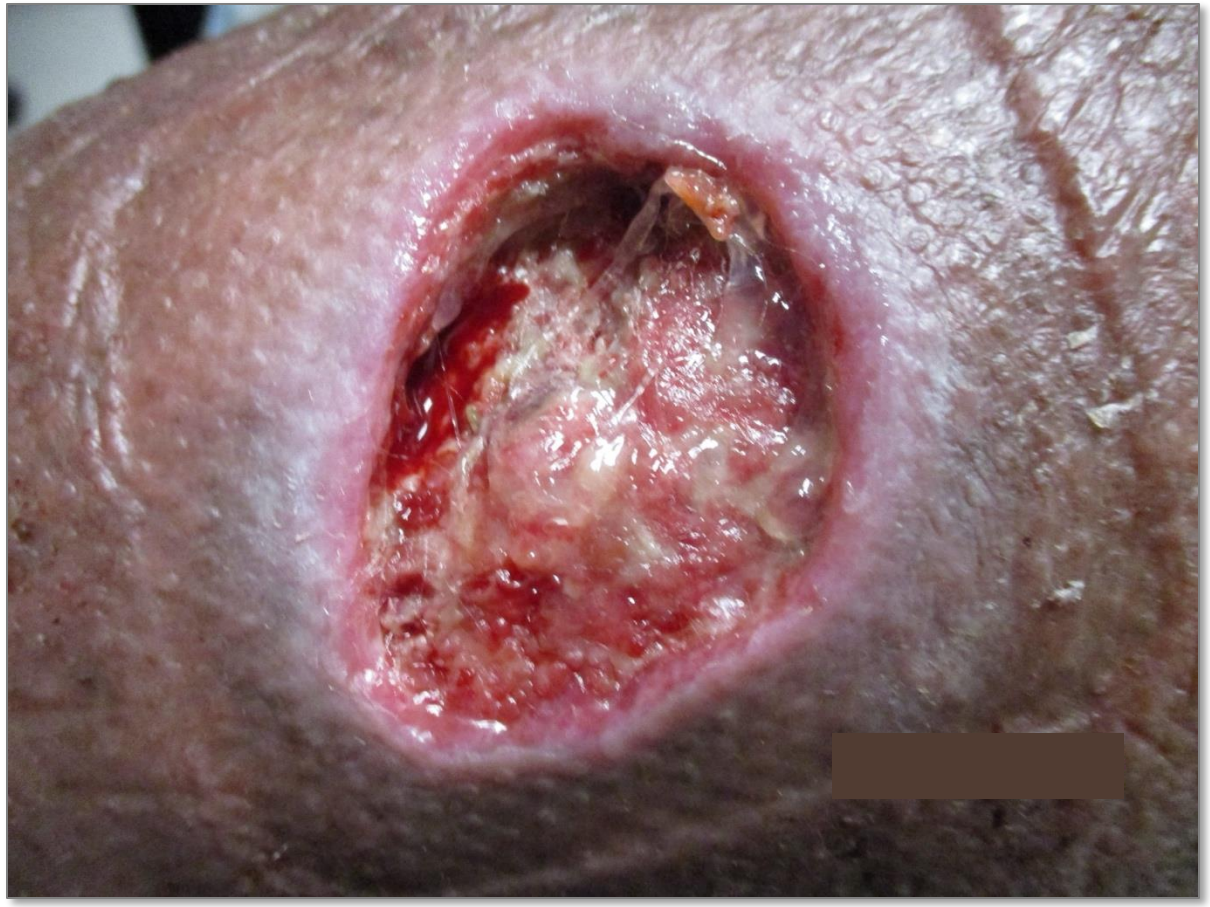
Before



After

Before and after Therapeutic Cleansing





Wound Cleansing Solutions

Considerations when Selecting a Cleansing Solution

- Type of wound dressing procedure and therapeutic cleansing technique that will be performed
- Characteristics of the wound
- The risk and/or presence of infection
- The abundance and profile of microorganisms in the wound (where known)
- Cytotoxicity, pH, and allergenicity of the solution
- Goals of care and other individual factors (eg, immunocompromised)
- Local policies, resources, and availability

Considerations when Selecting a Cleansing Solution

Cleansing solution*	Properties	Concentration	pH	Therapeutic index**	Safety profile#	Mode of Action

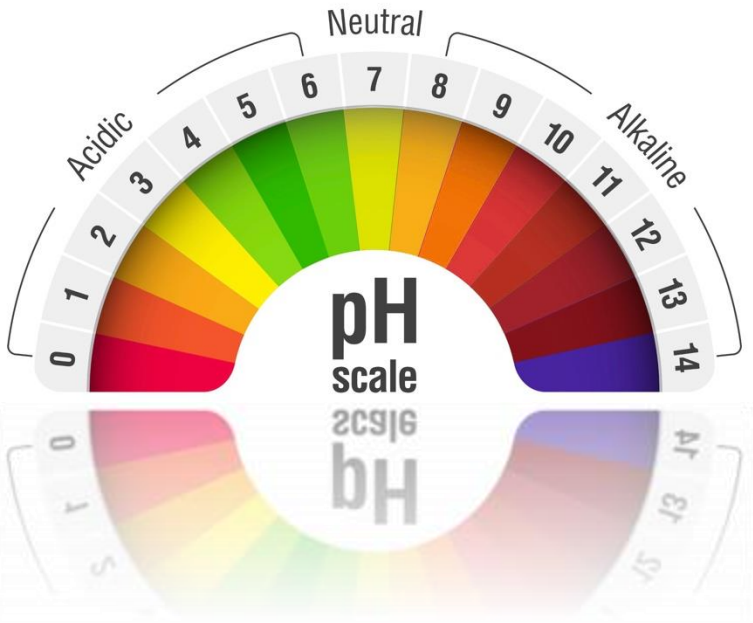
pH Basics

The pH of a wound bed is usually different from the pH of normal skin

- *The pH of the skin usually ranges between 4.0–5.5*
- *There is evidence that chronic wounds have a higher pH of 7.4–8.9*

The pH scale is logarithmic

- Each increase of 1 = 10x
  - *An increase of 5.5 to 8.5 = 1000x*



Color indicates proper wound pH

Healing Processes Affected by Changes in pH

Effects of lowering the pH to a more acidic environment

- Increased oxygen release into the wound
- Increased collagen formation
- Increased macrophage activity
- Increased fibroblast activity
- Increased graft take
- Control enzyme activity (ie, MMPs)
- Promotes angiogenesis
- Reduced toxicity of bacterial end products
- Reduced microbial proliferation and infection rates
- Reduced biofilm formation
- Reduced bacterial virulence
- Immunological responses

MMP = matrix metalloproteinase.

Gethin G. *Wounds UK*. 2007;3(3):52-56. Olson ER. *Mol Microbiol.* 1993;8(1):5-14. Hostacka A, et al. *Folia Microbiol, (Praha).* 2010;55(1):75-78. Lipsky BA, et al. *Diabetes Metab Res Rev*. 2016;32(Suppl 1):45-74.

Considerations when Selecting a Cleansing Solution

Cleansing solution*	Properties	Concentration	pH	Therapeutic index**	Safety profile#	Mode of Action

Therapeutic Index:

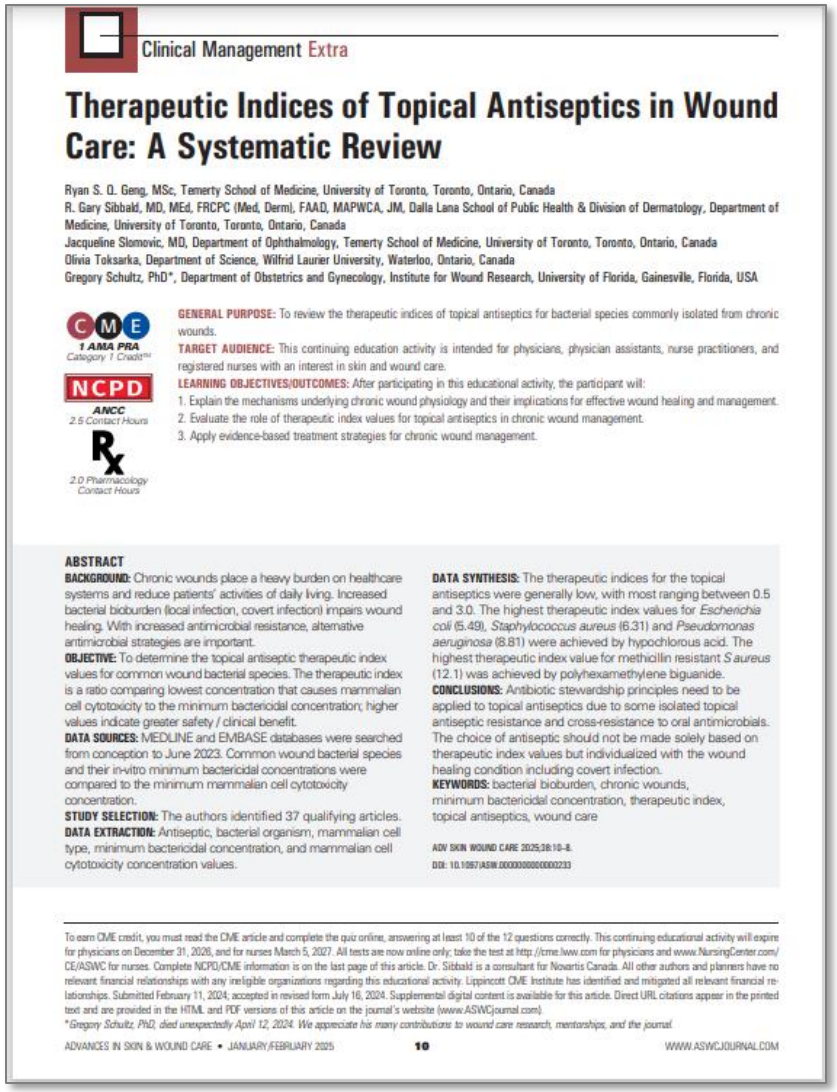
Quantitative measure of the relative safety of a solution with regard to risk of damage to healthy cells

Therapeutic Index Calculation

Mean cytotoxic concentration in mammalian cells

Mean MBC of bacterial species

- Higher values indicate greater safety and potential clinical effectiveness



Clinical Management Extra

Therapeutic Indices of Topical Antiseptics in Wound Care: A Systematic Review

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Gregory Schultz, PhD*, Department of Obstetrics and Gynecology, Institute for Wound Research, University of Florida, Gainesville, Florida, USA

CME 1 AMA PRA Category 1 Credit™
NCPD ANCC 2.5 Contact Hours
Rx 2.0 Pharmacology Contact Hours

GENERAL PURPOSE: To review the therapeutic indices of topical antiseptics for bacterial species commonly isolated from chronic wounds.
TARGET AUDIENCE: This continuing education activity is intended for physicians, physician assistants, nurse practitioners, and registered nurses with an interest in skin and wound care.
LEARNING OBJECTIVES/OUTCOMES: After participating in this educational activity, the participant will:
1. Explain the mechanisms underlying chronic wound physiology and their implications for effective wound healing and management.
2. Evaluate the role of therapeutic index values for topical antiseptics in chronic wound management.
3. Apply evidence-based treatment strategies for chronic wound management.

ABSTRACT

BACKGROUND: Chronic wounds place a heavy burden on healthcare systems and reduce patients' activities of daily living. Increased bacterial bioburden (local infection, covert infection) impairs wound healing. With increased antimicrobial resistance, alternative antimicrobial strategies are important.
OBJECTIVE: To determine the topical antiseptic therapeutic index values for common wound bacterial species. The therapeutic index is a ratio comparing lowest concentration that causes mammalian cell cytotoxicity to the minimum bactericidal concentration; higher values indicate greater safety / clinical benefit.
DATA SOURCES: MEDLINE and EMBASE databases were searched from conception to June 2023. Common wound bacterial species and their in-vitro minimum bactericidal concentrations were compared to the minimum mammalian cell cytotoxicity concentration.
STUDY SELECTION: The authors identified 37 qualifying articles.
DATA EXTRACTION: Antiseptic, bacterial organism, mammalian cell type, minimum bactericidal concentration, and mammalian cell cytotoxicity concentration values.
DATA SYNTHESIS: The therapeutic indices for the topical antiseptics were generally low, with most ranging between 0.5 and 3.0. The highest therapeutic index values for *Escherichia coli* (5.49), *Staphylococcus aureus* (6.31) and *Pseudomonas aeruginosa* (8.81) were achieved by hypochlorous acid. The highest therapeutic index value for methicillin resistant *S aureus* (12.1) was achieved by polyhexamethylene biguanide.
CONCLUSIONS: Antibiotic stewardship principles need to be applied to topical antiseptics due to some isolated topical antiseptic resistance and cross-resistance to oral antimicrobials. The choice of antiseptic should not be made solely based on therapeutic index values but individualized with the wound healing condition including covert infection.
KEYWORDS: bacterial bioburden, chronic wounds, minimum bactericidal concentration, therapeutic index, topical antiseptics, wound care

ADV SKIN WOUND CARE 2025;38:10-8.
DOI: 10.1097/ASW.0000000000000233

To earn CME credit, you must read the CME article and complete the quiz online, answering at least 10 of the 12 questions correctly. This continuing educational activity will expire for physicians on December 31, 2026, and for nurses March 5, 2027. All tests are now online only; take the test at http://cme.lww.com for physicians and www.NursingCenter.com/CE/ASWC for nurses. Complete NCPD/CME information is on the last page of this article. Dr. Sibbald is a consultant for Novartis Canada. All other authors and planners have no relevant financial relationships with any ineligible organizations regarding this educational activity. Lippincott CME Institute has identified and mitigated all relevant financial relationships. Submitted February 11, 2024; accepted in revised form July 16, 2024. Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's website (www.ASWCJournal.com).

**Gregory Schultz, PhD, died unexpectedly April 12, 2024. We appreciate his many contributions to wound care research, mentorships, and the journal.*

Highest Therapeutic Indices over 1.0

- The therapeutic indices for the topical antiseptics included in this study were generally low with most ranging between 0.5 and 3.0
- Of the topical antiseptics with adequate data points, the highest indices over 1.0 for the bacterial species included in this study were:
  - MRSA: **PHMB 12.1**, Octenidine 3.33, Chlorhexidine 2.55 (Hypochlorous acid (HOCl) not tested)
  - *S. aureus:* **Hypochlorous acid 6.31**, Octenidine 1.15
  - *P. aeruginosa*: **Hypochlorous acid 8.81**, PHMB 1.14
  - *E coli*: **Hypochlorous acid 5.49**, Octenidine 1.33, Hydrogen Peroxide 1.19, Chlorhexidine 1.15


Clinical Management Extra

Therapeutic Indices of Topical Antiseptics in Wound Care: A Systematic Review

HOCl = hypochlorous acid.

Geng RSQ, et al. *Adv Skin Wound Care*. 2025;38(1):10-18.

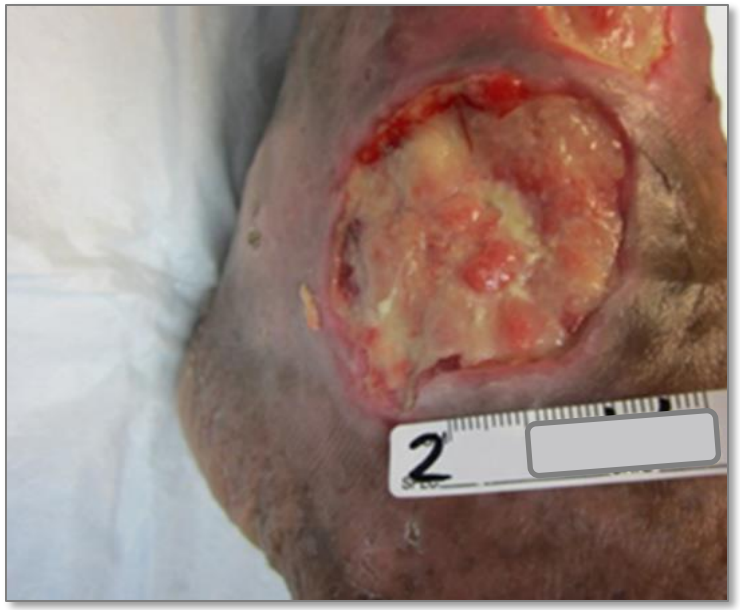
Cleansing Solutions with Data

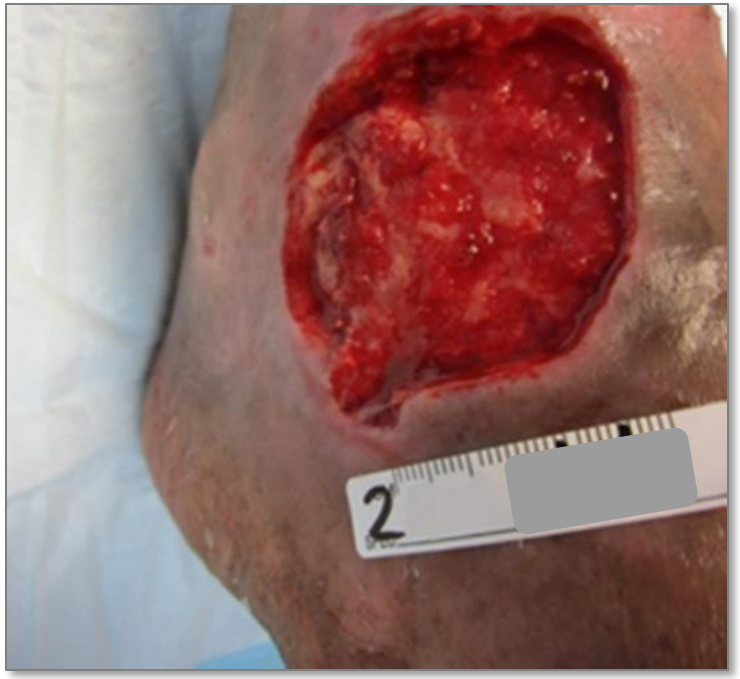
Cleansing Solution	Properties	Concentration	pH	Mean Therapeutic Indices	Safety Profile
Betaine and Poly-hexamethylene biguanide (PHMB)	Surfactant (betaine) Antimicrobial (PHMB)	0.1%	6-8	MRSA 12.12 *P. aeruginosa* 1.14 *E. coli* 0.66 *S. aureus* 0.60 Note: Some of the studies in this analysis used PHMB without added betaine at a range of concentrations	• Minimal cytotoxicity is reported • Potential for allergic reaction is low
Chlorhexidine	Antimicrobial	0.05%	5.5-7	MRSA 2.43 *P. aeruginosa* 0.70 *E. coli* 1.15 *S. aureus* 0.07	• Cytotoxicity reported • Reported to damage granulating tissue • Hypersensitivity reported
Hypochlorous Acid (HOCl)	Antimicrobial Hypotonic	0.03%	3.5-6.5	*P. aeruginosa* 8.81 *S. aureus* 6.31 *E. coli* 5.49	• No cytotoxicity
Sodium Hypochlorite (NaOCl)	Antimicrobial	0.057%–0.125%	9-12	MRSA 0.008 *E. coli* 0.004 *S. aureus* 0.003 *P. aeruginosa* 0.002	• Dose-dependent cytotoxic effect on cells, concentration below 0.025% is suggested
Povidone-Iodine (PI)	Antimicrobial	10%	4	*E. coli* 0.40 *S. aureus* 0.69 MRSA 0.35	• Dose-dependent cytotoxic effect on cells • Contraindicated in neonates, iodine sensitivity, thyroid or renal disorders, and very large wounds

*Saline has no measurable therapeutic index

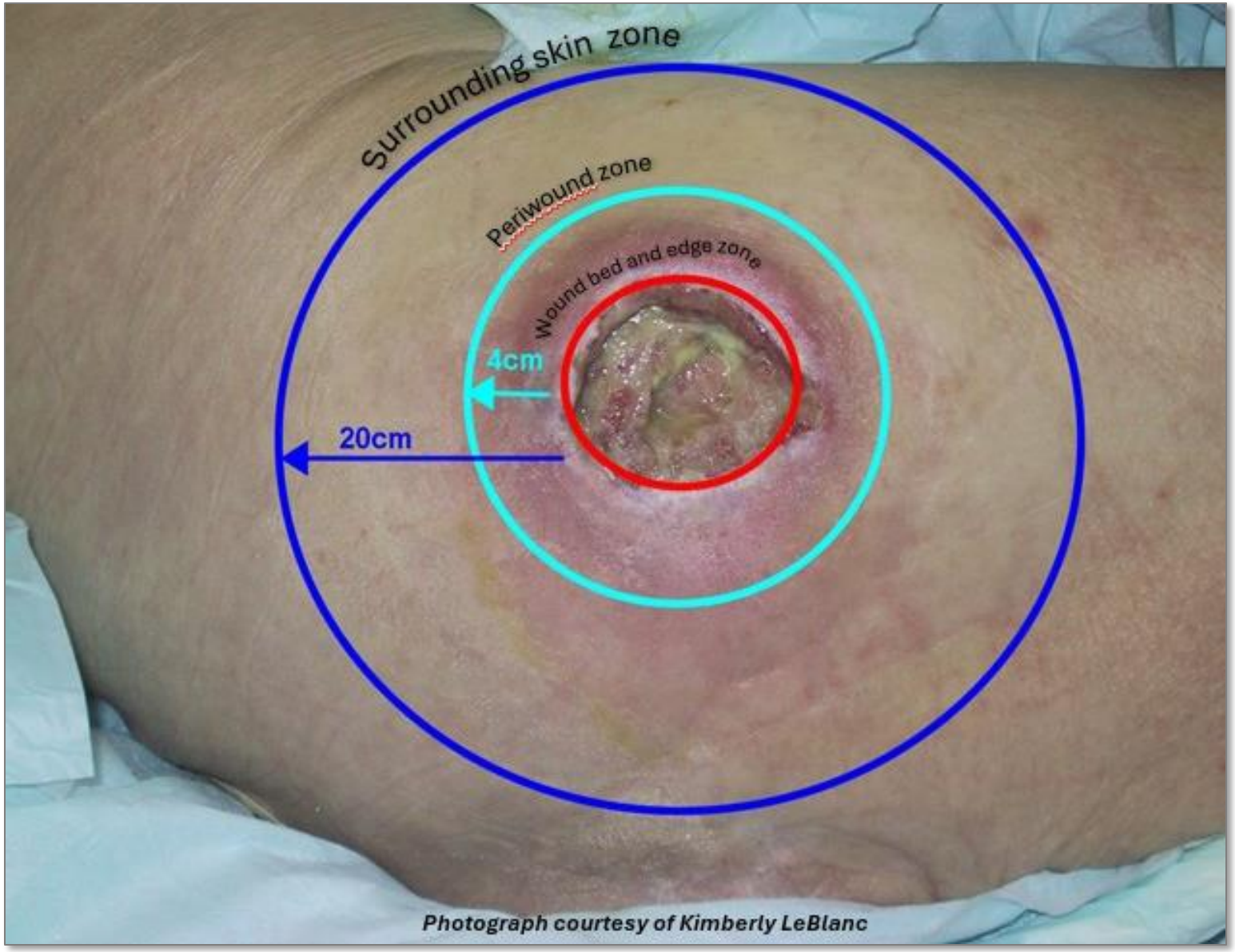
Sequencing of Cleansing Techniques

1. Communication
2. Prepare the individual and the environment
3. Remove old dressings/bandages
4. Therapeutic skin cleansing
5. Therapeutic wound cleansing
6. Debridement and
7. Post-debridement cleansing
8. Wound examination
9. Complete wound dressing procedure
10. Documentation for local policy





Three-Zone Cleansing Model



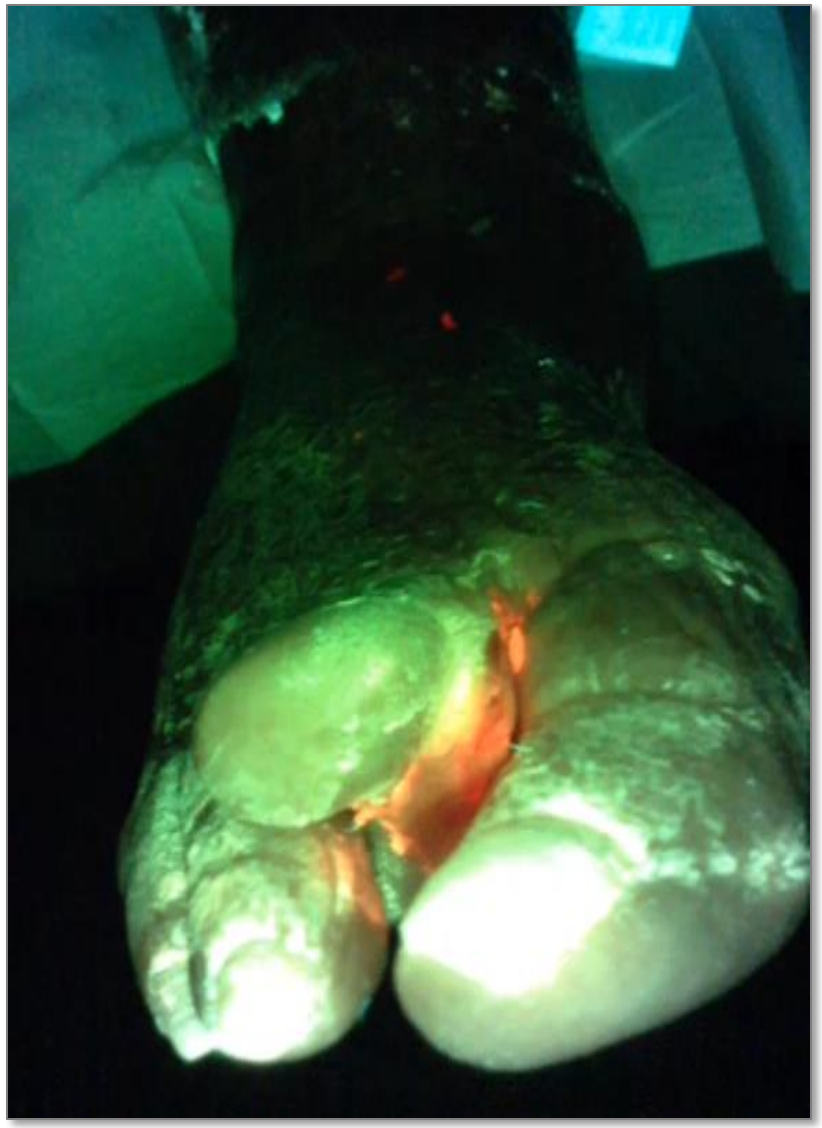
Limb Hygiene

Cleansing and drying of the affected limb to achieve and maintain skin integrity

- Essential to maintain the health and integrity of the skin
- Gentle cleansing daily
  - If compression used, cleanse at each wrap change
- pH-balanced skin cleanser and moisturizer
- Include feet and toes

Toe Flossing

The action of cleaning and drying between the toes, usually with moistened gauze, cloth, or a device designed for the purpose.



In Summary……

- Always consider the environment we are creating

- Adapt therapeutic wound cleansing

Clean it like you mean it!

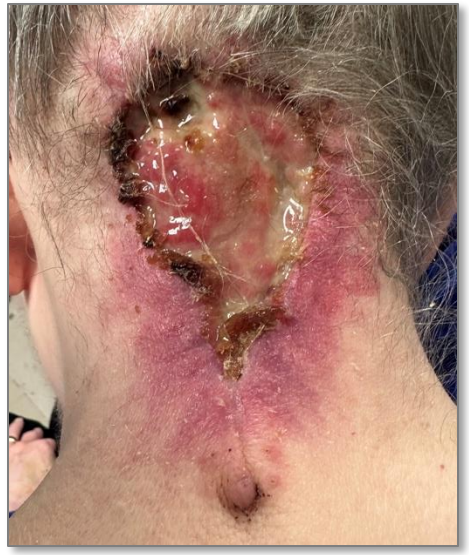
Addressing the Infected Wound

Kara Couch, MS, CRNP, CWCN-AP, FAAWC
Director, Wound Care Services, George Washington University
Associate Research Professor of Surgery, School of Medicine and Health Sciences, George Washington University
Washington, D.C.

Wound Infection: Contamination vs Colonization

- Chronic wounds affect 20 million individuals worldwide
- Annual cost for their treatment and management is **$31 billion**

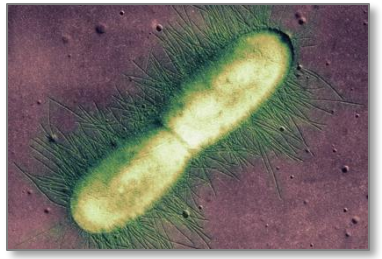
- Wound infection delays the wound healing rate and requires immediate treatment
- 3 stages in the wound infection continuum
  - CONTAMINATION
  - COLONIZATION
  - INFECTION



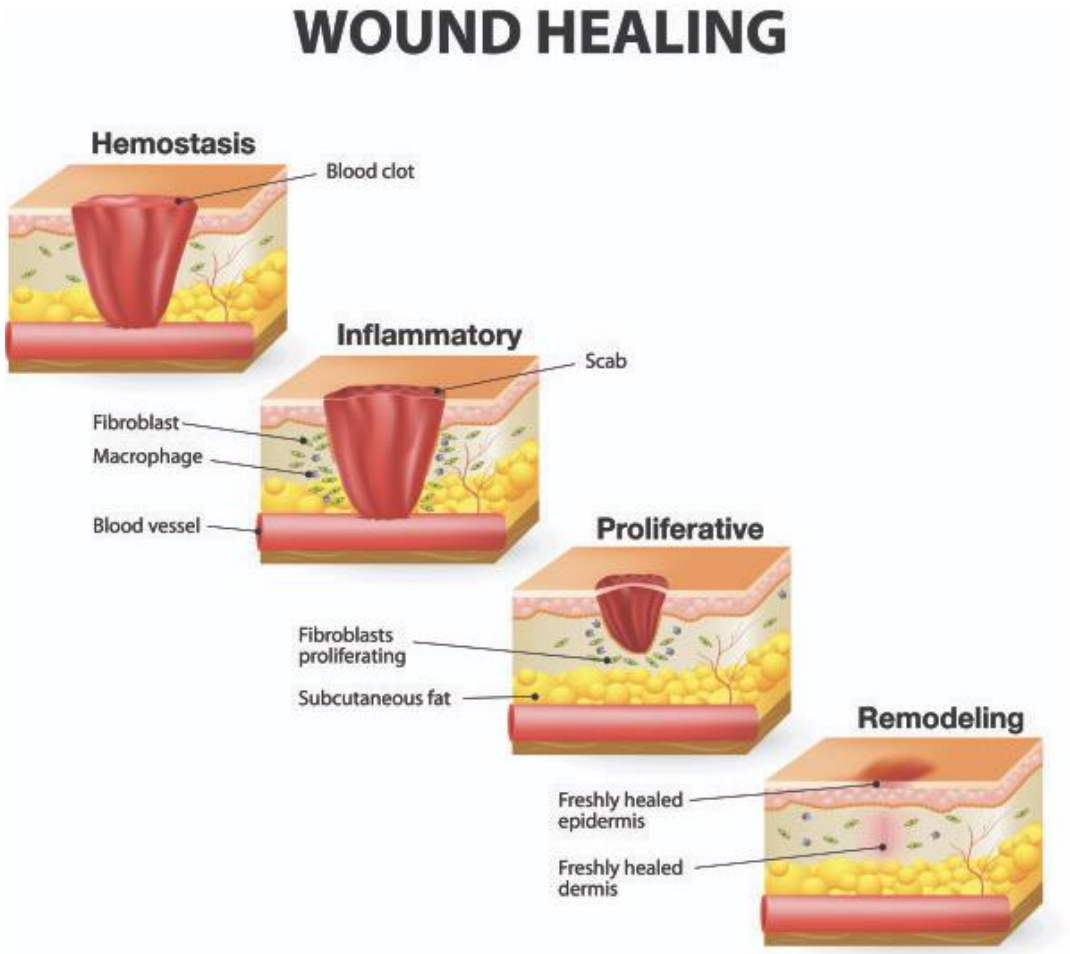
Sun H, et al. *Curr Drug Targets.* 2020;21(12):1264-1275.

Wound Infection: Contamination vs Colonization

- **Wound contamination** is the presence of non-replicating microbes in an open wound
  - The presence of small numbers of microbes does not affect normal inflammatory responses and wound healing processes
- **Microbial replication causes wound colonization**
  - Prolongs the **inflammatory phase** of wound healing and leads to further tissue damage



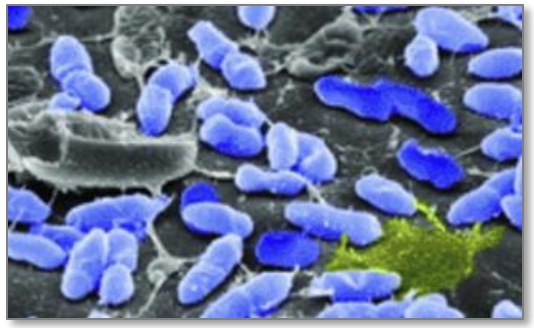
Credit: CNRI / Getty Images



Slide courtesy of A. Chaffin, MD.

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
- **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

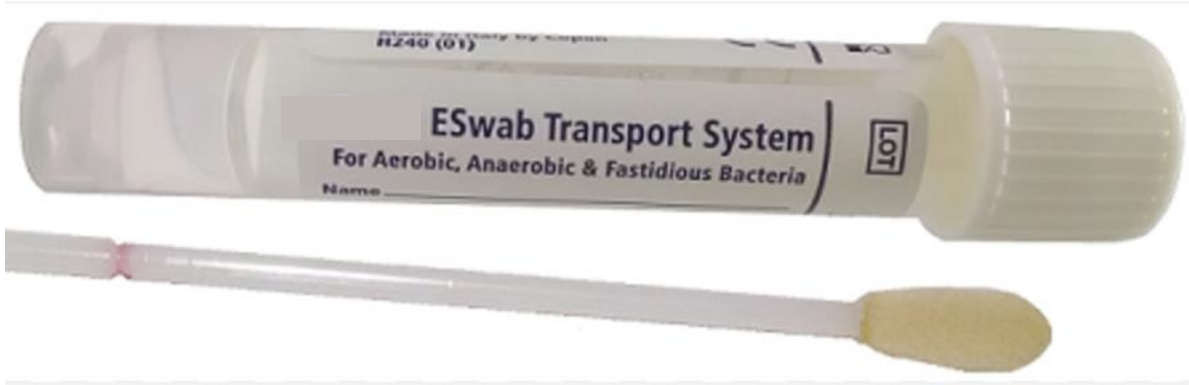


Slide courtesy of A. Chaffin, MD.

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

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

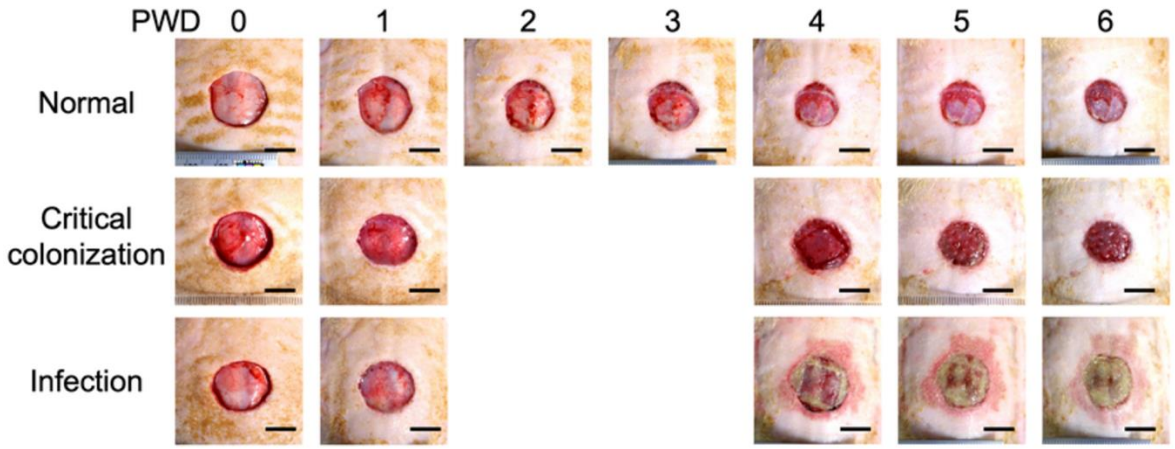


Slide courtesy of A. Chaffin, MD.

Critical Wound Colonization

- Multiplication of organisms without invasion, but **interfering with wound healing**
  - Wounds often stagnate, rather than improve, in condition
  - Obvious signs of infection, such as fever and inflammation, tend to be absent
  - Discoloration and odor may be observed
- Bioburden level of >105 bacteria/gm of tissue is the threshold at which critical colonization crosses into infection
- >106 bacteria/gm of tissue leads to impeded wound healing

- TIPPING POINT where treatment becomes necessary TO STOP THE PROGRESSION TO INFECTION
  - Topical antiseptics can help control the bioburden
  - Allow wound healing to proceed



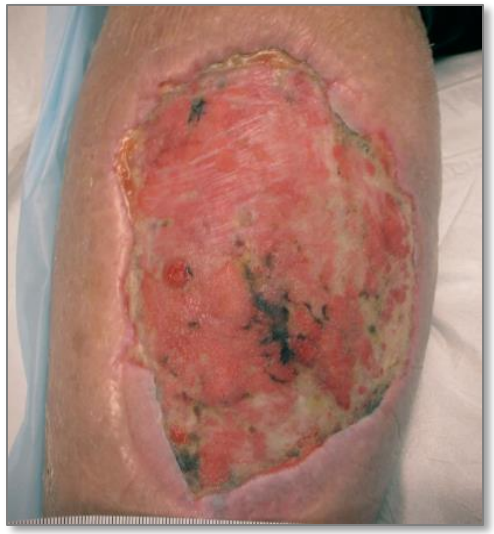
Slide courtesy of A. Chaffin, MD.

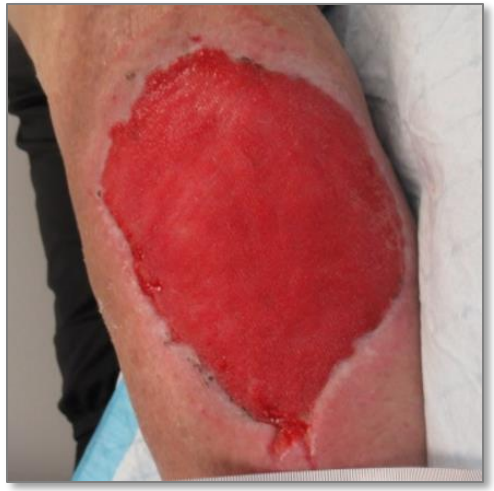
Landis S, et al. Krasner DL, Ed. *Chronic Wound Care: The Essentials—A Clinical Source Book for Healthcare Professionals*. 1st Ed. Malvern, PA; HMP Communications. 2014;87-130. Takizawa C, et al. *Int J Wound.* 2023;20(4):1088-1097.

Mary Ann Liebert, Inc. publishers
ADVANCES in WOUND CARE

Wound Infection

Contamination	All open wounds may contain microorganisms. They will not multiply or persist until suitable nutritive and physical conditions are available for each microbial species, or they successfully evade host's defenses. Consequently, their presence is only transient and wound healing is not delayed.
Colonization	Microbial species successfully grow and divide, but do not cause damage to the host or initiate wound infection.
Local infection	Covert (subtle) signs of local infection: Hypergranulation (excessive "vascular tissue"); bleeding, friable granulation; epithelial bridging and pocketing in granulation tissue; wound breakdown and enlargement; delayed wound healing beyond expectations; new or increasing pain; increasing malodor. overt (classic) signs of local infection: Erythema; local warmth; swelling; purulent discharge; delayed wound healing beyond expectations; new or increasing pain; increasing malodor.
Spreading infection	Extending in duration +/− erythema; lymphangitis; crepitus; wound breakdown/dehiscence with or without satellite lesions; malaise/lethargy or nonspecific general deterioration; loss of appetite; inflammation, swelling of lymph glands.
Systemic infection	Severe sepsis; septic shock; organ failure; death.





Slide courtesy of A Gheritis MD

International Wound Infection Institute (IWII) Wound infection in clinical practice. *Wounds International.* 2016.

Surgical Site Infection

NHSN NATIONAL HEALTHCARE SAFETY NETWORK

January 2024

Surgical Site Infection Event (SSI)

- CDC healthcare-associated infection (HAI) prevalence survey
  - 110,800 surgical site infections (SSIs) associated with inpatient surgeries in 2015
  - **4% increase in SSI** standardized infection ratio (SIR) related to all National Healthcare Safety Network (NHSN) operative procedure categories combined compared to previous year

- Advances have been made in infection control practices
  - Improved operating room ventilation
  - Improved sterilization methods, barriers
  - Improvements in surgical techniques
- However, SSIs remain a substantial cause of
  - Morbidity
  - Prolonged hospitalization
  - Mortality

HAI = healthcare-associated infection; SSI = surgical site infection; SIR = standardized infection ratio; NHSN = National Healthcare Safety Network.

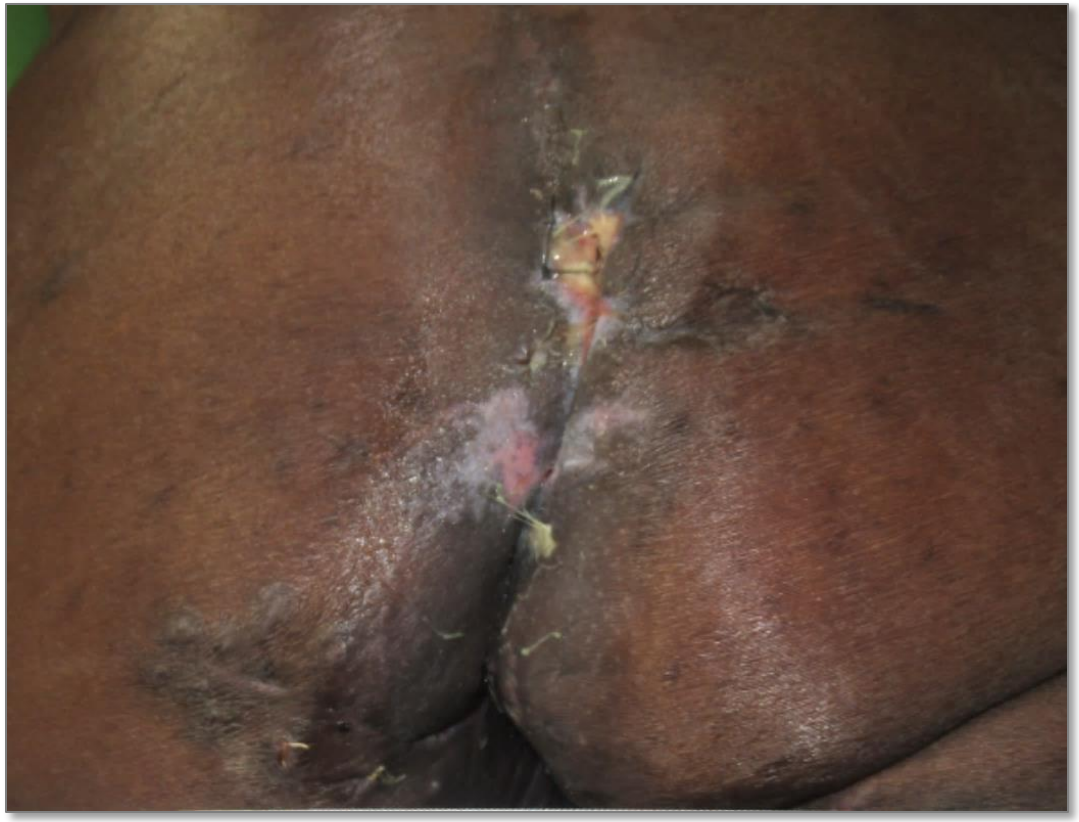
Surgical Site Infection

NHSN
NATIONAL HEALTHCARE SAFETY NETWORK

January 2024

Surgical Site Infection Event (SSI)

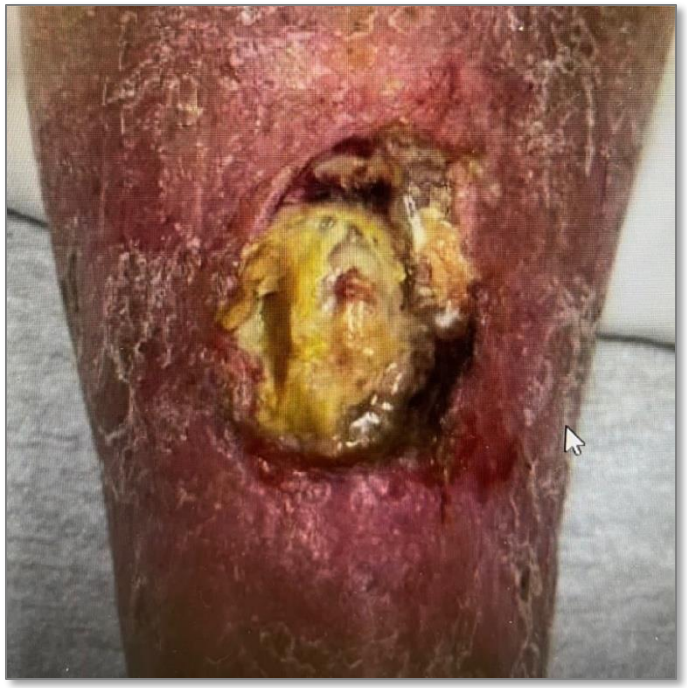
- SSIs account for **20% of all HAIs**
- SSIs are associated with a **2- to 11-fold** increase in the risk of mortality
- **75% of SSI-associated deaths** are directly attributable to the SSI
- **SSI is the most costly HAI type**
  - Estimated annual cost of **$3.3 billion**
  - Extends hospital **length of stay (LOS)** by 9.7 days
  - Cost of hospitalization increased by more than **$20,000 per admission**



Slide courtesy of A. Chaffin, MD.

Surgical Site Infection Wound Class

- An assessment of the **degree of contamination of a surgical wound** at the time of the surgical procedure
- **Wound class** is assigned by a person involved in the surgical procedure based on the wound class schema
  - Surgeon, circulating nurse
- The 4 wound classifications available within the NHSN application are
  - **Clean (C)**
  - **Clean-Contaminated (CC)**
  - **Contaminated (CO)**
  - **Dirty/Infected (D)**



Slide courtesy of A. Chaffin, MD.

Surgical Site Infection

ACS-NSQIP surgical wound classifications [11]

Clean	Uninfected operative wounds without inflammation; respiratory, alimentary, genital or uninfected urinary tracts are not entered
Clean/ Contaminated	Operative wounds in the respiratory, alimentary, genital or uninfected urinary tracts are electively entered; without unusual contamination
Contaminated	Open, fresh, accidental wounds, operations with major breaks in sterile technique or gross spillage from the gastrointestinal tract, and incisions in which acute, non-purulent inflammation is encountered
Dirty	Old traumatic wounds with retained devitalized tissue or those that involve existing clinical infection or perforated viscera

ACS-NSQIP, American College of Surgeons-the National Surgical Quality Improvement Program.

Mioton LM, et al. *Arch Plast Surg.* 2013;40(5):522-529.

Surgical Site Infection

Comparison of overall postoperative SSIs reported in ACS-NSQIP stratified by wound classification [13]

Population	Clean	Clean/Contaminated	Contaminated	Dirty
All specialties[a)]	2.58%	6.67%	8.61%	11.80%
Plastic surgery	2.75%	2.82%	4.94%	5.06%

ACS-NSQIP, American College of Surgeons-the National Surgical Quality Improvement Program; SSIs, surgical site infections.

Rates of overall complications, surgical site infections, reoperation, and mortality by wound classification

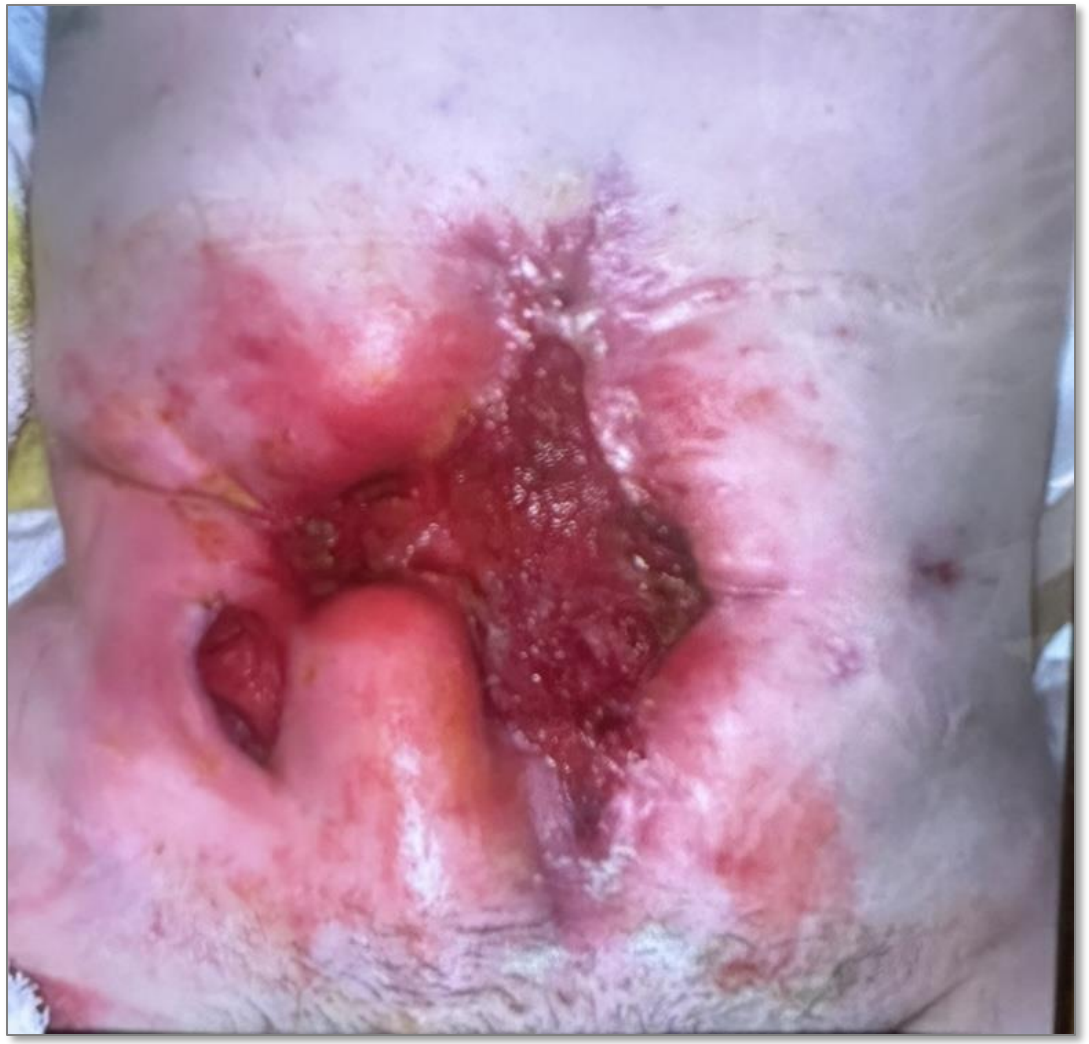
Postoperative outcomes	Clean (n = 12,530)	Clean/Contaminated (n = 1,098)	Contaminated (n = 850)	Dirty (n = 811)
Overall complications	603 (4.81)	101 (9.06)	134 (15.76)	160 (19.73)
Overall surgical site infection	344 (2.75)	31 (2.82)	42 (4.94)	41 (5.06)
Superficial SSI	237 (1.89)	18 (1.64)	19 (2.24)	16 (1.97)
Deep SSI	80 (0.64)	7 (0.64)	19 (2.24)	18 (2.22)
Organ/Space SSI	34 (0.27)	7 (0.64)	4 (0.47)	8 (0.99)
Reoperation	404 (3.23)	68 (6.19)	100 (11.76)	154 (18.99)
Mortality	10 (0.08)	2 (0.18)	12 (1.41)	28 (3.45)

SSIs, surgical site infections.

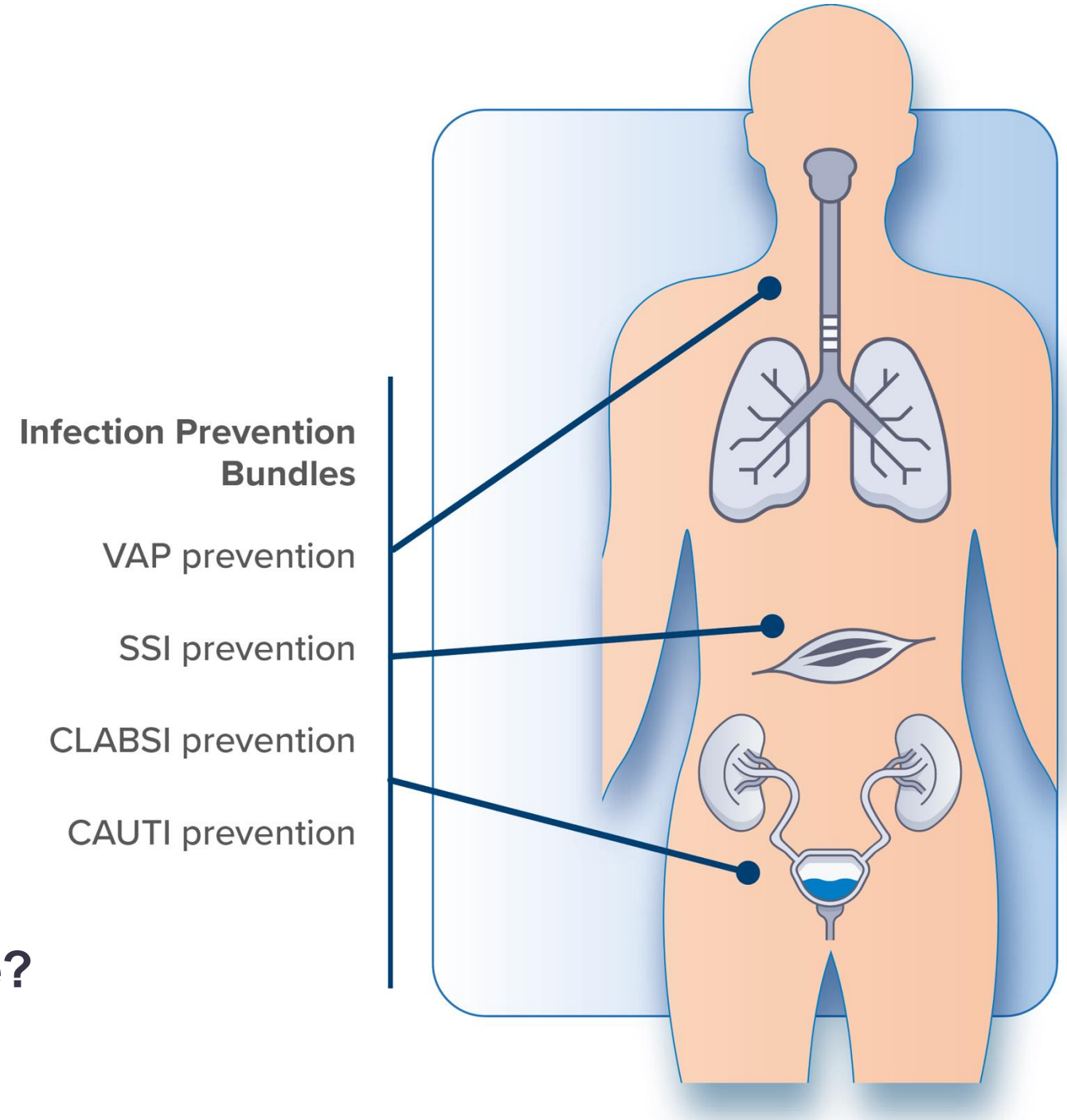
Mioton LM, et al. *Arch Plast Surg.* 2013;40(5):522-529.

SSI Rates per Wound Class

- Clean: 1%-5%
- Clean-Contaminated: 3%-11%
- Contaminated: 10%-17%
- Dirty/Infected: >27%

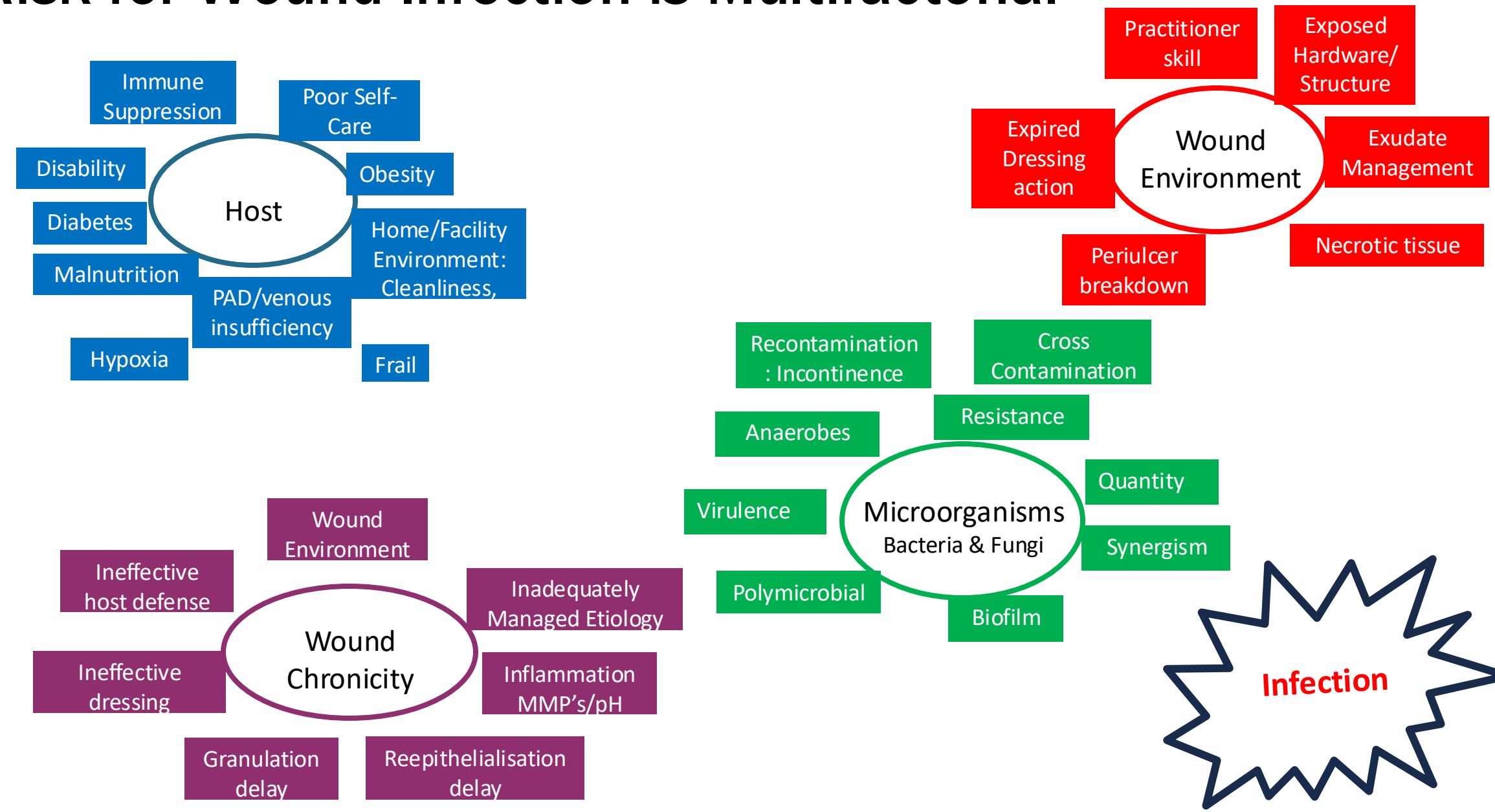


Wounds are the final frontier of non-standardized practice to prevent infection



Why is there no skin bundle?

Risk for Wound Infection is Multifactorial

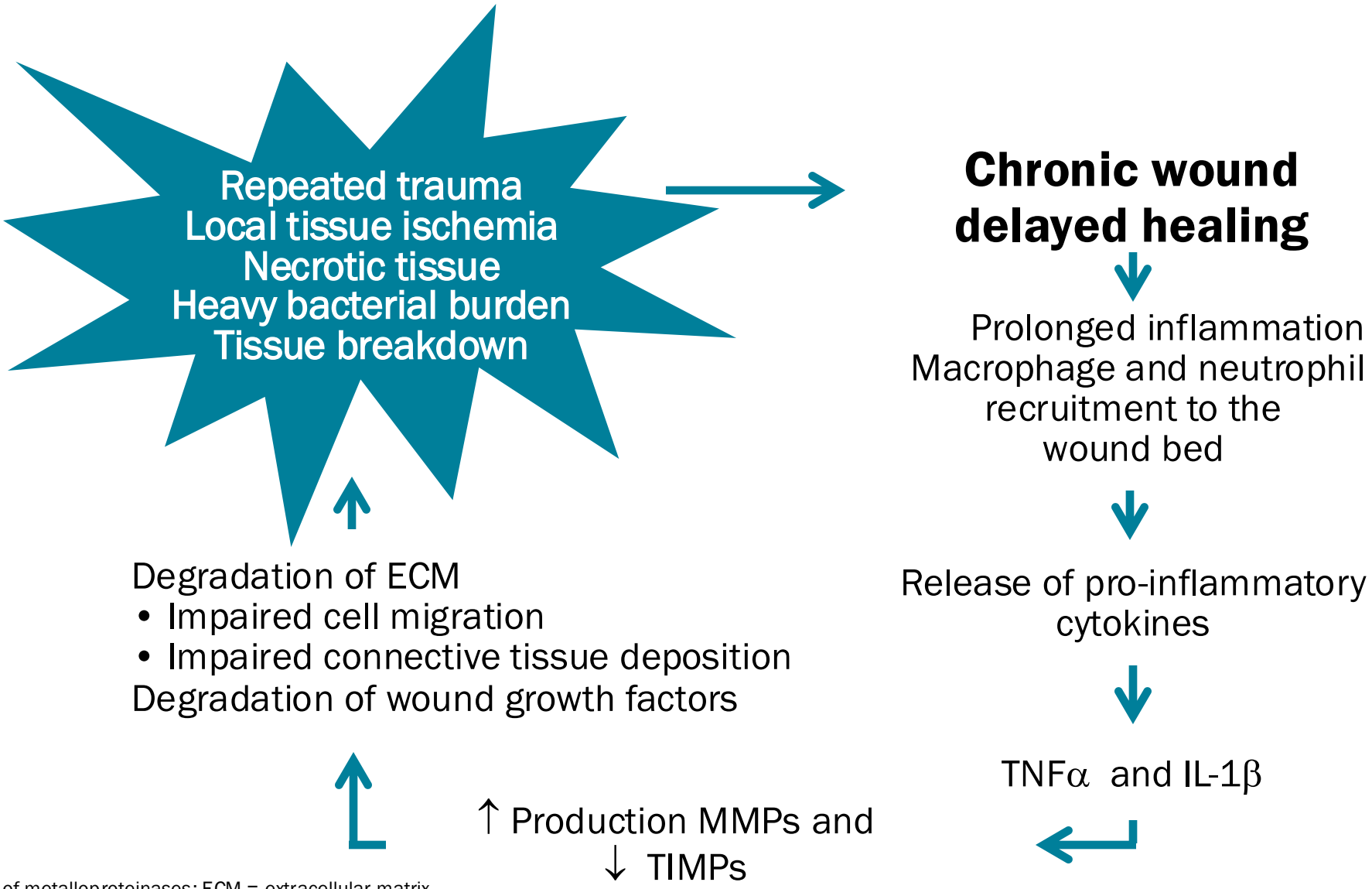


Infection

- ✓ Studies show that between 30%-50% of inpatient antibiotic use is either unnecessary or inappropriate
- ✓ 16.4% of all antibiotic prescriptions are for wounds
- ✓ 53%-71% of patients are prescribed at least 1 course per chronic wound
- ✓ 2.8 million antibiotic-resistant infections occur in the U.S. each yr
- ✓ More than 35,000 people die from these infections

Dolk FCK, et al. *J Antimicrob Chemother.* 2018;73(Suppl 2):ii2-ii10. CDC. Antimicrobial Resistance. Published Feb. 5, 2025. Accessed Sept. 1, 2025. https://www.cdc.gov/antimicrobial-resistance/data-research/facts-stats/index.html Siddiqui AR, Bernstein JM. *Clin Dermatol.* 2010;28(5):519-526. CDC. Published May 3, 2016. Accessed Sept. 1, 2025. https://archive.cdc.gov/www_cdc_gov/media/releases/2016/p0503-unnecessary-prescriptions.html. Caputo WJ, et al. *Diagnostics (Basel).* 2022;12(12):3207.

Advanced Wound Care Cycle of Delayed Healing



TIMP = tissue inhibitor of metalloproteinases; ECM = extracellular matrix.

Mast BA, Schultz GS. *Wound Repair Regen.* 1996;4(4):411-420.

Practice Points

- Only collect a wound sample in the presence of clinical signs and symptoms of wound infection

- Use an inert wound cleanser and debride the wound (if required) prior to collecting a wound specimen to avoid false positive results

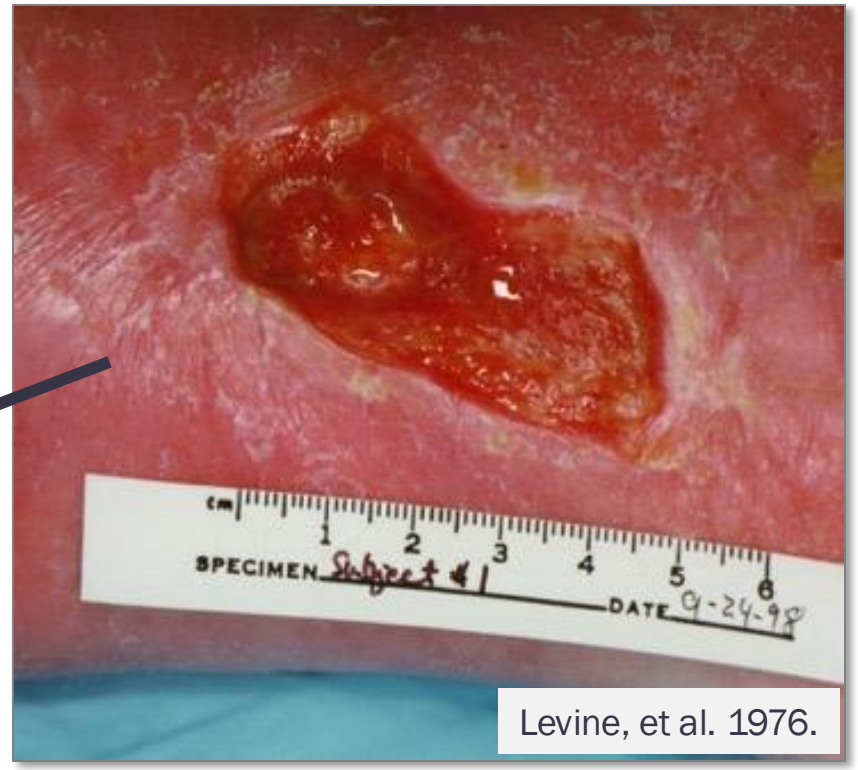
- Tissue biopsy is the preferred wound specimen for obtaining accurate cultures. When this is not an option, use the Levine technique to collect a wound swab. This will express microbes from below the wound tissue.

Levine Swab Technique

Table 6. Concordance of qualitative swab and tissue cultures

	Wound exudate (%)	Z-technique (%)	Levine's (%)
All organisms			
Mean concordance	83	78	78
Staphyloccus aureus			
Total concordance	95	93	96
Occurrence concordance	91	88	94
Nonoccurrence concordance	90	85	92
Pseudomonas aeruginosa			
Total concordance	95	92	96
Occurrence concordance	69	56	75
Nonoccurrence concordance	95	91	96
Groups A or B *Streptococcus*			
Total concordance	99	99	99
Occurrence concordance	67	67	67
Nonoccurrence concordance	99	99	99

N=83.



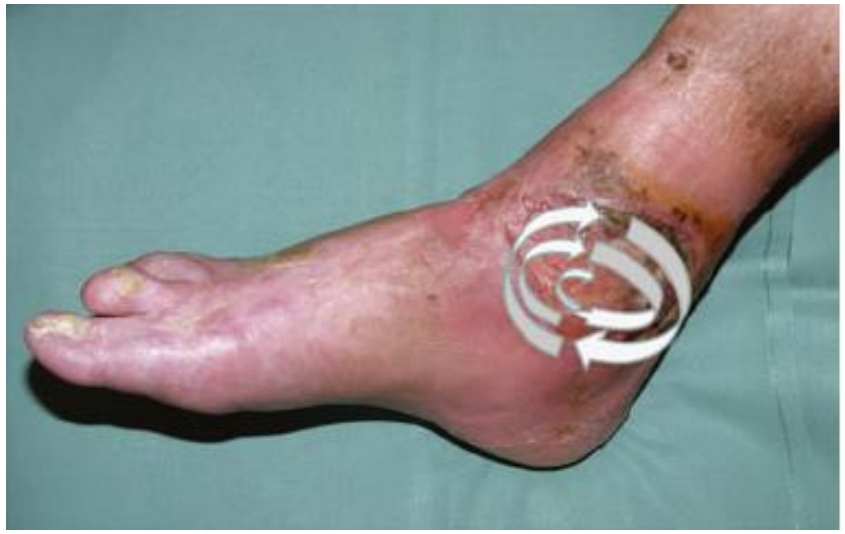
Levine, et al. 1976.

- Cleanse with sterile saline (not antibacterial)
- Sample 1cm^2 area with sufficient pressure to obtain tissue fluid
- Most reflective of tissue microbes

Slide courtesy of A. Chaffin, MD.

Gardner SE, et al. *Wound Repair Regen*. 2006;14(5):548-557. Levine NS, et al. *J Trauma*. 1976;16(2):89-94.

Essen Rotary Swab Technique



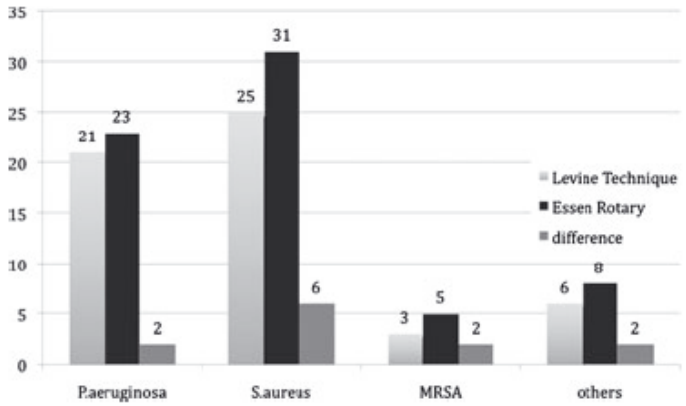
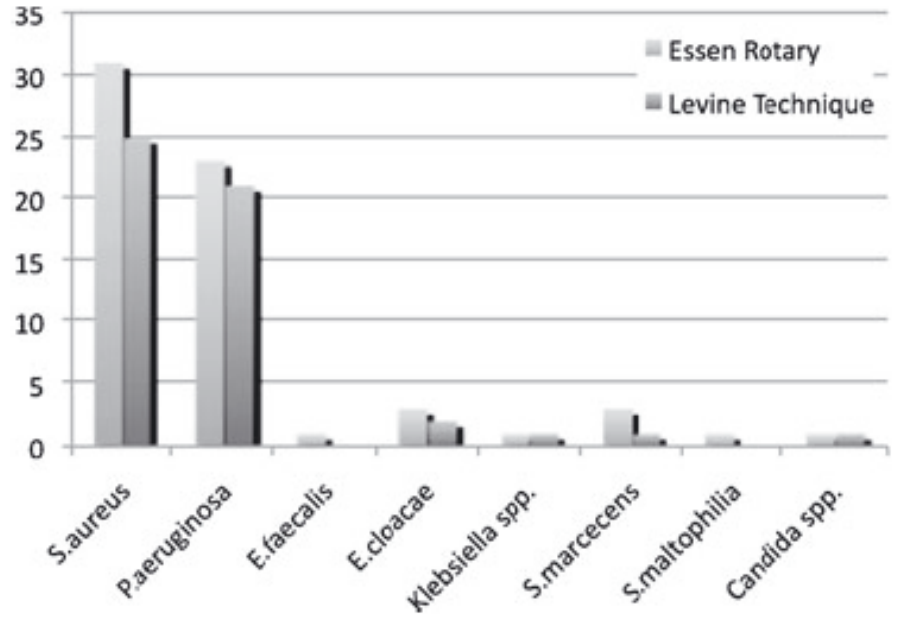


Figure 5 Direct comparison of the absolute results. Essen Rotary vs. conventionally performed swab according to the Levine technique.



Al Ghazal P, Körber A, Klode J, Schmid EN, Buer J, Dissemond J. Evaluation of the Essen Rotary as a new technique for bacterial swabs: results of a prospective controlled clinical investigation in 50 patients with chronic leg ulcers. *Int Wound J*. 2014;11(1):44-49.

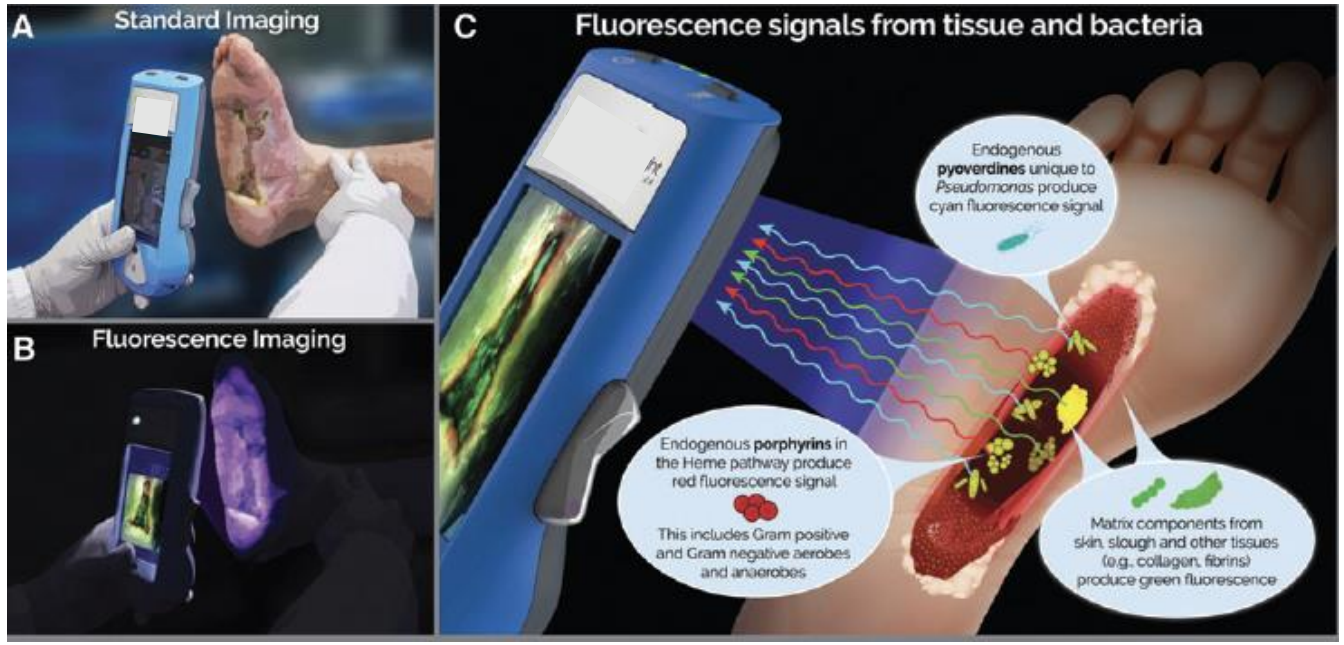
Slide courtesy of A. Chaffin, MD.

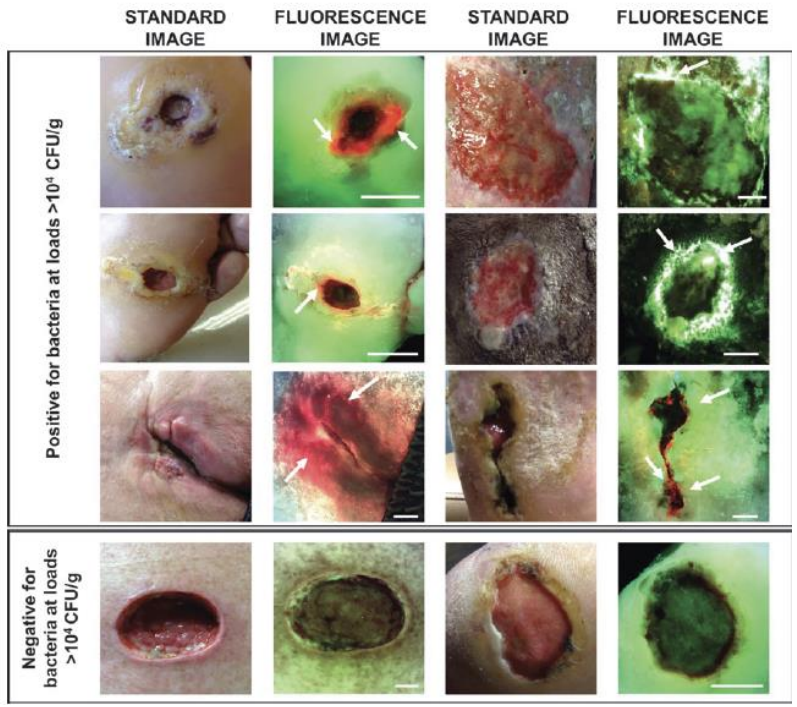
Non-Specific Options

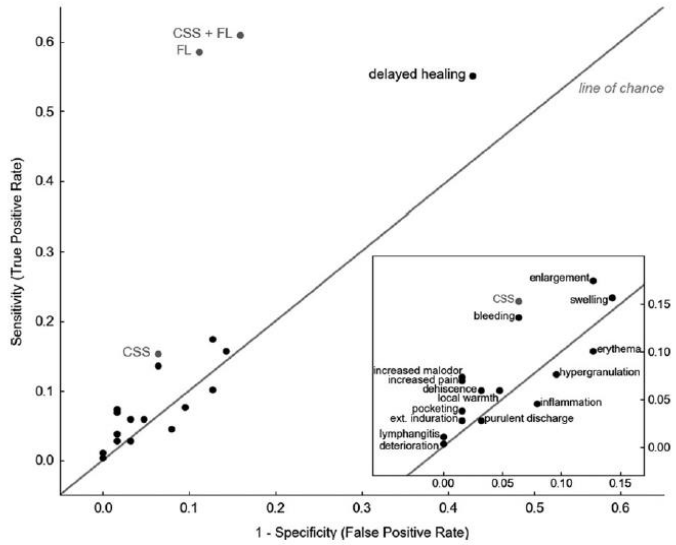
- Temperature
- pH
- Inflammatory markers
- X-rays and other imaging

Slide courtesy of A. Chaffin, MD.

Point-of-Care Technology





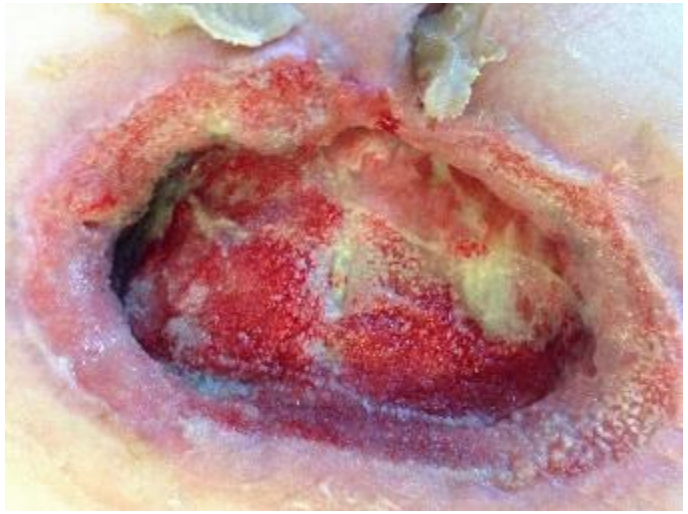


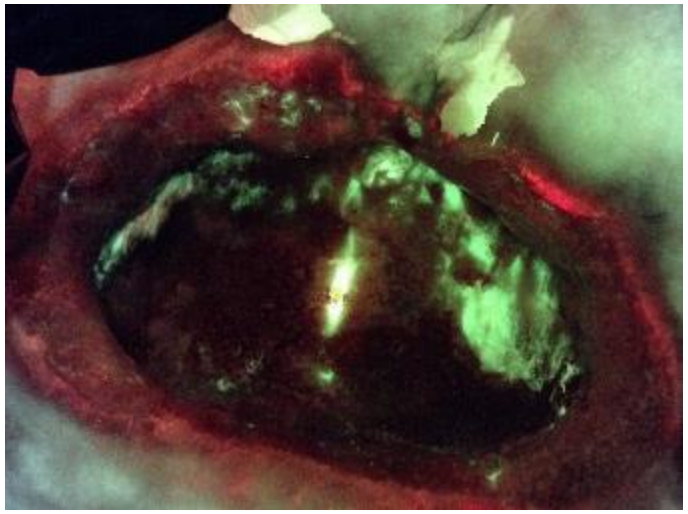
Lam L, et al. *Adv Wound Care.* 2020;10:123-136.

Fluorescence Imaging and NPWT

Standard NPWT device under dressing

Wound Bed

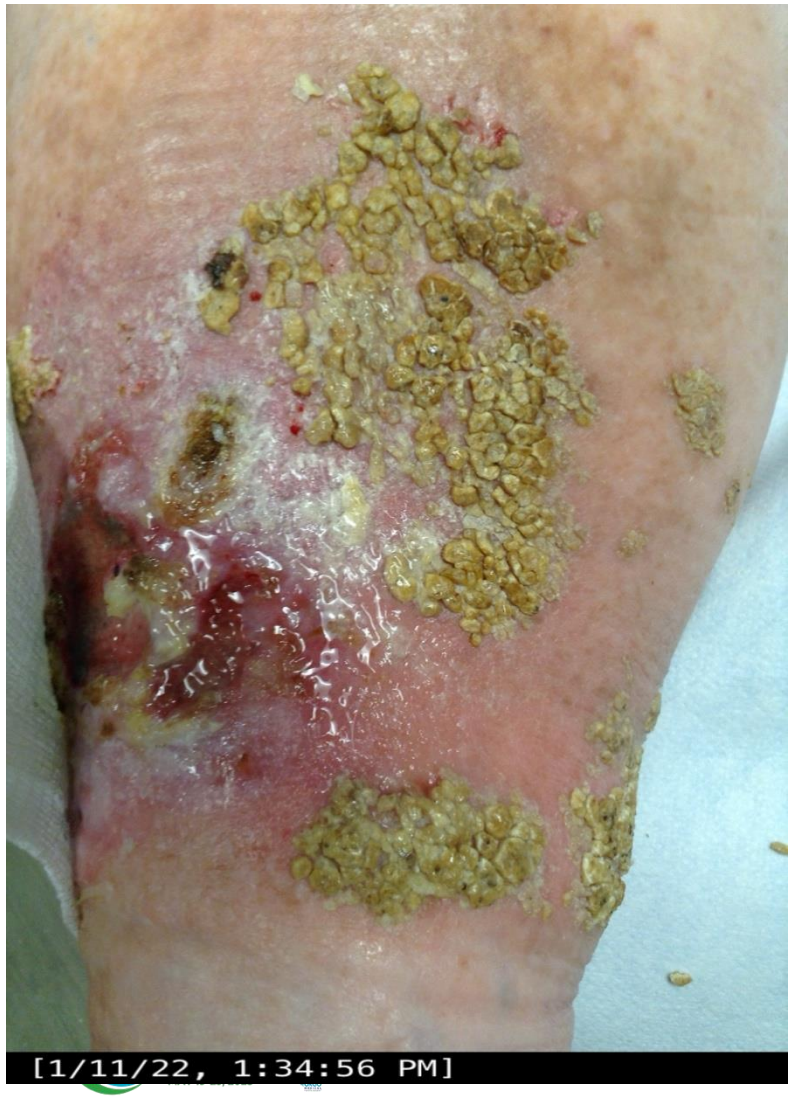




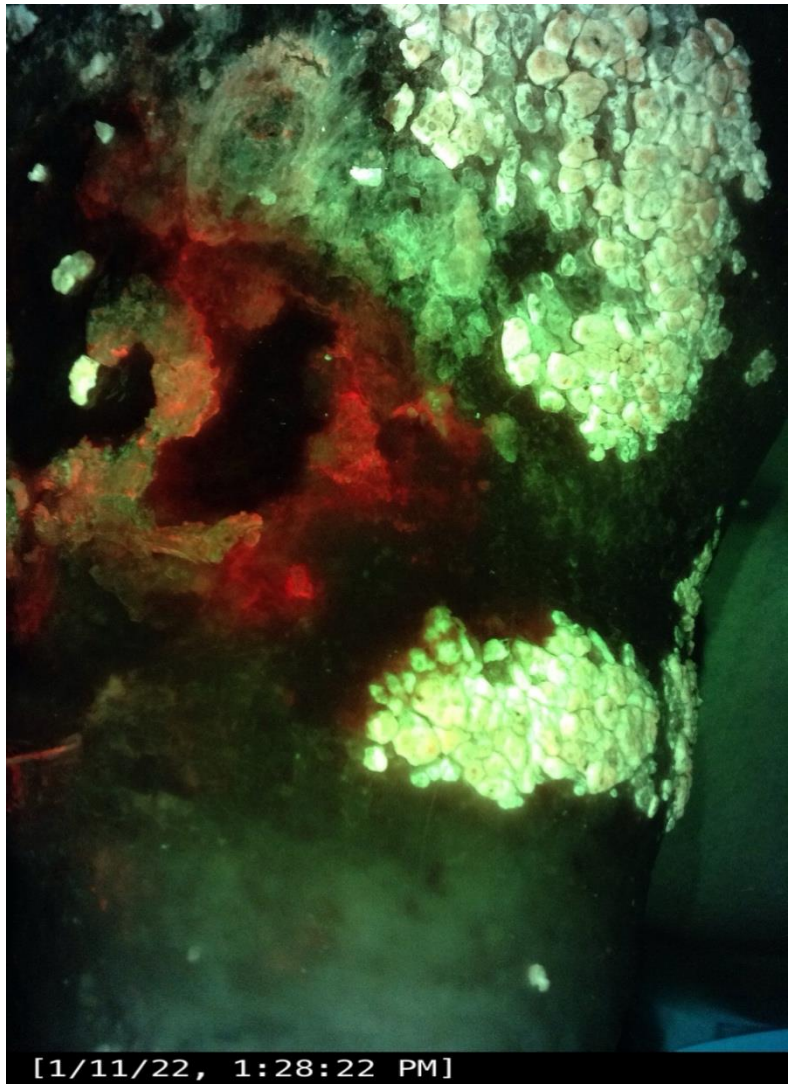
- **Sacrum pressure ulcer**
  Detection of red bacterial fluorescence after 2 days prompted an earlier dressing change and a switch to an instillation NPWT device

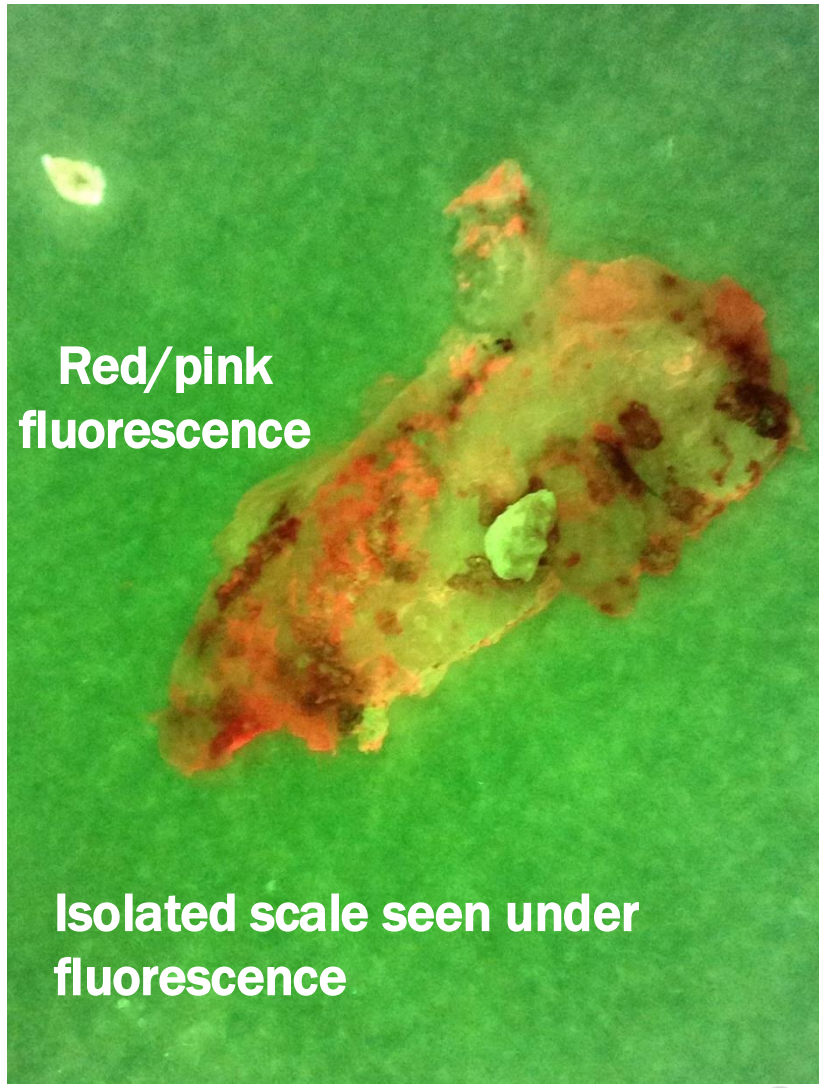
Raizman R, *et al. J Wound Care.* 2019;28(12):824-834.

Standard Image

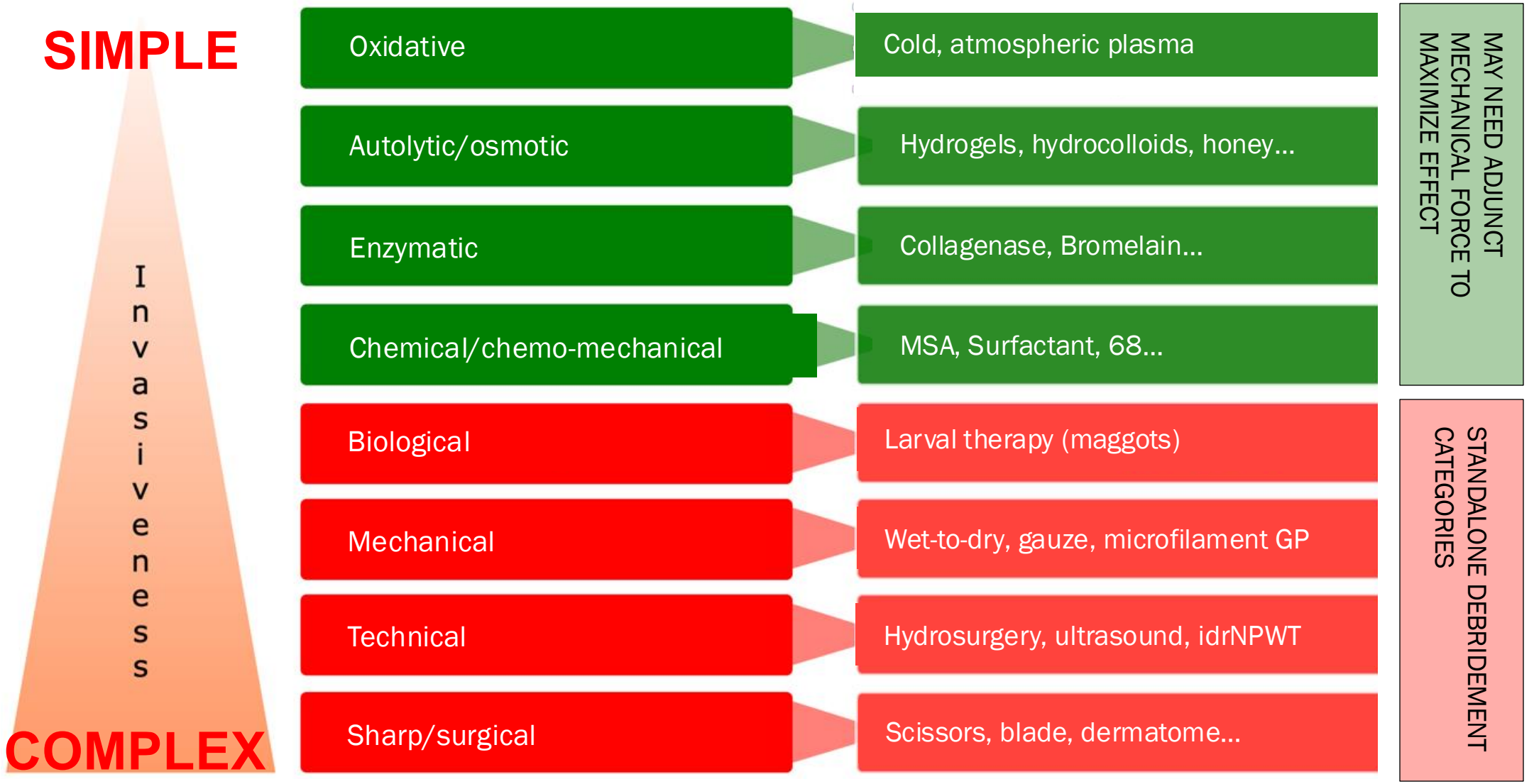


Fluorescence Image





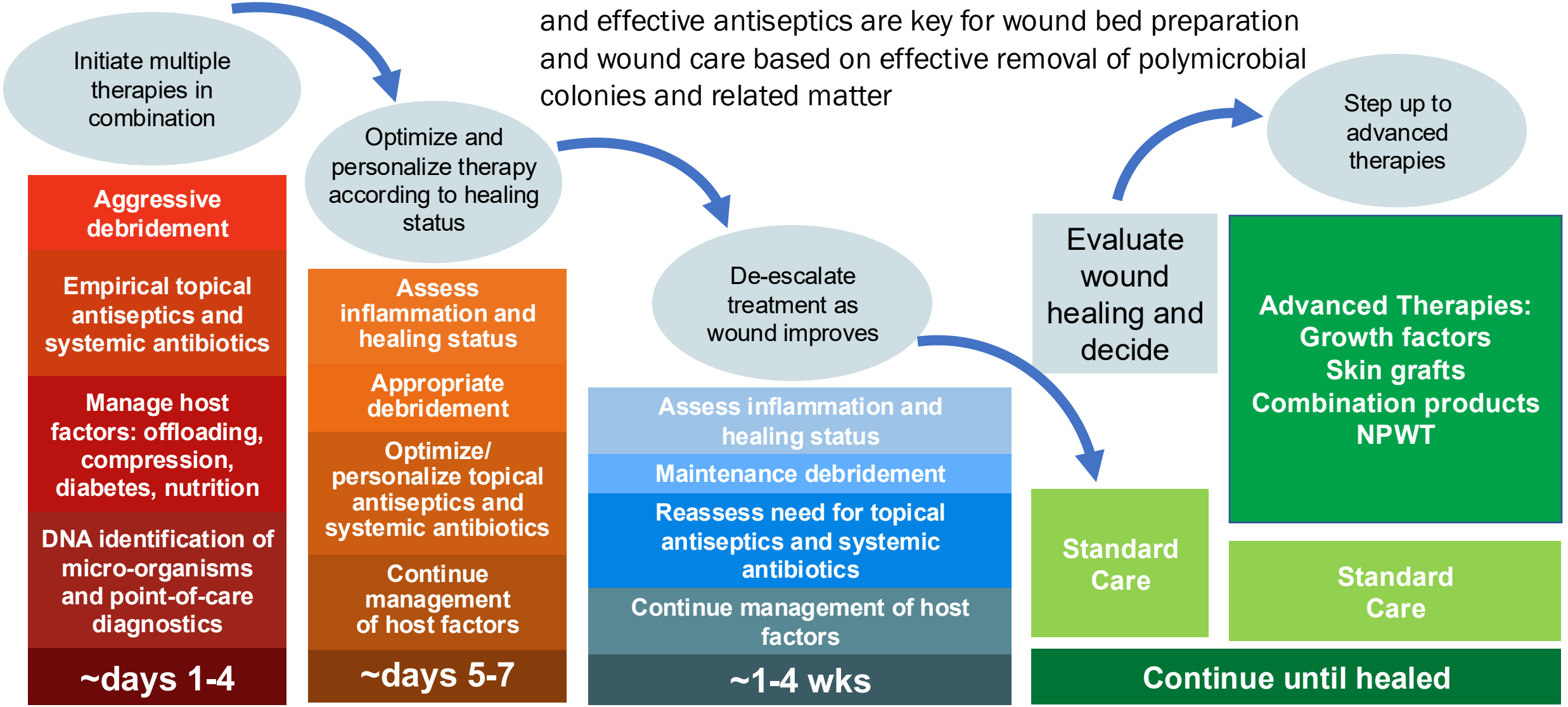
Complexity of Wound Debridement Procedures



Mayer D, et al. *J Wound Care*. In press.

Step-Down then Step-Up Treatment Strategy

Early intervention with debridement and multiple therapies and effective antiseptics are 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 wide variety of use cases and safe with other modalities

Market

Evolutionary

vs

Revolutionary

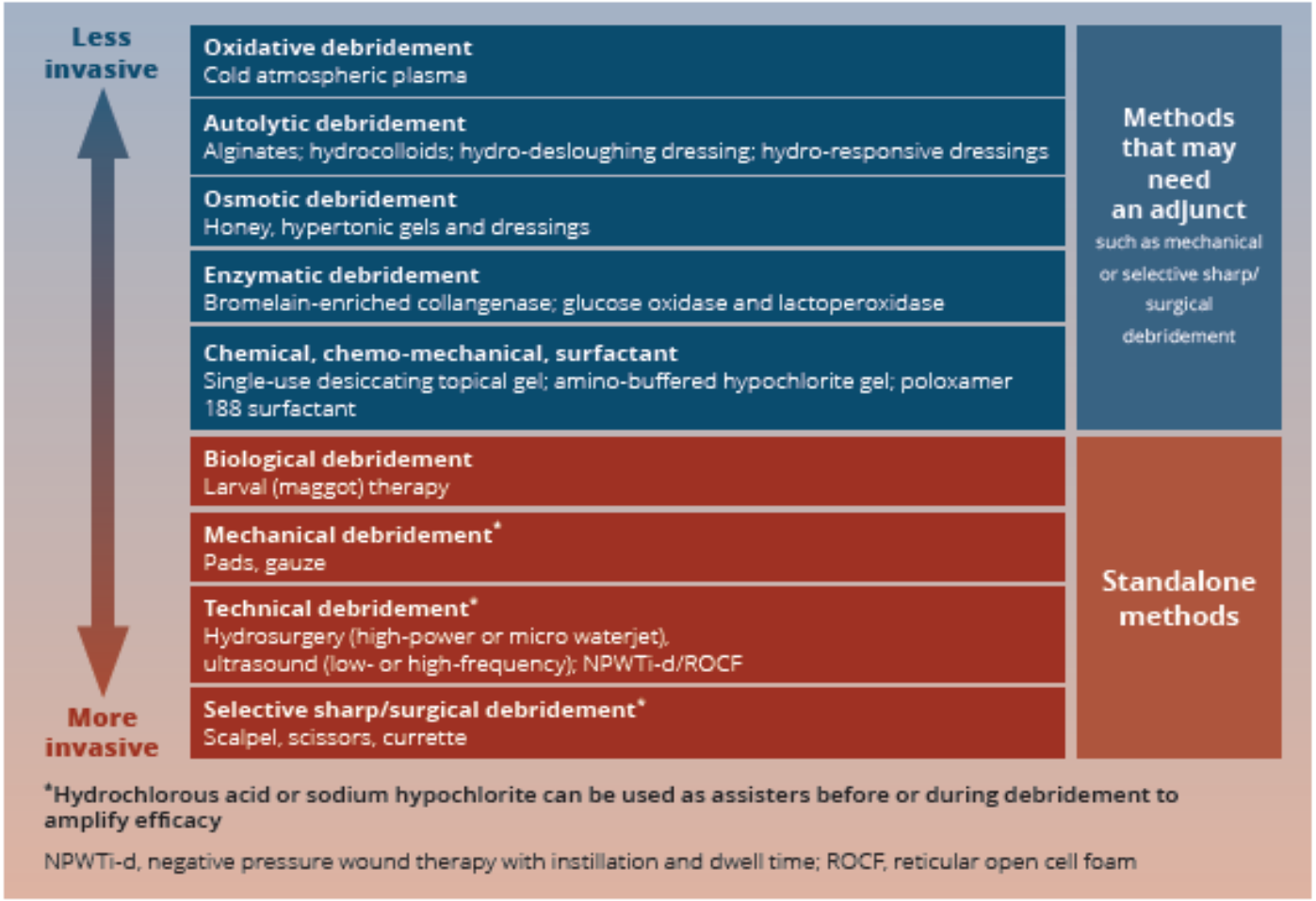
New Concept: Integral debridement is “the combined use of different but complementary methods of debridement on the same wound.”

Example: Sharp debridement followed by the use of negatively charged fibers.

Mayer DO, et al. *J Wound Care.* 2024;33(6 SupC):S2-S32.

Debridement Options

Figure 8. Debridement methods by invasiveness and need for an adjunct

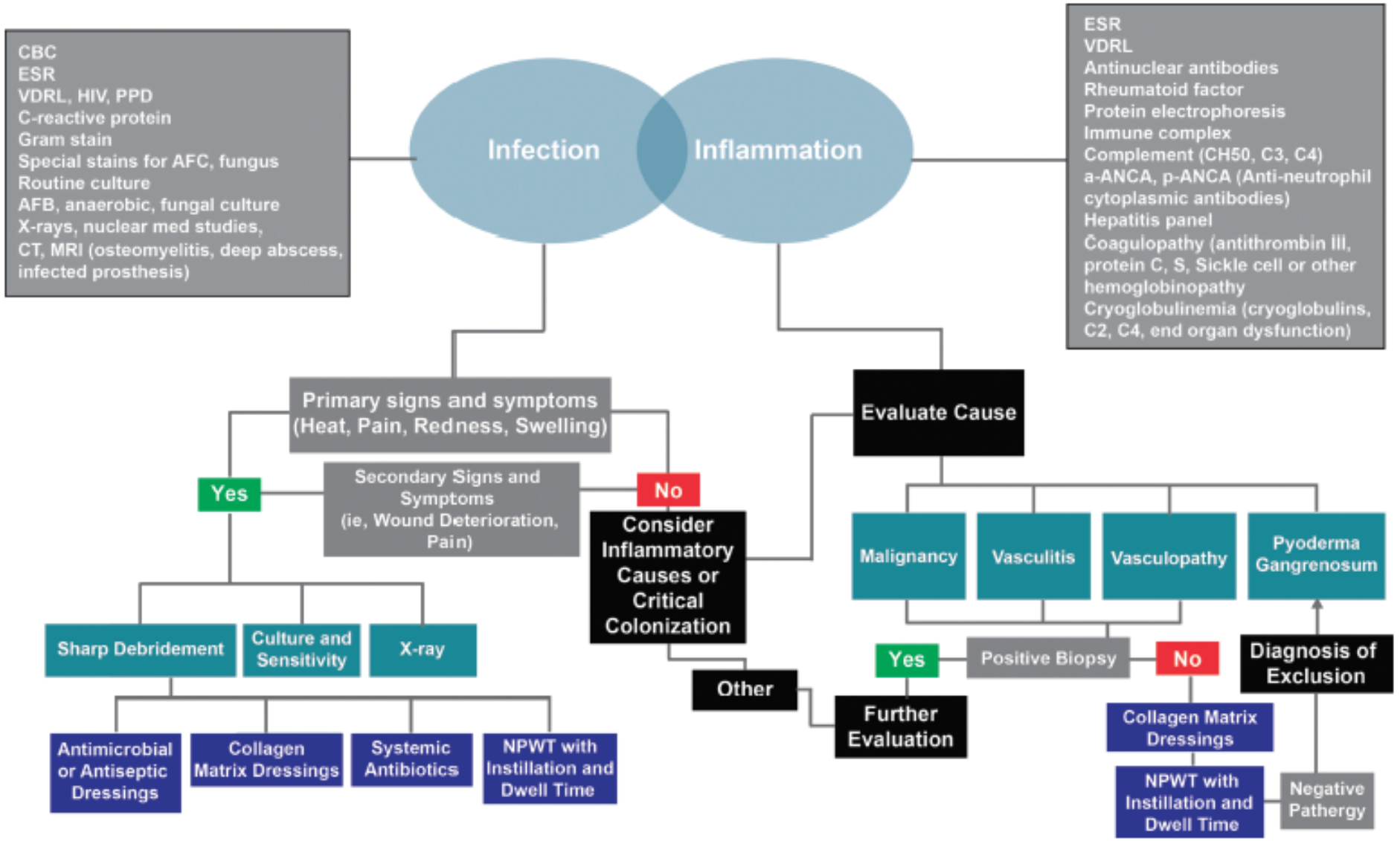


*Hydrochlorous acid or sodium hypochlorite can be used as assisters before or during debridement to amplify efficacy

NPWTi-d, negative pressure wound therapy with instillation and dwell time; ROCF, reticular open cell foam

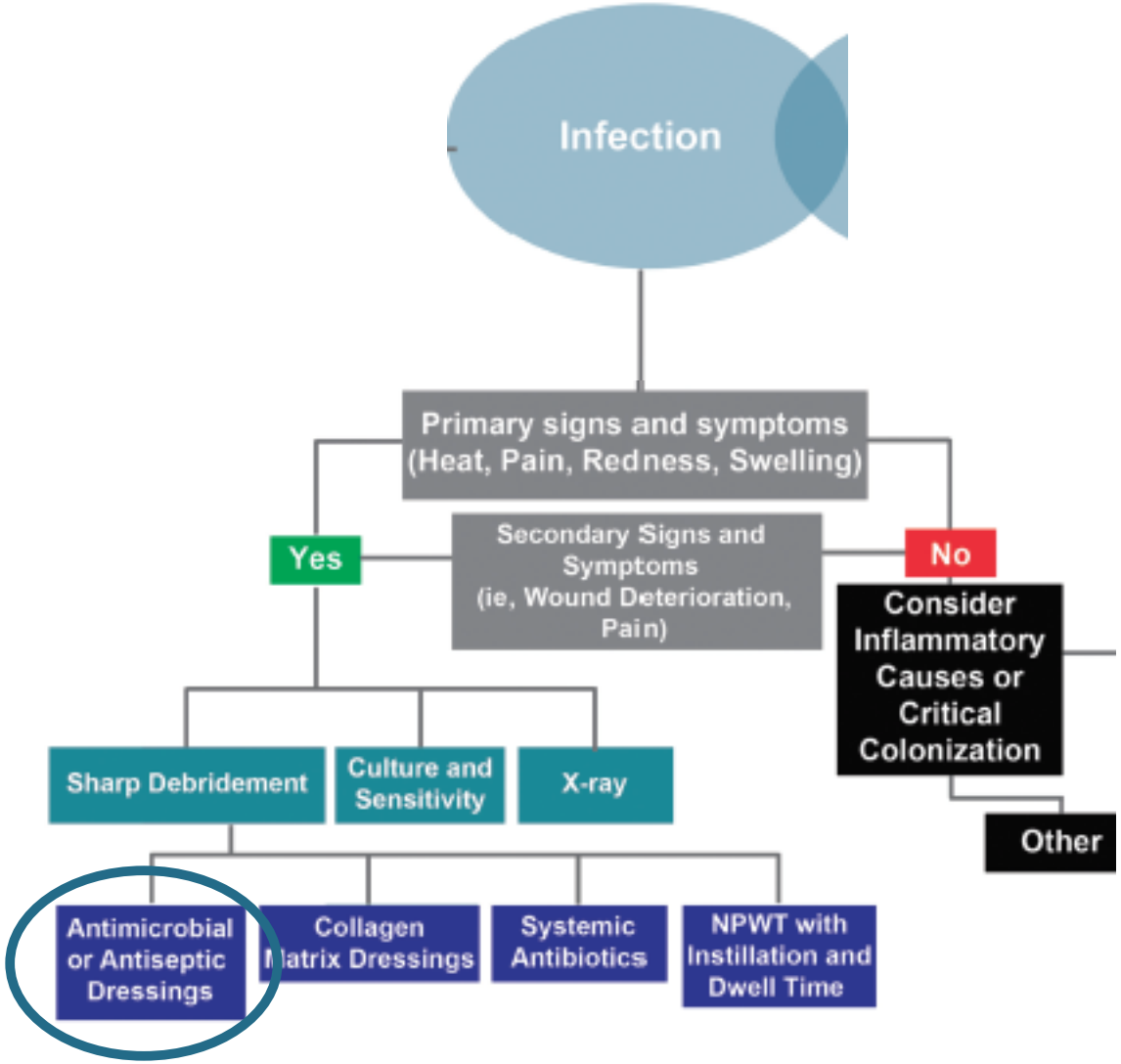
Mayer DO, et al. *J Wound Care.* 2024;33(6 SupC):S2-S32.

Infection/Inflammation



Snyder RJ, et al. *Adv Skin Wound Care*. 2016;29(5):205-215.

Infection



Snyder RJ, et al. *Adv Skin Wound Care*. 2016;29(5):205-215.

Treatment

Primary Topical	Effective Against
Bacitracin	Gram-negative/-positive *cocci* and *Bacilli*
Cadexomer iodine ointment	Broad spectrum, (thyroid caution)
Gentamicin sulfate	Gram-negative microbes
Metronidazole	Anaerobes
Mupirocin	Gram-positive/-negative, MRSA
Neomycin sulfate	Broad spectrum, gram-negative/-positive
Triple antibiotic ointment	Broader spectrum than neomycin, bacitracin, or polymyxin
Peroxide	Gram-negative microbes, cytotoxic
Polymyxin B sulfate	Gram-negative microbes
Silver sulfadiazine	Broad spectrum, gram-positive/-negative microbes, *Candida albican*, (sulfa allergy caution)

Source: Livingston M, Wolvos T. (2009)

Treatment

Antiseptics/Antimicrobial Preserved Cleansers	Effective Against
Acetic Acid	Gram-positive/negative, *Pseudomonas*, must be diluted
Chlorhexidine gluconate	Broad spectrum, must be diluted, ***cytotoxic*** starting on day 3
Povidone-iodine	Gram-positive/negative, yeast, fungi
Sodium hypochlorite	Bacteria, viruses, fungi, must be diluted, ***cytotoxic,*** BID treatment for efficacy
Hypochlorous acid	Gram-positive/negative, yeast, fungi, biofilm disruptor, ***non-cytotoxic***

Source: Livingston M, Wolvos T. (2009)

Treatment

Antimicrobial Barrier Dressings	
Silver	Broad spectrum, fungi, viruses, MRSA, VRE
Manuka Honey	Broad spectrum, MRSA, VRE, deodorizes, debrides
Iodine	Consider thyroid disruption
Polyhexamethylene Biguanide	Broad spectrum, MRSA, *E. coli*, *Pseudomonas*

- Sustained antimicrobial effect to entire wound base
- Moist environment
- Available as impregnated gauze, foams, island dressings, films, absorptive fillers, and other forms
- Provides a barrier against other microbes
- Controls exudate
- Protects wound from further trauma

When to Implement Antimicrobial Barrier Dressings

- Contamination/colonization
  - Topical antimicrobial barrier dressings are not indicated because bioburden is not causing clinical problems
- Localized infection
  - Topical antimicrobial barrier dressings indicated
- Systemic infection
  - Topical antimicrobial barrier dressings + antibiotics

Active Antimicrobial Barrier Dressings

Provide sustained release of the antiseptic agent at the wound surface = long lasting antimicrobial action in combination with maintenance of moist wound healing

- Iodine/cadexomer starch
- Silver dressings
- Activated charcoal
- Leptospermum honey
- Methylene blue/gentian violet PVA sponge
- Anti-biofilm agents

Sibbald, RG, et al. *Adv Skin Wound Care*: 2006;19:447-461.

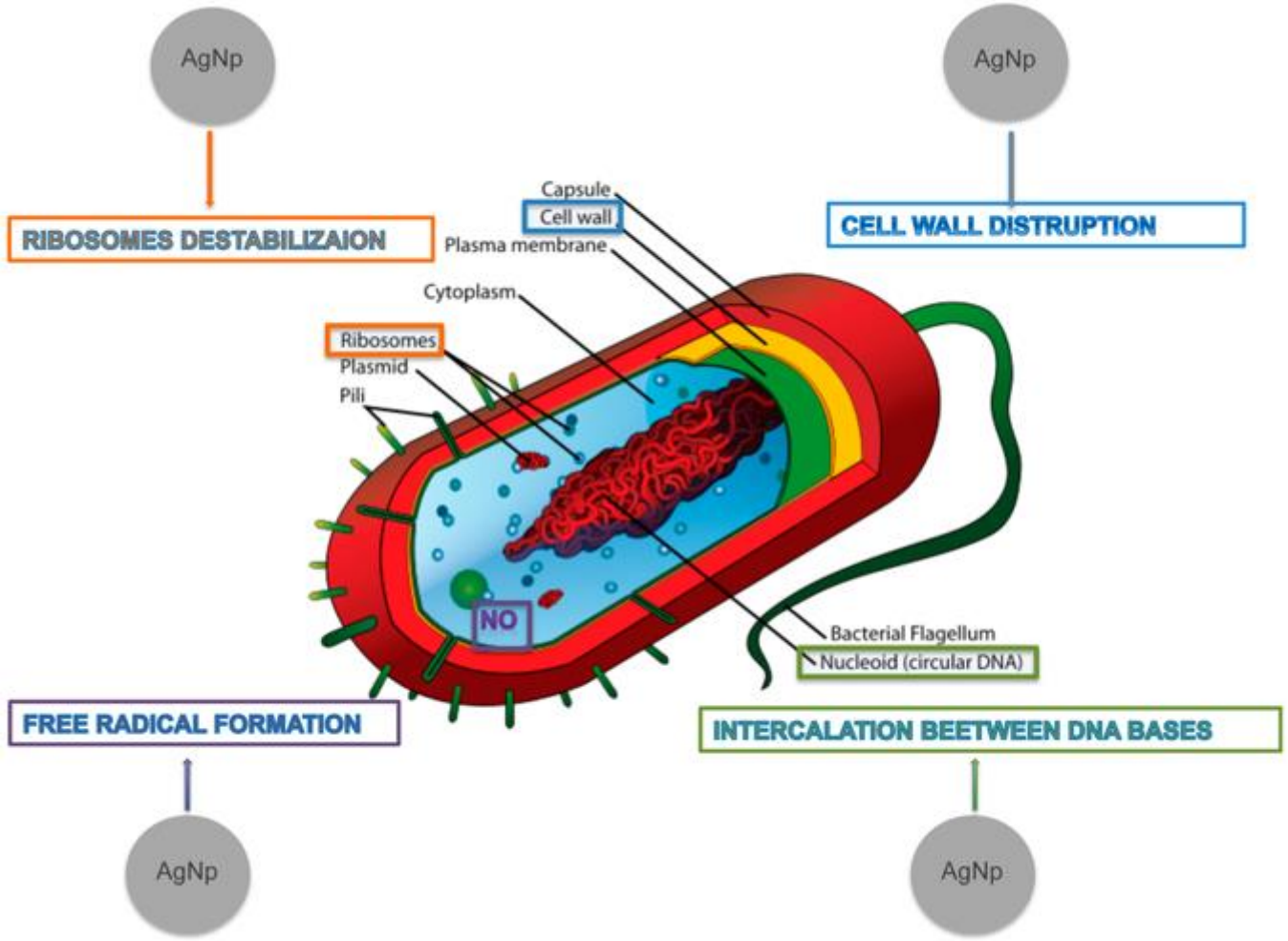
The Use of Silver: A Historical Perspective

Centuries of Use

- Romans used silver nitrate therapeutically
- People of ancient Greece and Rome used silver containers for keeping liquids fresh
- Silver foil dressings were used for dressing wounds until just after WWII (when antibiotics became widespread)

International consensus. *Appropriate use of silver dressings in wounds. An expert working group consensus.* London: Wounds International, 2012.

Silver Modes of Action



Franci G, et al. *Molecules*. 2015;20(5):8856-8874.

Inappropriate Use of Silver Dressings

- Lack of or low risk of infection
- Closed wounds
- Appropriately healing wounds
- Patients with silver sensitivities
- Pregnant or lactating women
- Consult silver product manufacturer for recommendations regarding safety with magnetic resonance imaging (MRI)*

International consensus. *Appropriate use of silver dressings in wounds. An expert working group consensus.* London: Wounds International, 2012.

The Use of Honey: A Historical Perspective

2000-Year History

- Smith Papyrus (the world's oldest known medical document, 4,000 yrs old) honey mixed with grease and lint to keep it on the wound
- Aristotle 2 millennia ago some honeys are better than others for use in wound treatment
- Usage declined at the introduction of penicillin in 1940s

Method of Action: Medical Honey

- Lowers the pH of the wound bed
  - Wounds heal best in acidic environment
  - Chronic wounds are alkaline
- High osmolarity
  - Bathes the wound in fluid from periwound
  - Causes autolytic debridement

Henry N, et al. *Br J Nurs*. 2019;28(6):S30-S35.

What Not To Do...

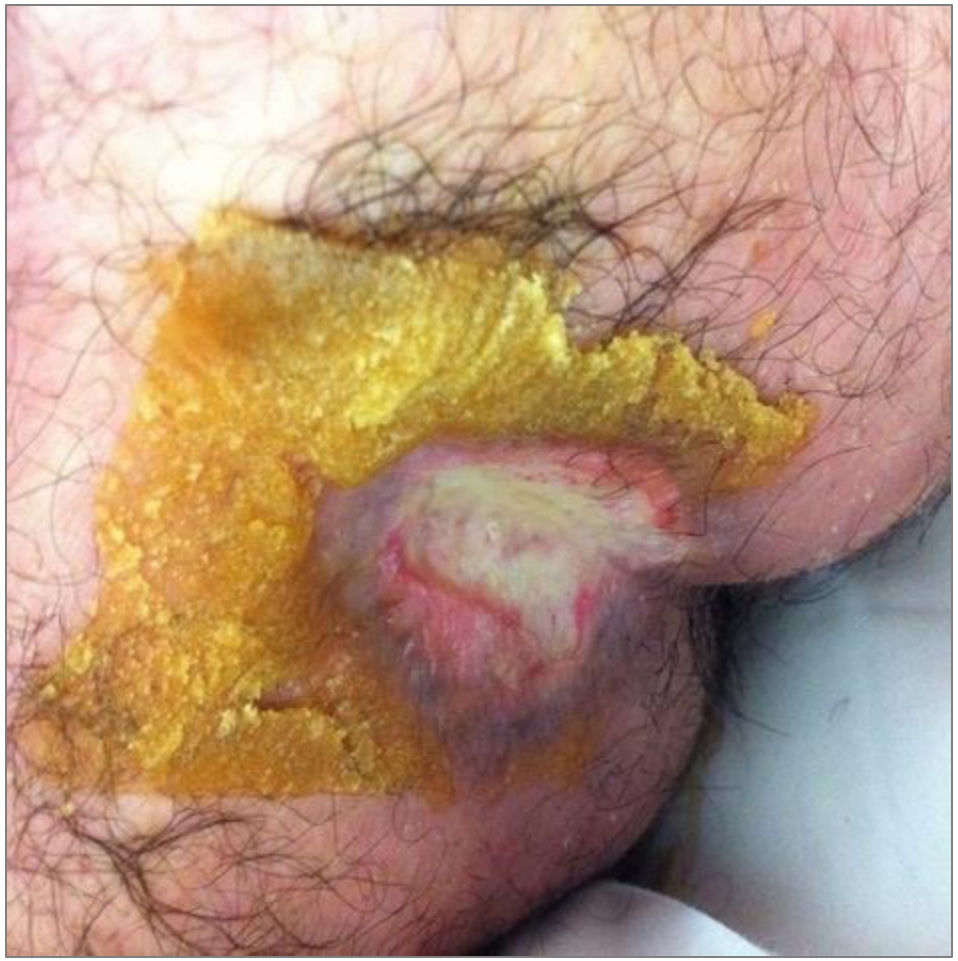
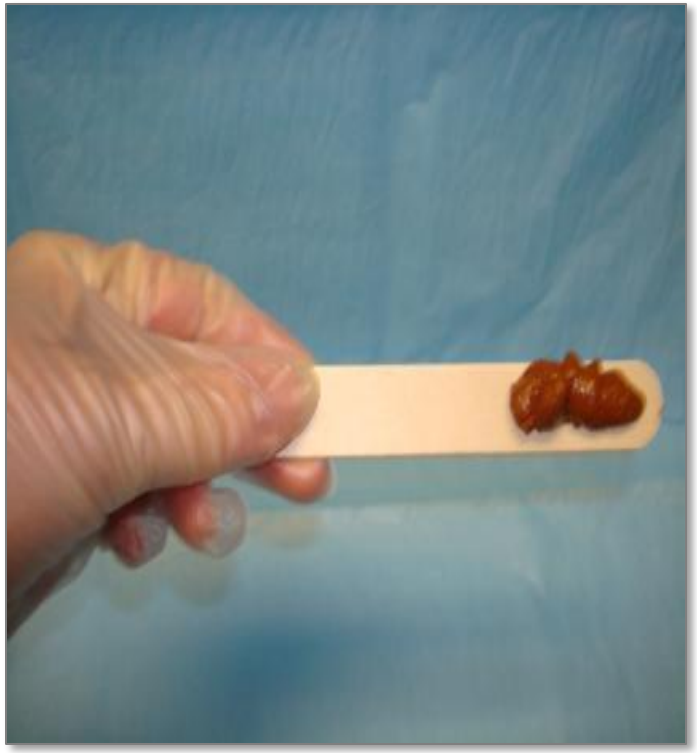


Photo courtesy of Kara Couch.

Cadexomer Iodine

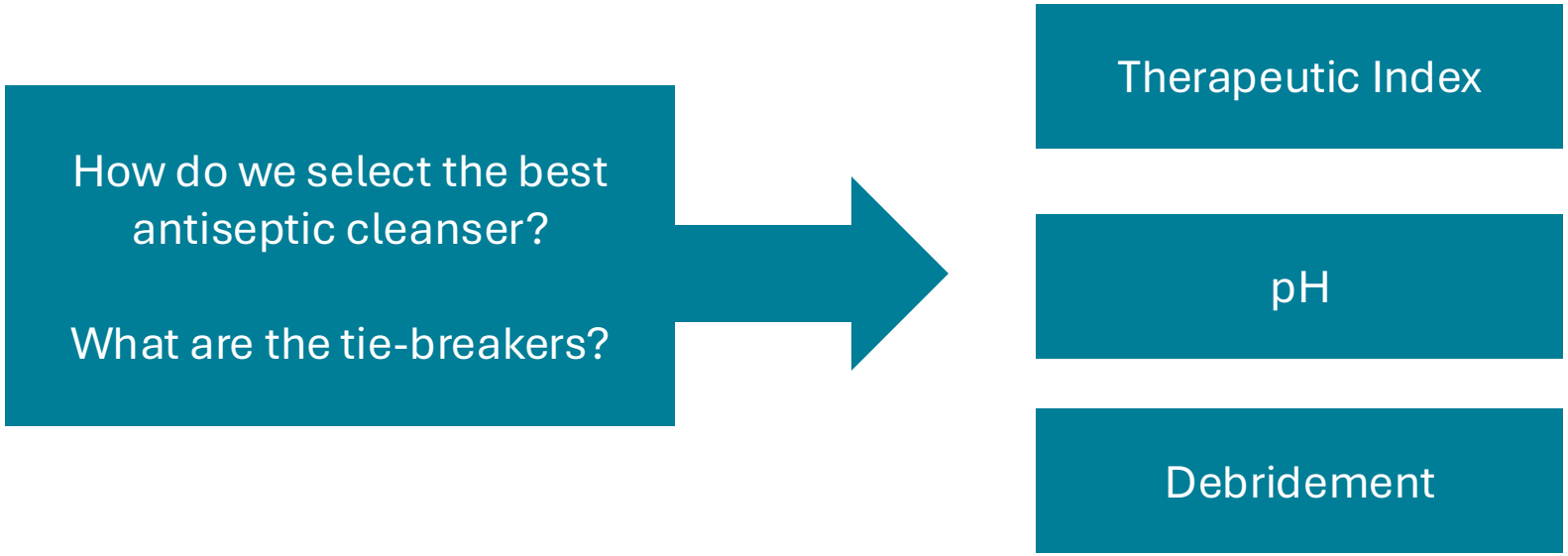
- Dilute cadexomer iodine in a starch lattice
- Demonstrates anti-biofilm action *in vivo* and *in vitro*
- Releases iodine as it absorbs fluid
  - "White-out"
- Sustained antimicrobial activity
- Considerations
  - Macerating/dehisced incisions and exudative wounds



Fitzgerald DJ, et al. *Wound Repair Regen*. 2017;25(1):13-24.

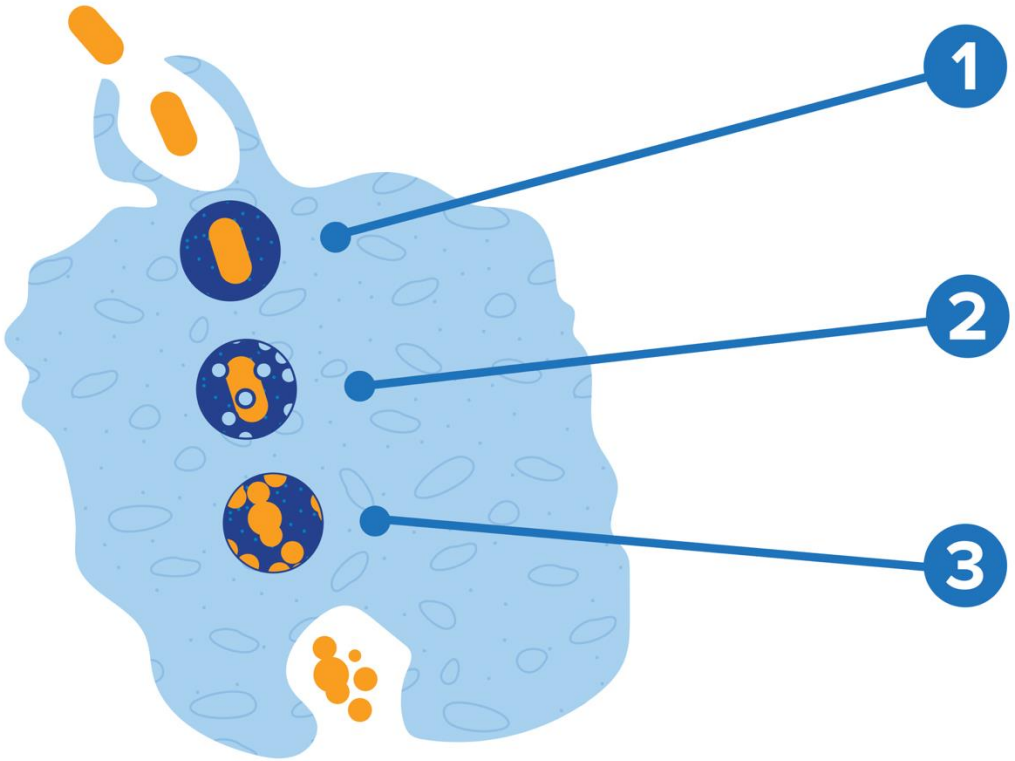
Antiseptic Solutions Could Be More Efficacious

- Cleansers with antiseptic properties led to a significantly greater reduction in bacteria than non-antiseptics and surfactants (saline, soap)
- There was no statistically significant difference between antiseptic cleansers.



Oropallo A, et al. *Int Wound J*. 2024;21(2):e14730.

Pure Hypochlorous Acid is used by the human body as a natural response to invading pathogens.

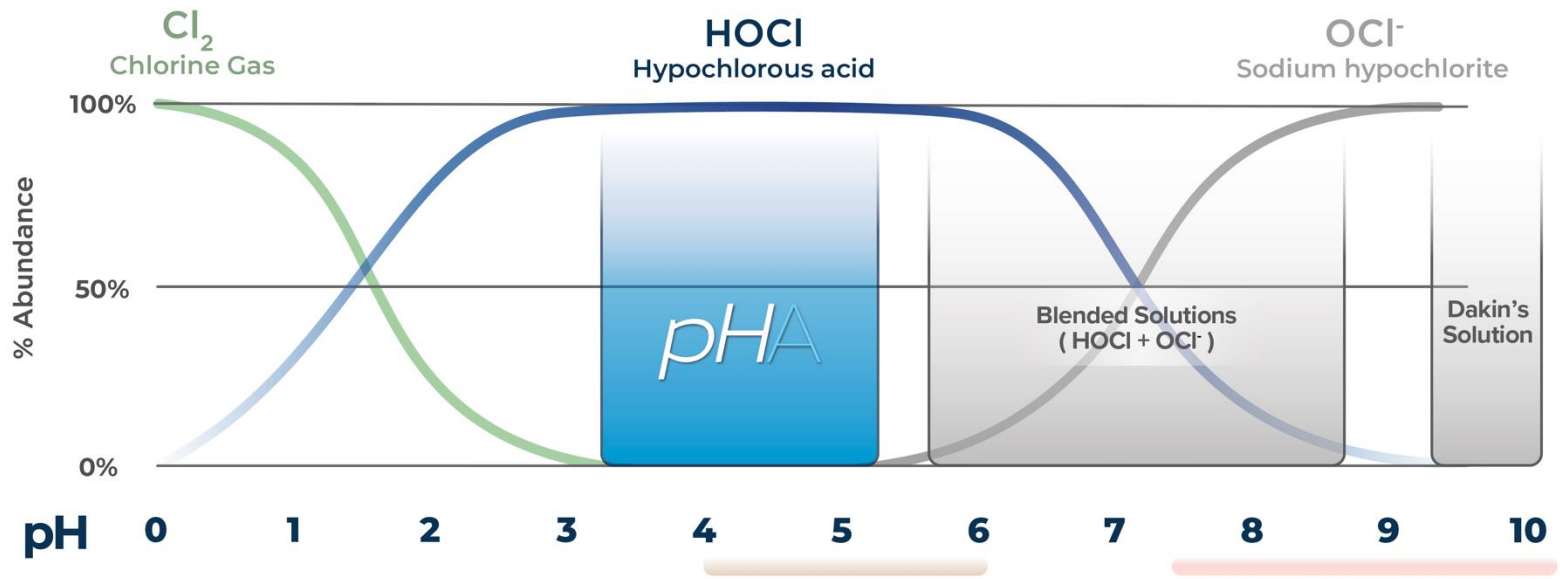


Pathogens are targeted and engulfed by white blood cells.

Hypochlorous acid (HOCl) is generated within the white blood cell.

Pathogens are destroyed by HOCl action.

The Connection of pH to Wound Healing



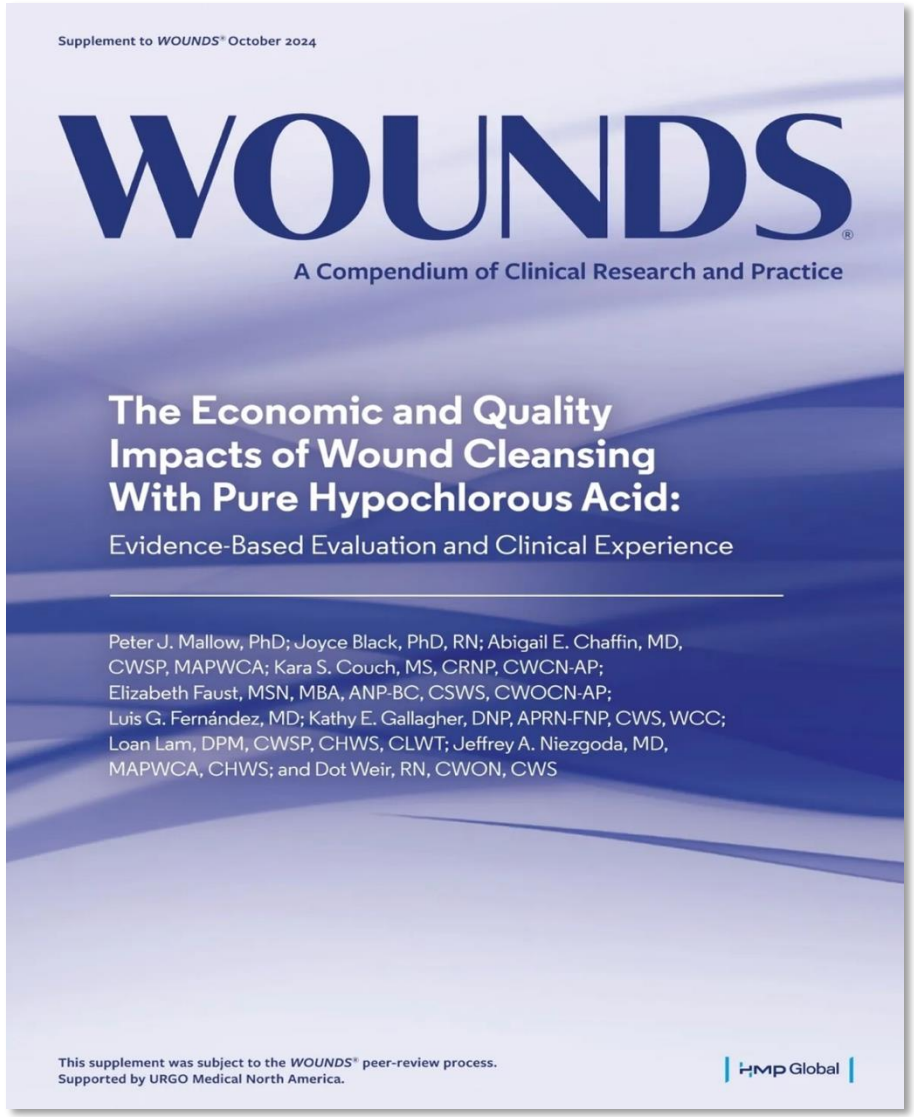
Healthy, Intact Skin – pH 4.0-6.0[14-18]
(Acidic environment**)**

- Higher antimicrobial properties
- Favorable to wound healing
- Preserves skin function
- Increased macrophage and fibroblast activity
- Ensures stratum corneum cohesion and barrier function

Vulnerable Skin – pH >7.5[14]
(Alkaline environment**)**

- Allows pathogens to thrive[19]
- Impedes the healing process[19]
- Inflammation and irritation[14]
- Same pH as Chronic wounds[20]

Cost Effectiveness: HOCl



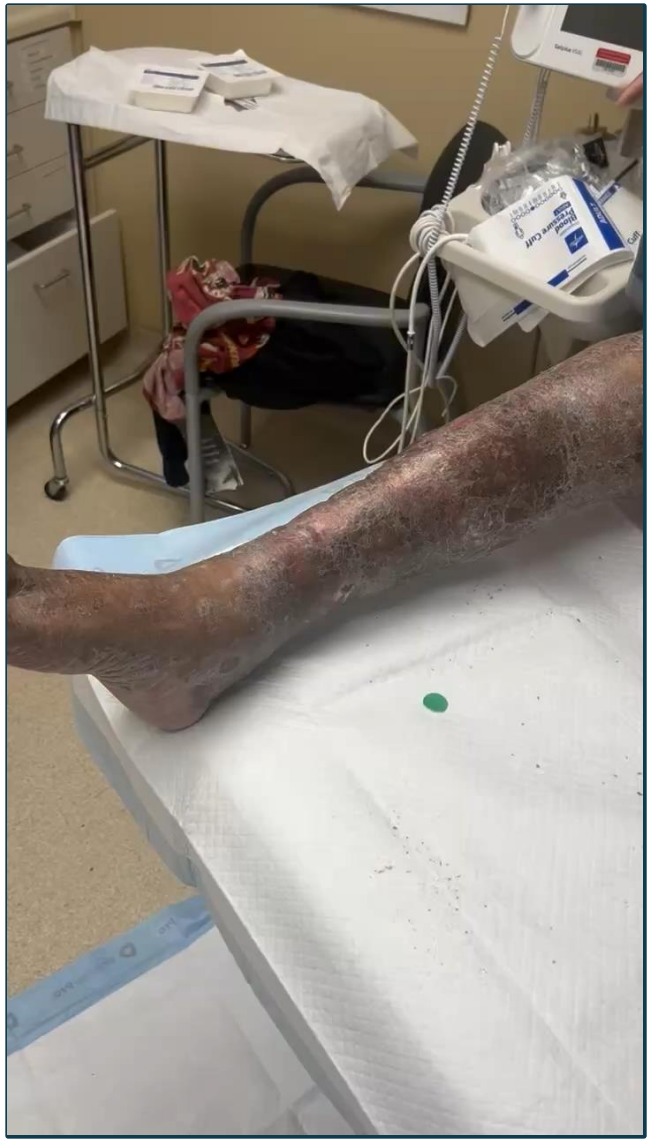
Limb Hygiene

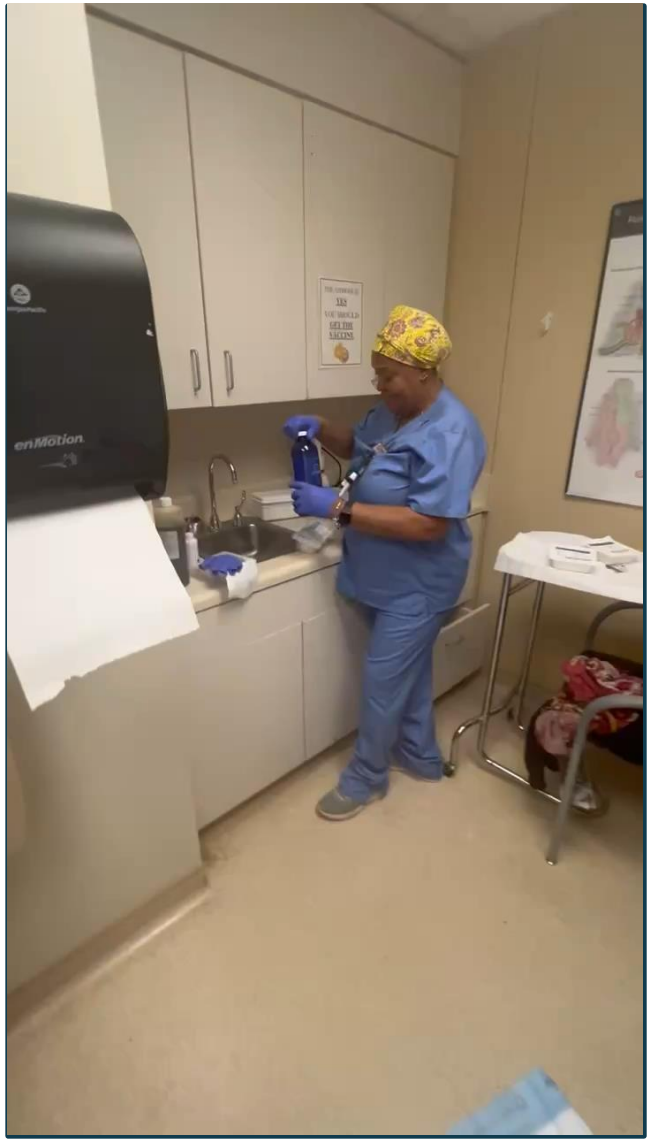
The cleansing and drying of the affected limb to achieve and maintain skin integrity.

- Essential to maintain health and integrity of the skin
- Gentle cleansing daily
  - If compression used cleanse at each wrap change
- pH-balanced skin cleanser and moisturizer
- Include feet and toes

LeBlanc K, et al. Best practice recommendations for the prevention and management of skin tears in aged skin. *Wounds International* 2018

Video: Limb Hygiene





Consensus and Guidelines

Wound Repair and Regeneration: Treatment Guidelines
April 2022

"All chronic wounds should be **assumed** to be contaminated or infected with bacteria."

Eriksson E, et al. *Wound Rep Regen.* 2022;30(2):156- 171.

Wound Repair and Regeneration: Treatment Guidelines
April 2022

"Using topical antimicrobials to reduce bacterial (and fungal) bioburden in chronic wounds to levels that do not impair healing is based on the principle that the topical antimicrobial treatments can **effectively kill the planktonic and biofilm bacteria without killing an unacceptable amount of wound cells** (fibroblasts, keratinocytes, vascular endothelial cells) that are required to actually heal the wound."

Eriksson E, et al. *Wound Rep Regen.* 2022;30(2):156- 171.

International Wound Infection Institute Consensus Guidelines
March 2022

"Topical antiseptics are non-selective and may be ***cytotoxic***. This means they ***may kill skin and tissue cells involved in wound repair*** (eg, neutrophils, macrophages, keratinocytes, and fibroblasts), thereby impairing the healing process."

International Wound Infection Institute Consensus Guidelines
March 2022

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

Chronic Inhibitory Bacterial Load (CIBL)

"The chronic presence of bacterial microorganisms in a wound or its surrounding tissue at loads which can damage tissues and be inhibitory to healing, as well as require clinical intervention, with or without the presence of clinical symptoms"

Armstrong DG, et al. *Int Wound J.* 2023;20(2):554-566.

Common Solutions in Soft Tissue Injury and Infection

- Control the source of infection
- Protect from re-infection
- Resuscitate the tissue
  - Edema management
  - Maintenance of tissue domain
  - Creation of new blood supply
  - Creation of new tissue
  - Epithelialization

SOFT TISSUE TOOLS

- **Debridement**
- **Antibiotics**
- **Nutrition**
- **Systemic Support**
- **Wound Care**

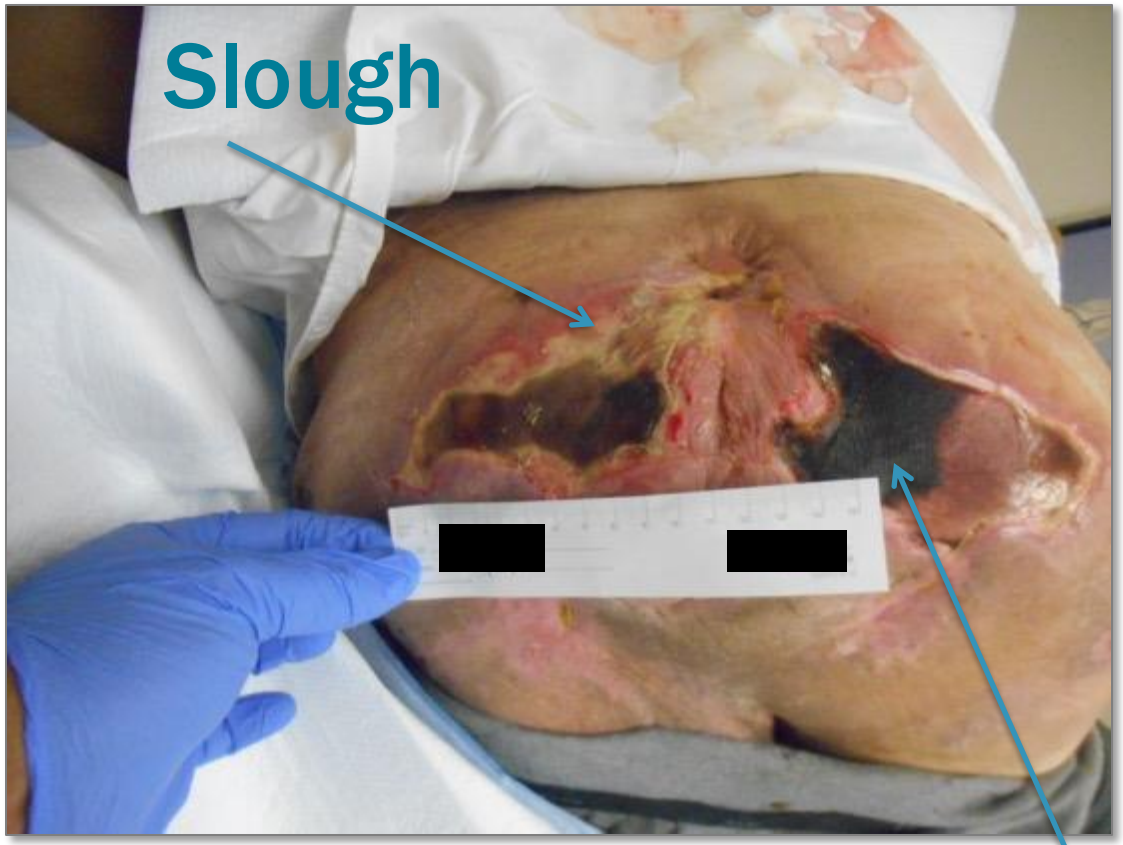
Stevens DL, et al. *Clin Infect Dis.* 2014;59(2):e10–e52. Ovington L. *Ostomy Wound Manage.* 2003;49(7A Suppl):8–12. Cheadle WG. *Surg Infect*. 2006;7(Suppl 1):S7–11. Sartelli M, et al. *World J Emerg Surg.* 2018;13(58)

Best outcomes come from thorough wound bed preparation

Slough: Composition, Analysis, and Effect on Healing

https://www.woundinfection-institute.com


Slough


Slough
Eschar

Microbial Colonies Begin to Re-Form within 24 Hours of 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"
- "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"
- "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"

Schultz, G. et al. *Wound Repair Regen*. 2017;25:744-757. International Wound Infection Institute (IWII) Wound Infection in Clinical Practice. *Wounds International*. 2022. European Pressure Ulcer Advisory Panel, National Pressure Injury Advisory Panel and Pan Pacific Pressure Injury Alliance. Prevention and Treatment of Pressure Ulcers/Injuries: Clinical Practice Guideline. The International Guideline. Emily Haesler (Ed.). EPUAP/NPIAP/PPPIA: 2019. **4.** Murphy C, et al. International consensus document. *J Wound Care*. 2020;29(Suppl 3b):S1-28.

What Is Slough? Characterization

Received: 6 December 2023 | Revised: 6 February 2024 | Accepted: 19 February 2024

DOI: 10.1111/wrr.13170

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

Elizabeth C. Townsend BA[1,2,3] | J. Z. Alex Cheong PhD[1,2] |
Michael Radzietza PhD[4] | Blaine Fritz PhD[5] | Matthew Malone PhD[4] |
Thomas Bjarnsholt PhD[5,6,7] | Karen Ousey PhD[7,8] | Terry Swanson MHSc, NP[7] |
Gregory Schultz PhD[7,9] | Angela L. F. Gibson MD, PhD, FACS[10] |
Lindsay R. Kalan PhD[1,7,11,12,13]

What Is Slough? Characterization

- Slough is a highly common and burdensome feature of wounds; however, its definition and composition remain poorly characterized
- Our findings demonstrate that
  - (i) the microscopic structure of slough is heterogenous and unique to each wound;
  - (ii) across subjects, wound slough is composed of proteins involved in the structure and formation of the skin, blood clot formation, and various immune responses;
  - (iii) the microbial community composition is diverse and corresponds to the wound's aetiology and location on the body and
  - (iv) the composition of slough is associated with wound healing outcomes
- Collectively, these findings underscore how the composition of slough itself may be useful for developing microbial and proteomic biomarkers prognostic of wound healing trajectories

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

Is There Anything to Address this Topically?

How Do Charged Fibers Work?

Biomaterials behave in predictable ways within complex tissue environments

- **Electrostatic Interactions**
  - **Steric Exclusion**
  - **Hydrophobic Interactions**
  - **Hydrogen Bonds**

Negatively charged fibers have a high attraction towards sloughy material which can be net positively charged in the wet wound

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

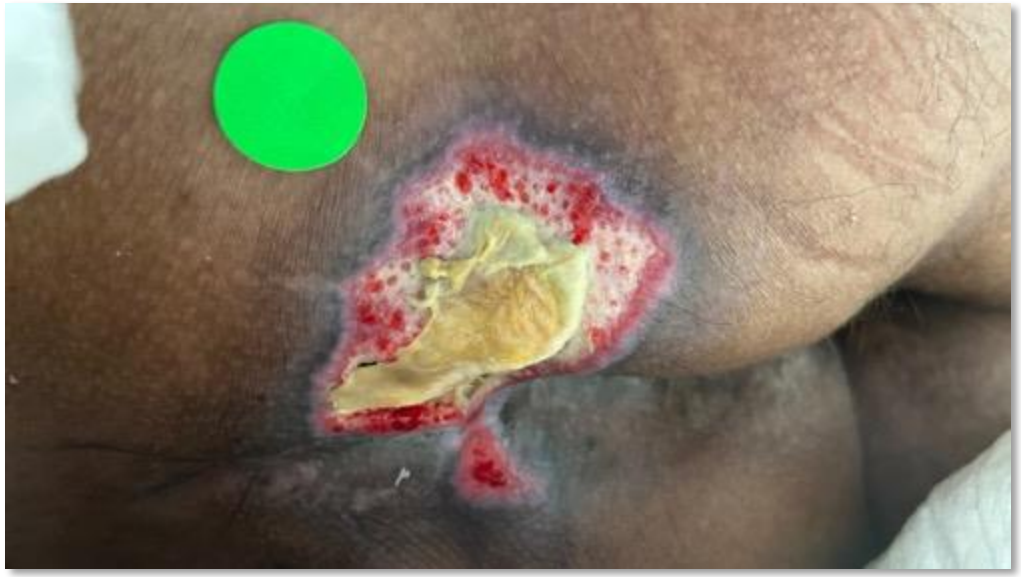
Case

- 54y Male with PMHx of FAP with initial colon cancer diagnosis in 2008 s/p colectomy and ileostomy, duodenal polyposis s/p Whipple procedure (2012), ventral hernia s/p mesh repair (2016), and h/o desmoid tumors s/p multiple resections with recurrent desmoid tumor small bowel resection c/b short gut syndrome
- Developed HAPU after decrease in function r/t cancer and overall medical issues

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

FAP = familiar adenomatous polyposis; HAPU = hospital-acquired pressure ulcer.

Case: Sacral Pressure Injury



12/14/23

- Prior to application of negatively-charged fiber (NCF) dressing with silver-containing lipido-colloid matrix
- Treated with medical-grade honey and cross hatching for 3 wks

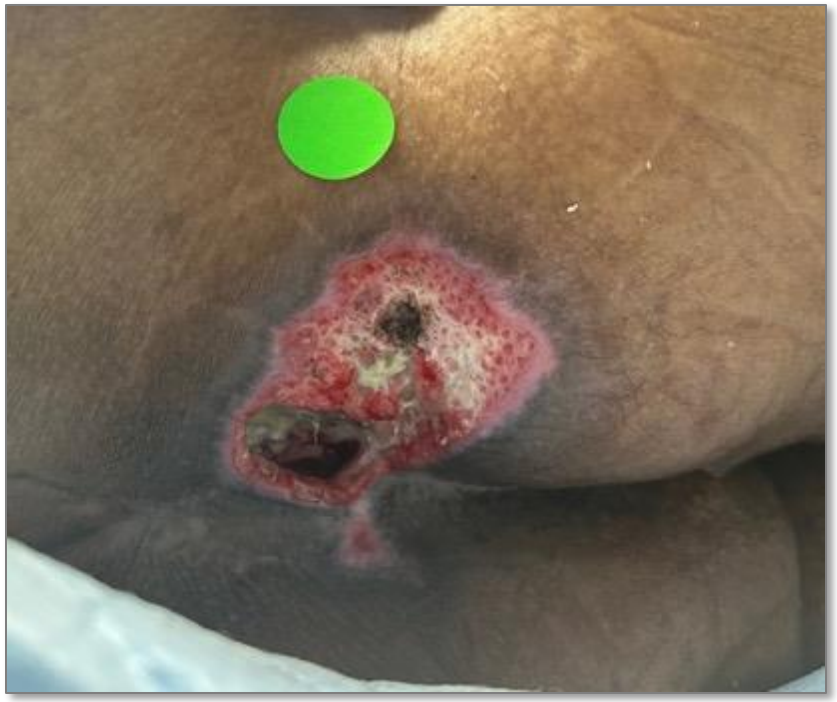
12/18/23

- After 1 dressing application

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

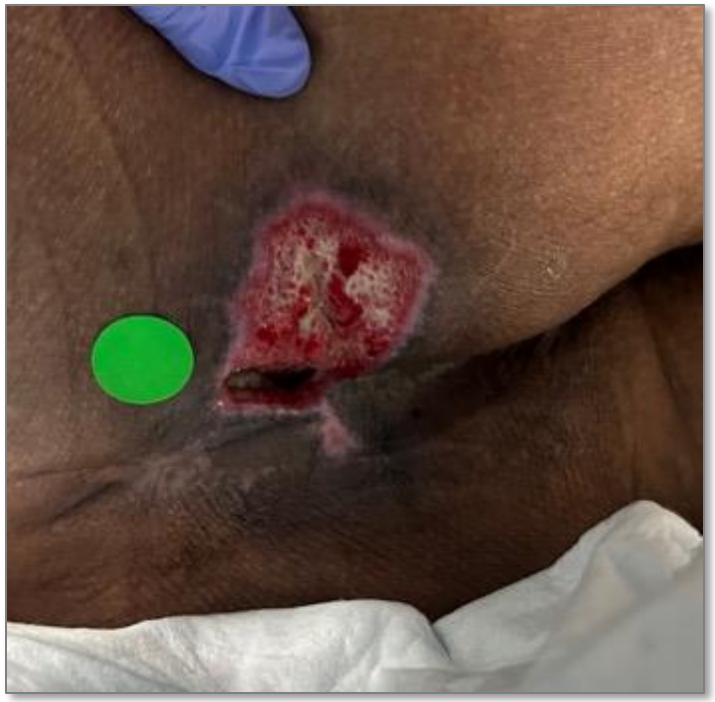
NCF = negatively-charged fiber.

Case: Sacral Pressure Injury



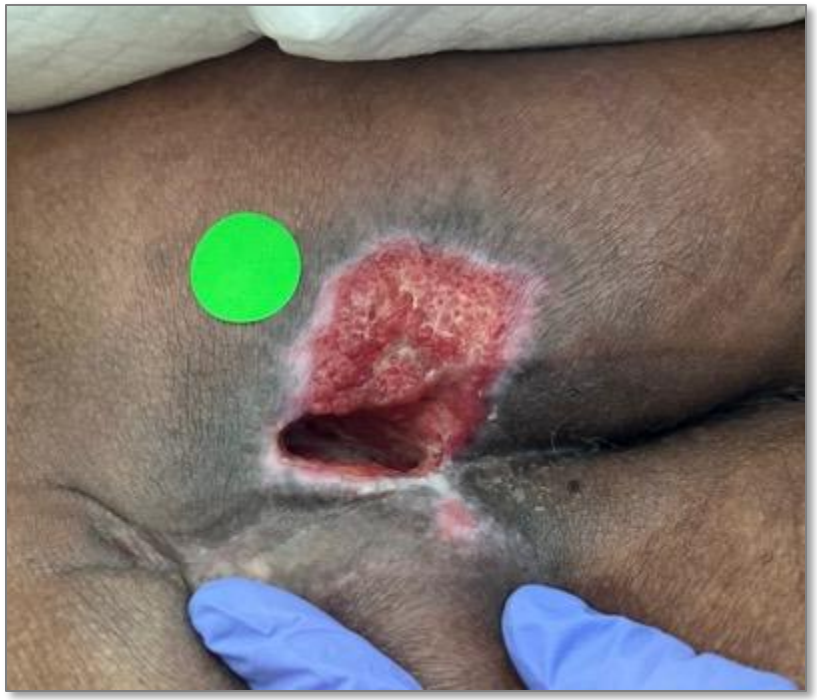
12/22/23

- Sharp debrided in OR
- NCF Ag lipido-colloid matrix dressing applied after debridement



12/27/23

- After application #3



1/2/24

- After application #5

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

Wound Infection Continuum

Solution

Intensity

- Gentle
- Moderate
- Rigorous
- Vigorous

Technique

Equipment

IWII THERAPEUTIC WOUND AND SKIN CLEANSING CONTINUUM

INTERNATIONAL WOUND INFECTION INSTITUTE

- Three zones for therapeutic cleansing: wound bed and edge, periwound and surrounding skin
- Apply antiseptics for the recommended contact time to achieve anitmicrobial activity
- Follow local policies and procedures

Increasing microbial burden in the wound

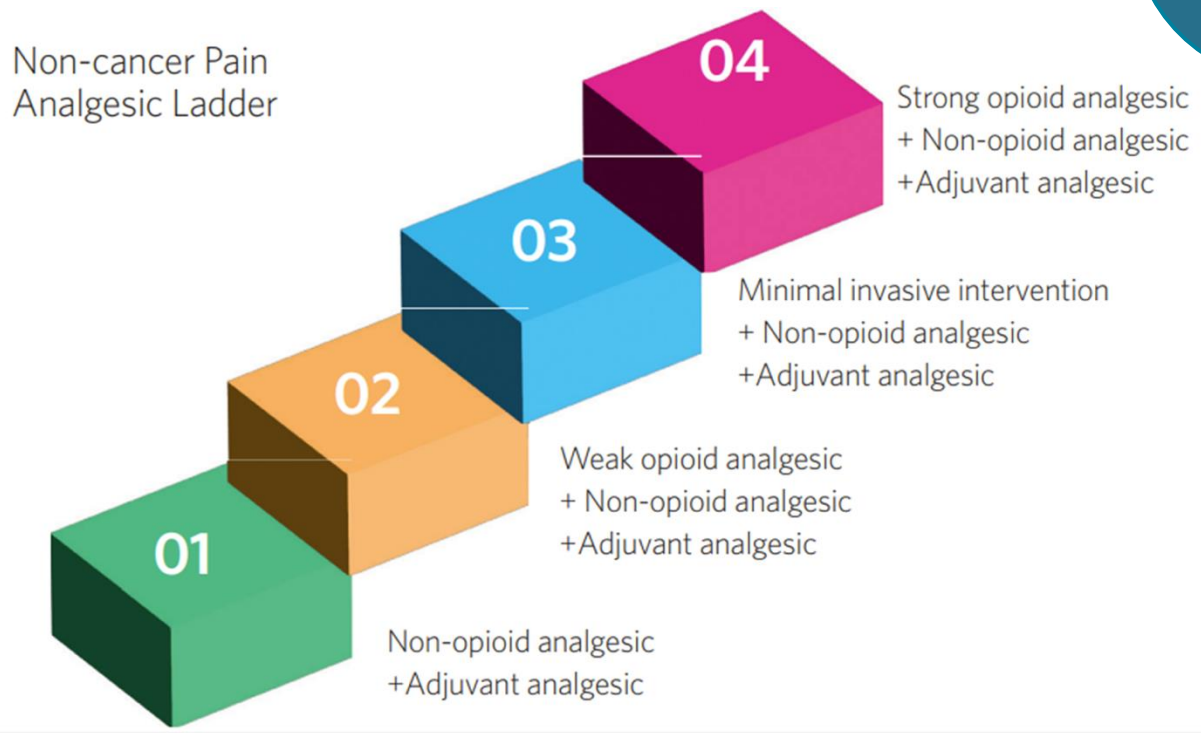
As the continuum green shading darkens, microbial burden increases

	HEALING	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
PAIN	• Continual pain assessment: Rember the 3 As of pain management: Anticipate, Administer and Assess						
WOUND CLEANSING SOLUTION	• Inert solutions	• Inert solutions	• Inert solutions • High risk: surfactants and/or antiseptics	• Antiseptics • Surfactants • Inert solutions		• Antiseptics • Surfactants • Inert solutions	
WOUND CLEANSING INTENSITY	• Gentle	• Gentle to moderate	• Moderate/ rigorous	• Moderate to vigorous		• Vigorous	
WOUND CLEANSING TECHNIQUE	• Therapeutic cleansing • Irrigation • Soaks	• Therapeutic cleansing • Irrigation • Soaks • Compress • Swabbing • Scrubbing/mechanical action • Instillation • Hydroresponsive dressings					
CLEANSING EQUIPMENT	• Cleansing wipes/cloth • Irrigation equipment • Cleansing pad/microfilament pad • Gauze						
SKIN CLEANSING	• Mild skin cleanser with pH close to normal skin (4 to 5.5) • Cleansing wipes/cloths/gauze • Soaks, swapping, scrubbing/mechanical action						

Overview: Wound Cleansing Techniques

Technique	When to Use
Irrigation, flushing	• Minimal exudate • Without slough • Minimal microbial burden
Swabbing	• Exudate • Visible debris, slough, and other nonviable tissue • Signs and symptoms of infection
Scrubbing, cleansing pad, monofilament fibre pad, gauze pad	• Exudate • Visible debris, slough, and other nonviable tissue • Signs and symptoms of infection
Compress	• Heathy granulation or new epithelialization with healthy or dry wound edges • Wet wound bed with macerated wound edges • Loose debris or signs and symptoms of local wound infection
Soaking, bathing, wet packing	• Require increased hydration/moisture (eg, dry healable wounds or moisture-balanced wound bed with desiccated wound edges) • Signs and symptoms of local wound infection and spreading infection • Visible debris • Surrounding skin or periwound with visible debris or hyperkeratotic tissue
Instillation	• Small debris particles that are more difficult to dislodge • Poor wound bed integrity • Need for grafting or granulation tissue formation
Hydro-responsive dressings	• Devitalised tissue requiring removal • Dry or moist wound bed

Addressing Pain Associated with Therapeutic Wound Cleansing



3 As of Pain:

- Anticipate
- Administer
- Assess

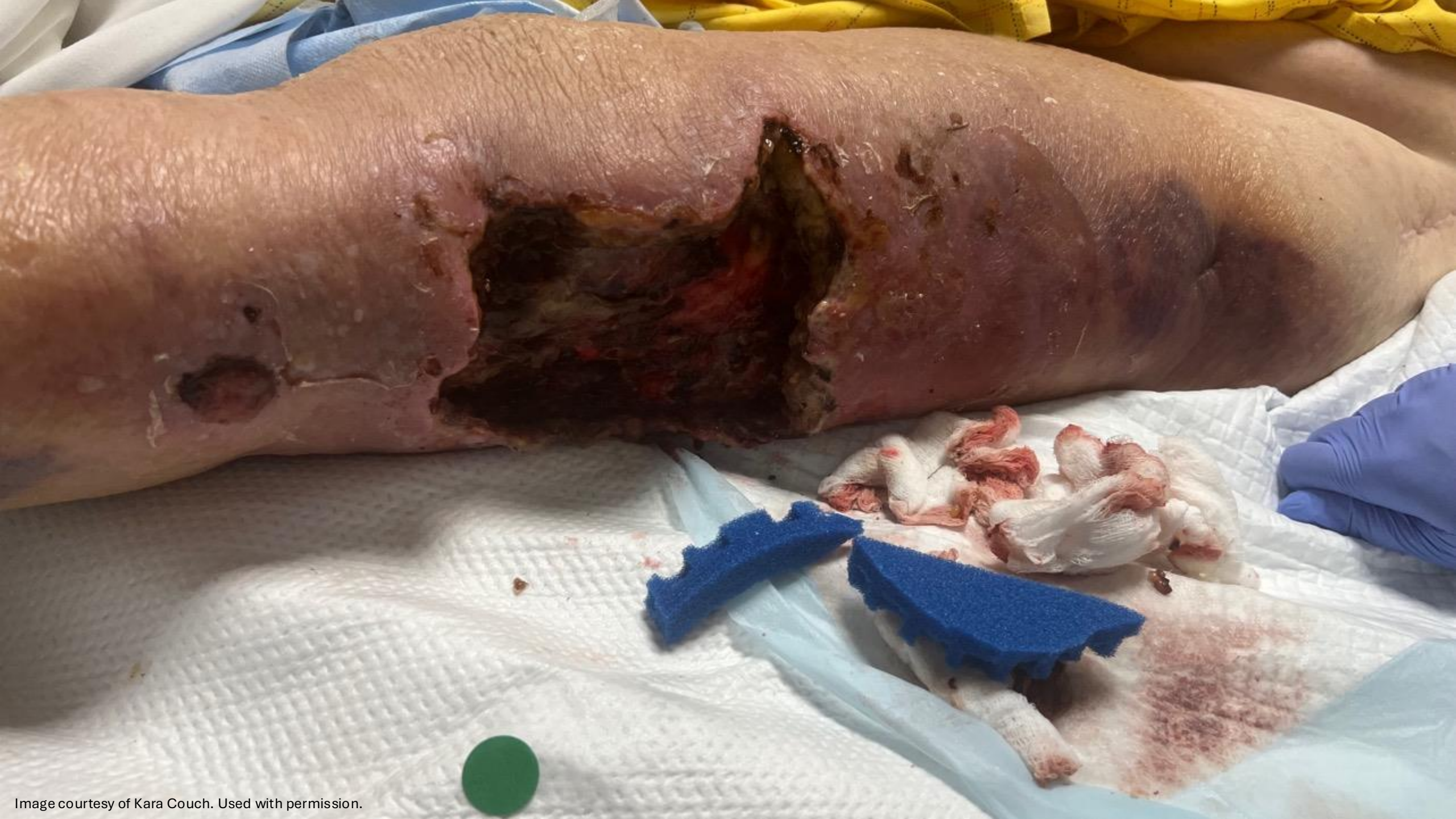
Strategies for pain

- **Topical and systemic analgesia**
- **Warm solutions**
- **Education and explanation**
- **Appropriate technique**

Updated non-cancer pain analgesic ladder (Yang, et al 2020. Anekar, et al. 2023)

Case

- 88y Female
- Traumatic hematoma s/p fall
- Bedside evacuation by surgery
- 1 application of NPWTi-d with HOCl x2 days



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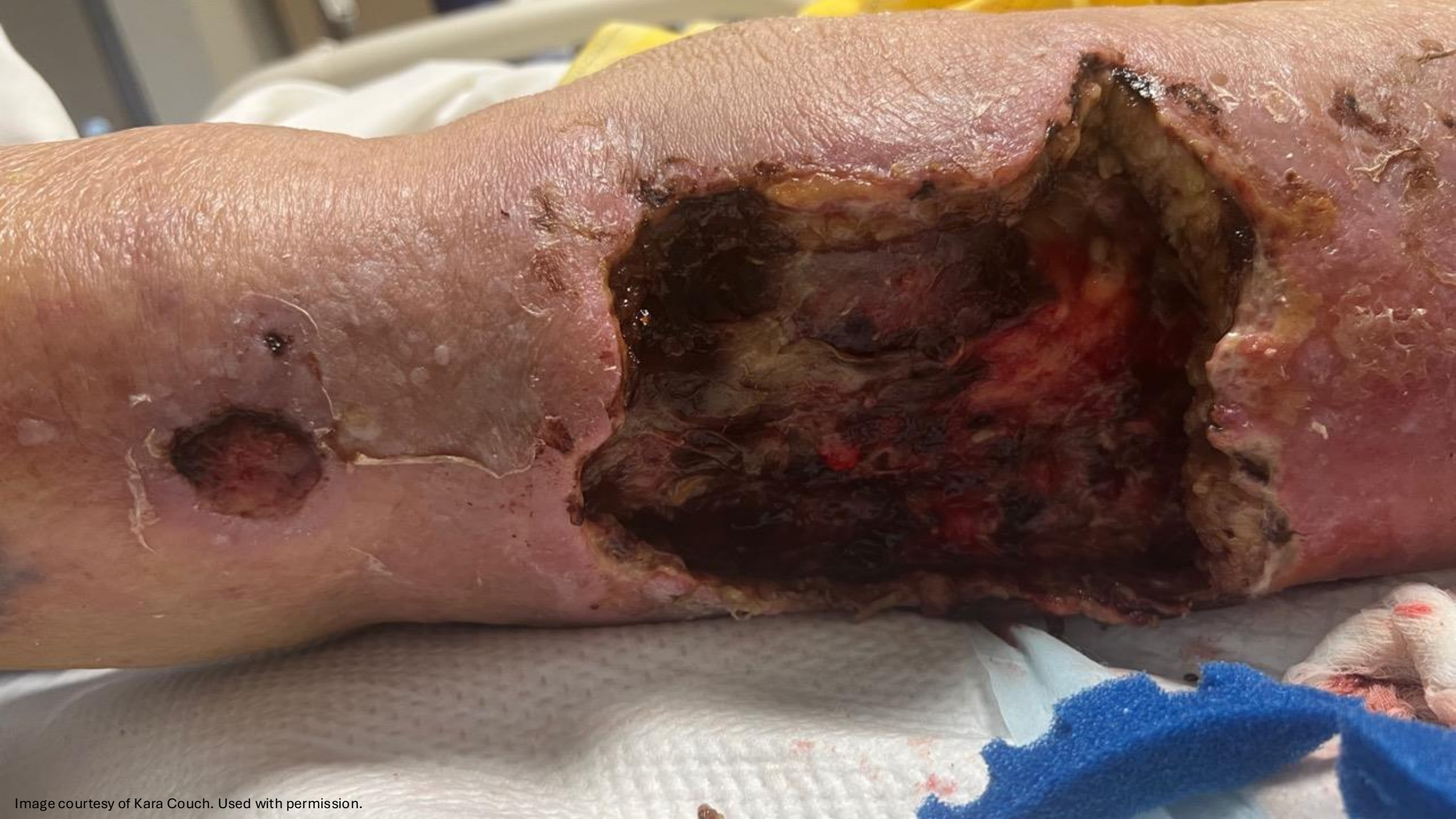

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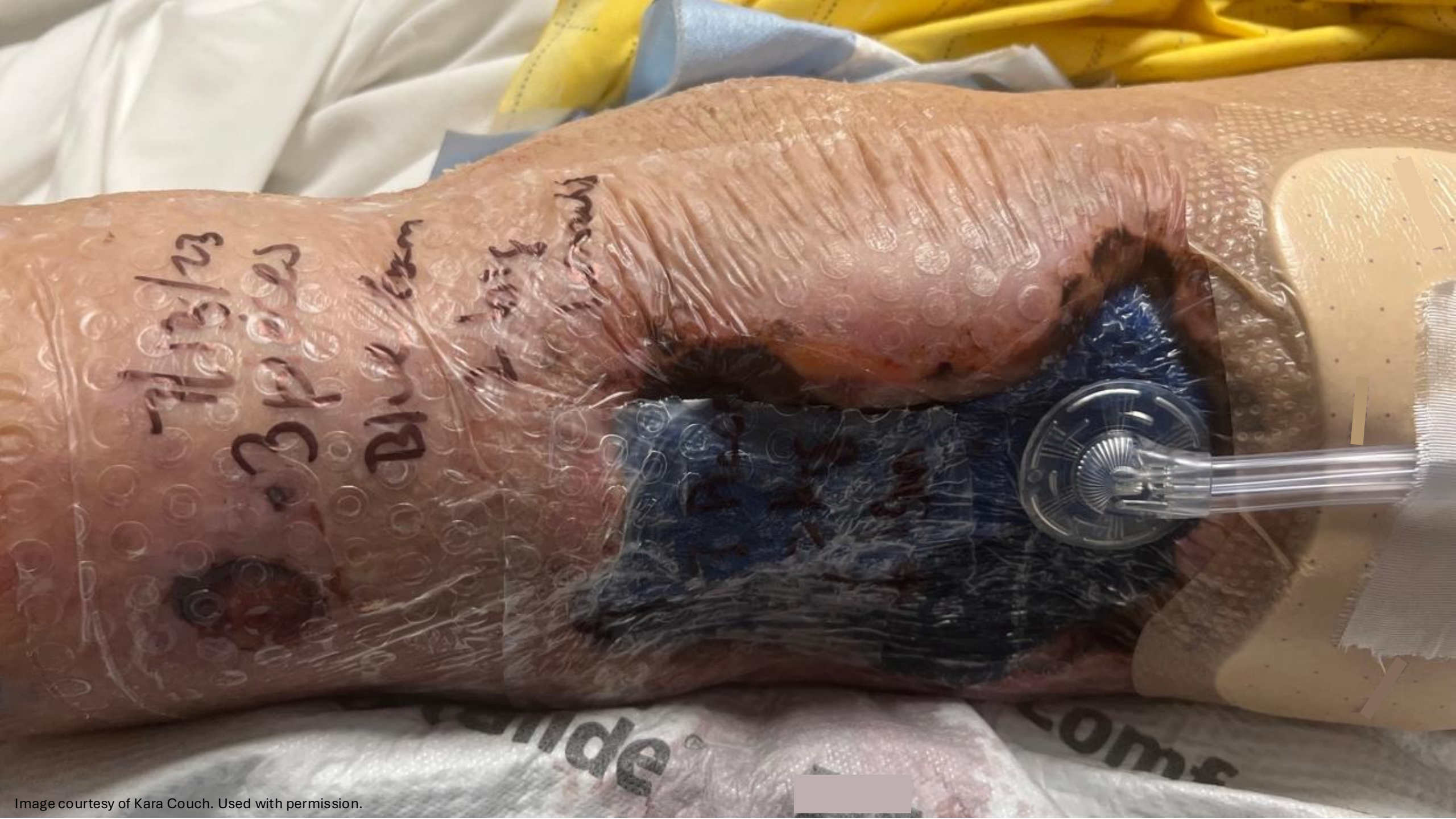

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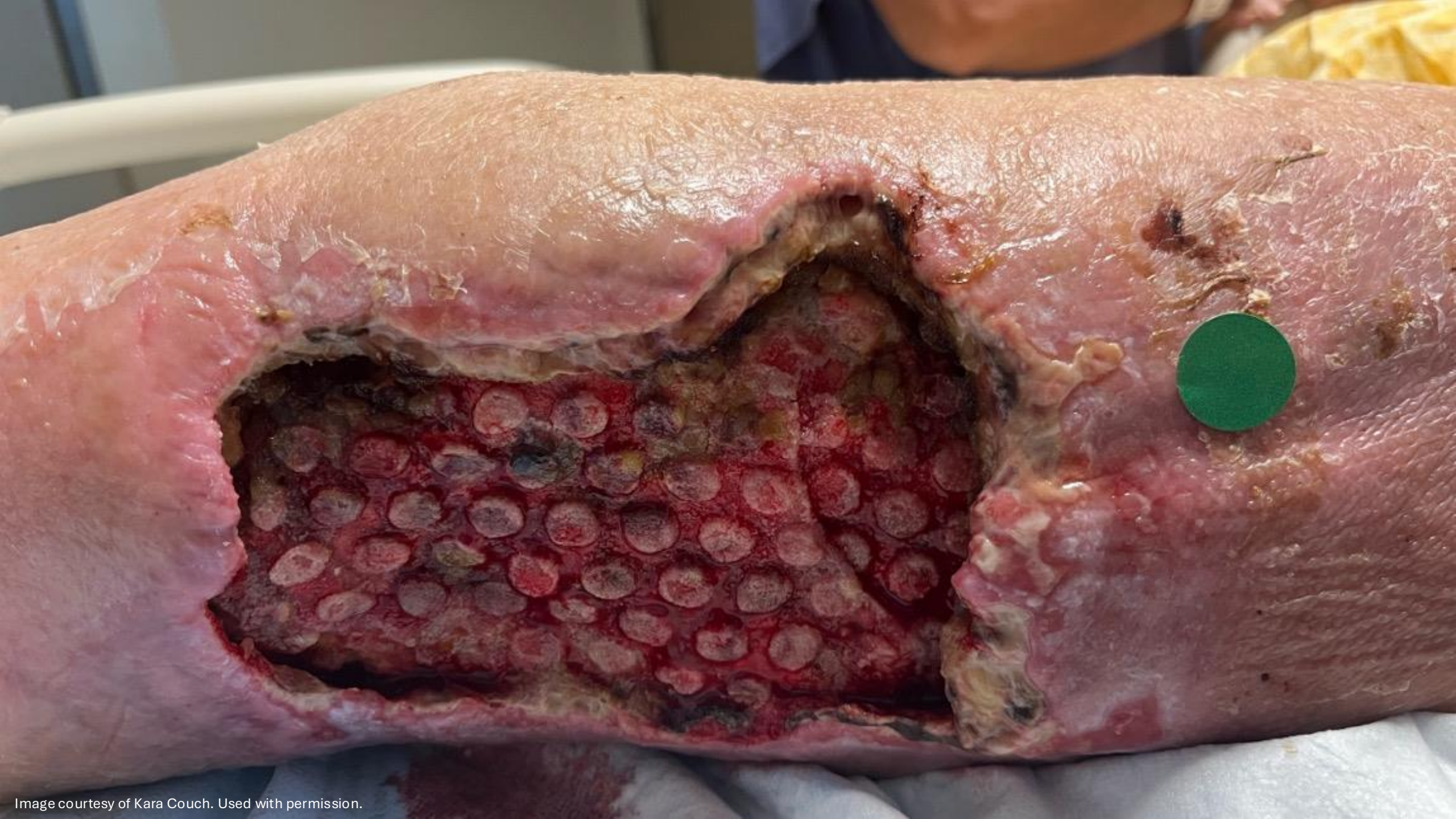

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Thank You