Wound Bed Preparation

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Disclosures

- Speaker's Bureau for:
  - Urgo
  - MolecuLight
  - Smith & Nephew
- Wound Hygiene Panel (sponsored by Convatec)

2

My Objectives

- Review barriers to closure in hard to heal wounds
- Discuss the concept of wound bed preparation
- Explore components of Wound Hygiene

3

What is a complex wound?

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

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Acute vs. Complex / Chronic wounds

- The wound healing process is complex and fragile: multiple factors can result in a healing stall or delay
- Delayed or non-healing should be regarded as a pathology that can be successfully addressed with the right tools, provided that the underlying etiology is managed with gold standard care
- Wounds should be triaged by level of risk, regardless of their duration

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Acute vs. Complex / Chronic wounds

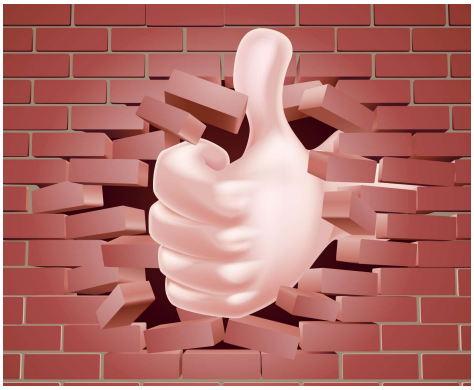
- Acute wound: A wound with an etiology that occurs suddenly, either with or without intention, but then heals in a timely manner.
- Chronic wound: a wound that has a slow progression through the healing phases, or shows delayed, interrupted or stalled healing due to intrinsic and extrinsic factors that impact on the individual and their wound.
  - A wound that has failed to respond to evidence-based standard of care

International Wound Infection Institute (IWII) Wound infection in clinical practice. Wounds International 2022
Murphy C, Atkin L, Swanson T, Tachi M, Tan YK, Vega de Ceniga M, Weir D, Wolcott R. International consensus document. Defying hard-to-heal wounds with an early antibiofilm intervention strategy: wound hygiene. J Wound Care 2020; 29(Suppl 3b):S1–28.

6

Hard to Heal Wounds

- Patient barriers that can be managed or at least mitigated
  - Improved glucose management
  - Weight loss
  - Improve perfusion
- Wound barriers are present that can be overcome
  - Uncontrolled or under-addressed etiology
  - Edema
  - Proteases
  - Unhealthy tissue = *Granulitis*
  - Bacteria / biofilm
  - pH



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Know and support the etiology

Venous Ulcers: Compression

Arterial lesions: Revascularize and protect

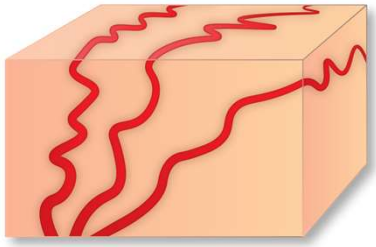
Diabetic Foot Ulcers: Offload

Pressure Injuries: Offload

Atypical Wounds: Biopsy

8

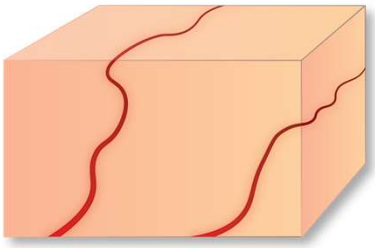
Edema Reduction/Tissue Decompression



Normal Tissue

Tissue edema is at minimum, perfusion is ideal

Tissue volume ↑, vascular density ↓, perfusion distance ↑, and blood flow decreases



Edematous Tissue

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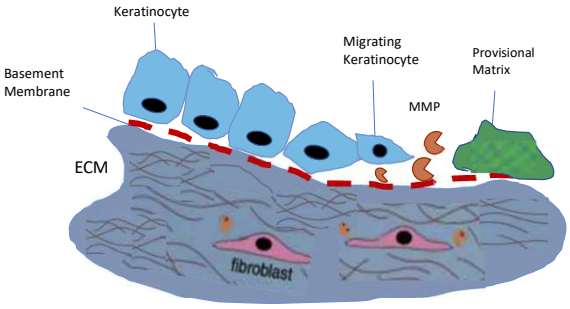
Matrix Metalloproteases

- Family of protein-degrading enzymes
- Synthesized & secreted by multiple cells
- Responsible for cellular migration
- Stopped by tissue inhibitors of Metalloproteases (TIMPs)
- Overproduction in response to bacteria, pH imbalance
  - Causes off target destruction



Caley MP, Martins VL, O'Toole EA. Metalloproteinases and Wound Healing. Adv Wound Care (New Rochelle). 2015;4(4):225-234.

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Respect the Bacteria

- Observe closely for subtle → dramatic changes
  - Exudate/Malodor
  - Change in tissue quality/quantity
  - Increase or new pain
  - Erythema
  - Purulence
  - Delay in healing
- Culture wisely with intent to treat
- Use topicals early practicing antimicrobial stewardship
- Practice wound hygiene

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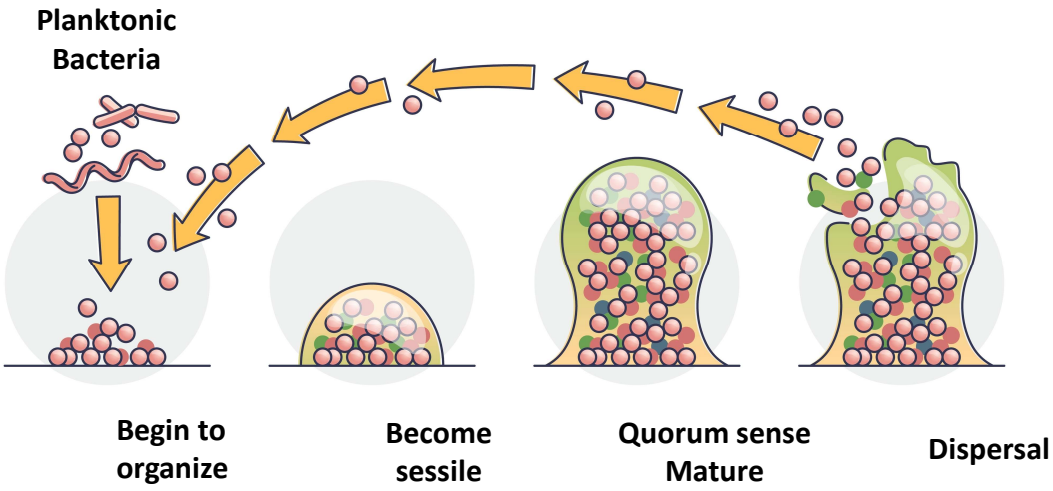
Respect the bacteria: The Mental Model of Biofilm



Bjarnsholt, T et al. The impact of mental models on the treatment and research of chronic infections due to biofilms. APMIS. 2021; 00: 1– 9.
International Wound Infection Institute (IWII) Wound infection in clinical practice. Wounds International 2016

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We've All Gotten This Text….

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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)	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

International Wound Infection Institute (IWII). Wound Infection in Clinical Practice. 2022.

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A word about culturing….it should be done with the intent to treat

- The decision has been made that the patient has a clinical wound infection that requires systemic antibiotics.
  - Based on overt S/S of infection, and/or prolonged non-healing despite appropriate care
- The wound is debrided, cleansed, cultured and then usually antibiotics are started empirically while awaiting culture results
- Culture and sensitivity results may guide antibiotic therapy, especially if patient has not responded to empiric treatment

International Wound Infection Institute (IWII). *Wound Infection in Clinical Practice*. 2022.
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.

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Granulitis - Inflamed, unhealthy granulation tissue

- Hard to heal wound believed to be linked to the presence of microbial biofilm
- Absence of naming this disease state as a specifically identified condition that is tangible to treat has led to some confusion and delay in possible therapeutic approaches
  - Antibiotics are too often inappropriately administered as a precaution
- Introduced as term to identify biofilm-induced, persistent inflammatory wound condition
  - Raise clinician and public awareness of the condition, guide appropriate and prompt local wound hygiene

Murphy CA, Bowler PG, Chowdhury MF. 'Granulitis': defining a common, biofilm-induced, hyperinflammatory wound pathology. J Wound Care. 2023 Jan 2;32(1):22-28. doi: 10.12968/jowc.2023.32.1.22. PMID: 36630113.

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Granulitis?

- What do we look for?

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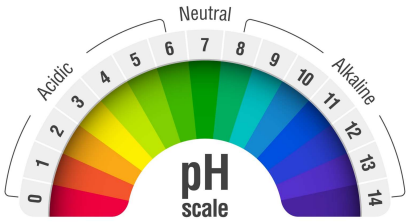
The Impact of pH on the Wound Environment

- The pH value within the wound directly and indirectly influences all biochemical reactions
- Bacteria produce ammonia, results in an alkaline environment
  - An increase in the pH of infected wounds may influence bacterial virulence as well as bacterial growth
  - Wound pH can also impact the effectiveness of antibiotics and antiseptics
- Lowering the pH to a more acidic environment
  - Reduces the toxicity of bacterial end products, such as ammonia
  - Promotes oxygen delivery
  - Increases macrophage and fibroblast activity
  - Controls enzyme activity
    - Many proteases break down proteins more rapidly at higher pH values



Actual acidity increases much faster than the numerical change (eg, pH of 5 is 10 times as acidic as a pH of 6)

Nagoba BS et al. Acidic Environment and Wound Healing: A Review. WOUNDS. 2015;27(1):5-11.
Derwin R, et al. Int Wound J. 2022;19(6):1397-1408.

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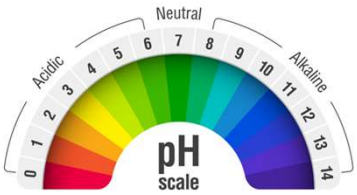
Beyond Proteases: Let's talk pH



- Normal intact skin pH is between 4.5-6.5
- pH of wounds is naturally more alkaline as trauma disturbs acidic milieu
  - Exposes underlying tissues with pH of 7.4
  - Studies report the pH of a chronic wound in a range of 7.15-8.9

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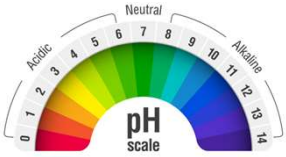
Beyond Proteases: Let's talk pH



- An increase in the pH of infected wounds may influence bacterial virulence, as well as bacterial growth
- Wound pH can also impact the effectiveness of antibiotics and antiseptic or antimicrobial (preserved) solutions
- Many proteases break down proteins more rapidly at higher pH values
- Lowering the pH to a more acidic environment reduces the toxicity of bacteria

Derwin, R, et al. The impact of topical agents and dressing on pH and temperature on wound healing: A systematic, narrative review. Int Wound J. 2022; 19(6): 1397- 1408
Gethin G. The significance of surface pH in chronic wounds. Wounds UK. 2007;3(3):52-56.

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Wound Bed Preparation

- Multistep process
- Defined as "the global management of the wound to accelerate endogenous healing or to facilitate the effectiveness of other therapeutic measures"
- Involves:
  - Decreasing the bacterial load
  - Managing exudate
  - Removing necrotic or fibrous tissue

Falanga V. Wound bed preparation and the role of enzymes: a care for multiple actions of the therapeutic agents. *Wounds*. 2002;14:47-57.

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Wound Bed Preparation : Using The TIME Acronym

- TISSUE (Non-viable or deficient)
- INFECTION / INFLAMMATION (Bacteria / Cytokines)
- MOISTURE (Imbalance)
- EDGE (Non-advancing/undermined or maceration)

Schultz G, Sibbald G, Falanga V, et al (2003) Wound bed preparation: a systematic approach to wound management. Wound Repair Regen 11: 1–28

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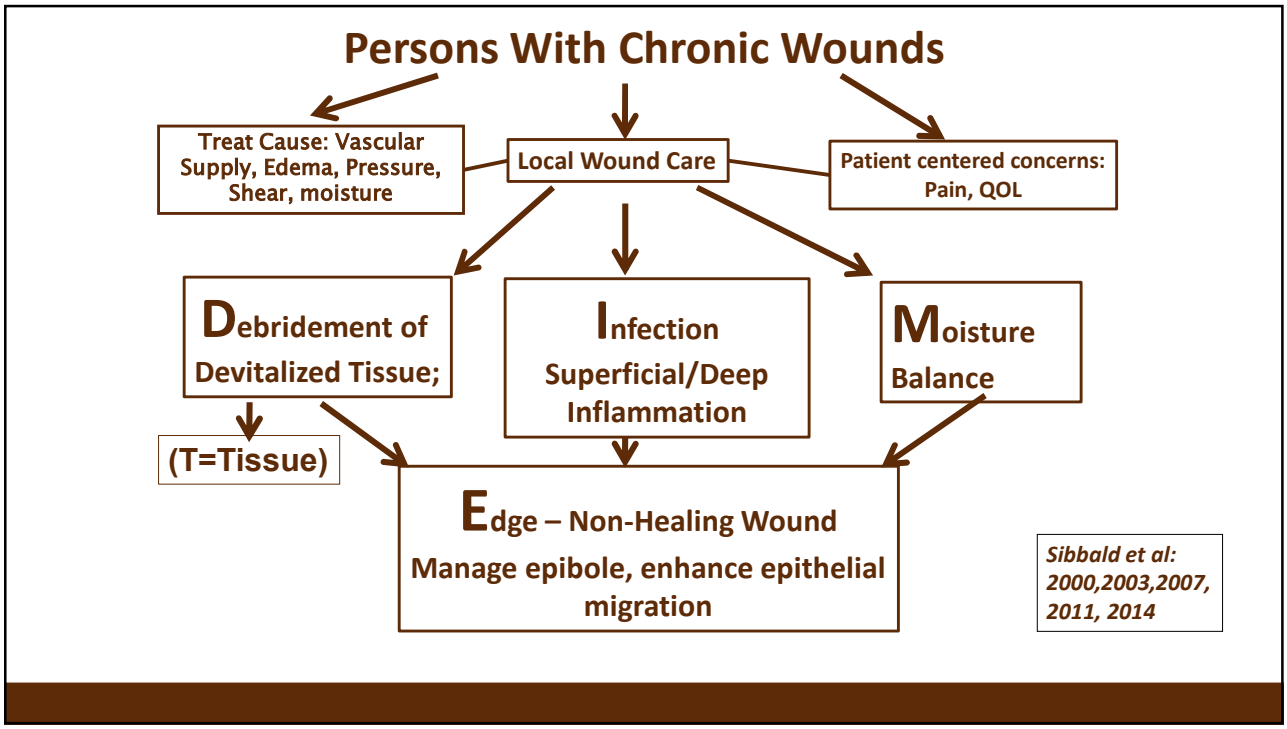
Persons With Chronic Wounds
Treat Cause: Vascular Supply, Edema, Pressure, Shear, moisture
Local Wound Care
Patient centered concerns: Pain, QOL
Debridement of Devitalized Tissue;
(T=Tissue)
Infection Superficial/Deep Inflammation
Moisture Balance
Edge – Non-Healing Wound
Manage epibole, enhance epithelial migration
Sibbald et al: 2000,2003,2007, 2011, 2014

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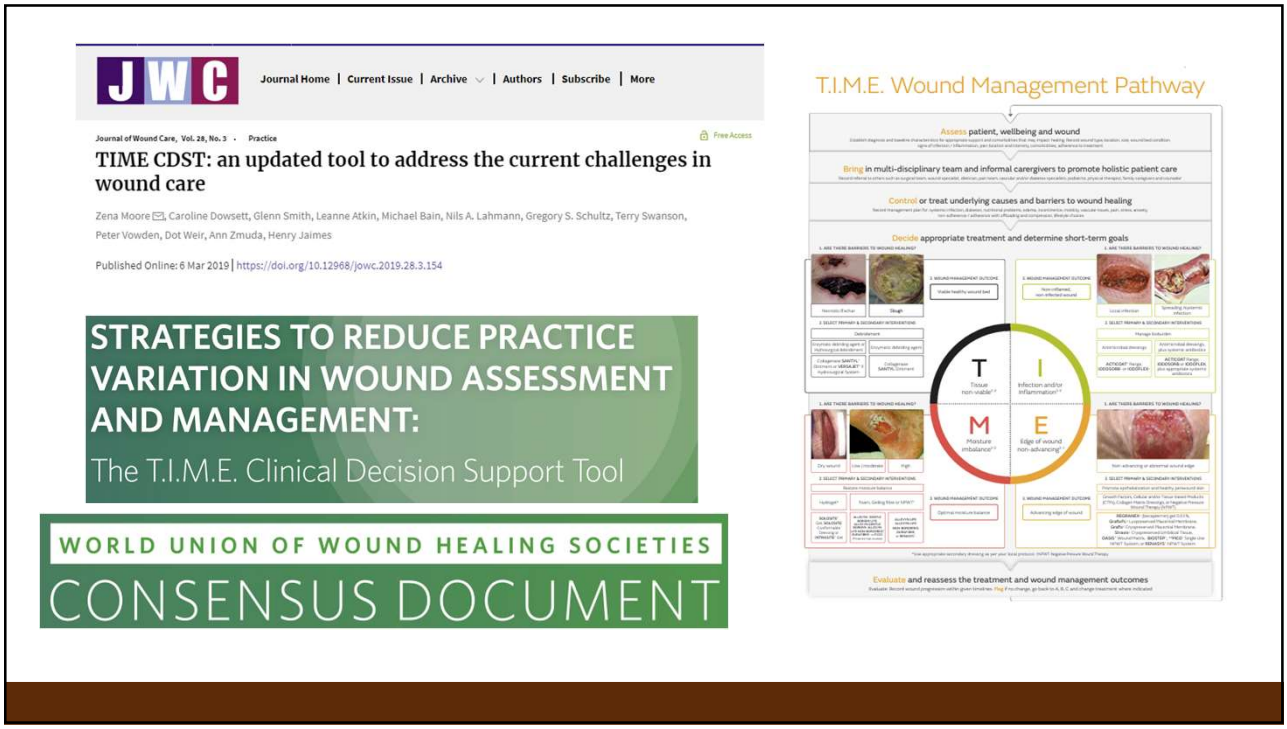
JWC
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Journal of Wound Care, Vol. 28, No. 3 · Practice
Free Access
TIME CDST: an updated tool to address the current challenges in wound care
Zena Moore, Caroline Dowsett, Glenn Smith, Leanne Atkin, Michael Bain, Nils A. Lahmann, Gregory S. Schultz, Terry Swanson, Peter Vowden, Dot Weir, Ann Zmuda, Henry Jaimes
Published Online: 6 Mar 2019 | https://doi.org/10.12968/jowc.2019.28.3.154
STRATEGIES TO REDUCE PRACTICE VARIATION IN WOUND ASSESSMENT AND MANAGEMENT:
The T.I.M.E. Clinical Decision Support Tool
WORLD UNION OF WOUND HEALING SOCIETIES
CONSENSUS DOCUMENT
T.I.M.E. Wound Management Pathway
Assess patient, wellbeing and wound
Bring in multi-disciplinary team and informal caregivers to promote holistic patient care
Control or treat underlying causes and barriers to wound healing
Decide appropriate treatment and determine short-term goals
T
I
M
E
Evaluate and reassess the treatment and wound management outcomes

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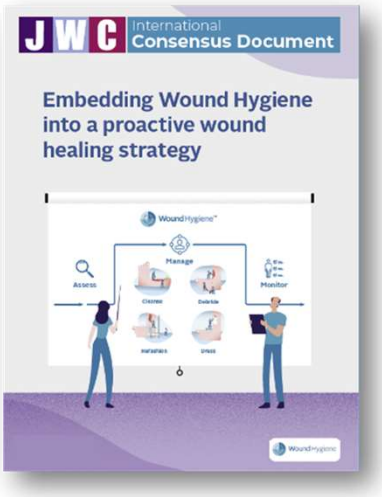
Wound "Hygiene"?



Murphy CA, Atkin L, Swanson T, Tachi M, Tan YK, Vega de Ceniga M, Weir D, Wolcott R. International consensus document. Defying hard-to-heal wounds with an early antibiofilm intervention strategy: wound hygiene. J Wound Care 2020; 29(3 Suppl 1):S1–28.

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Wound Bed Preparation

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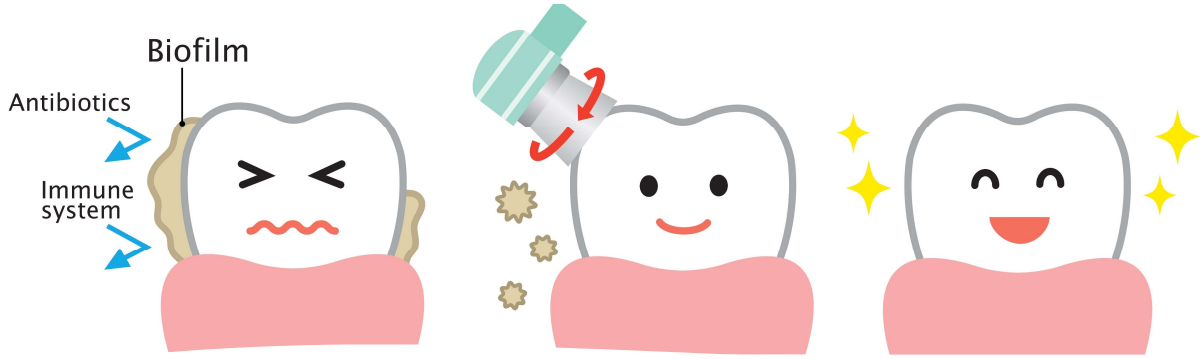

Wound Hygiene

- The concept of wound hygiene is based on the premise that all hard-to-heal wounds contain biofilm
- Familiarity with oral hygiene makes this concept make sense

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Components of Wound Hygiene

Cleanse the wound and peri-wound skin

Debride

Refashion the wound edges

Dress the wound

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Wound Cleansing

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Common Myth….

NOT

This is cleansing

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Therapeutic Wound and Periwound Cleansing

- Wound cleansing is the use of fluids and/or devices to remove loosely adherent contaminants and devitalized material from the wound surface and wound edges
- Promotion of periwound skin cleansing is considered part of completing a dressing change
- When cleansing the periwound skin, concentrate on the area that is **10–20** cm away from the wound edges, or that is covered by the dressing, whichever is larger
- Use an antimicrobial (preserved)/antimicrobial/antiseptic wash or surfactant for cleansing, if possible, and avoid cross-contamination

Murphy C, Atkin L, Swanson T, Tachi M, Tan YK, Vega de Ceniga M, Weir D, Wolcott R. International consensus document. Defying hard-to-heal wounds with an early antibiofilm intervention strategy: wound hygiene. J Wound Care 2020; 29(Suppl 3b):S1–28.

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Challenges of Obtaining a Clean Wound

- Pain and Trauma
  - History of need to avoid; avoidance of pain prevails
  - Plan for the pain
    - Pre-medicate
    - Topical lidocaine / EMLA
- Availability of adequate solutions
  - Avoidance of toxicity
  - Site of care
- Modern threats to wound healing
- Decide
  - How to clean
  - What to clean with

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Debridement

- Clearly a fail-safe way to get a wound clean
- Clean AGAIN after debridement

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Adequate Wound Cleansing

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Understanding Fluorescent signals

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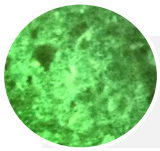
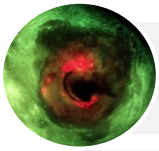
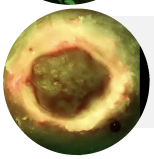


Green fluorescence shows tissue components (slough, skin, scales)



Red/blush/pink fluorescence is indicative of gram positive, negative, aerobic and anaerobic bacteria

Cyan fluorescence (glowing white center with blue/green halo) is indicative of *Pseudomonas*



Yellow due to overlap of green/red fluorescence signals

Bacterial loads >10^4 CFU/g

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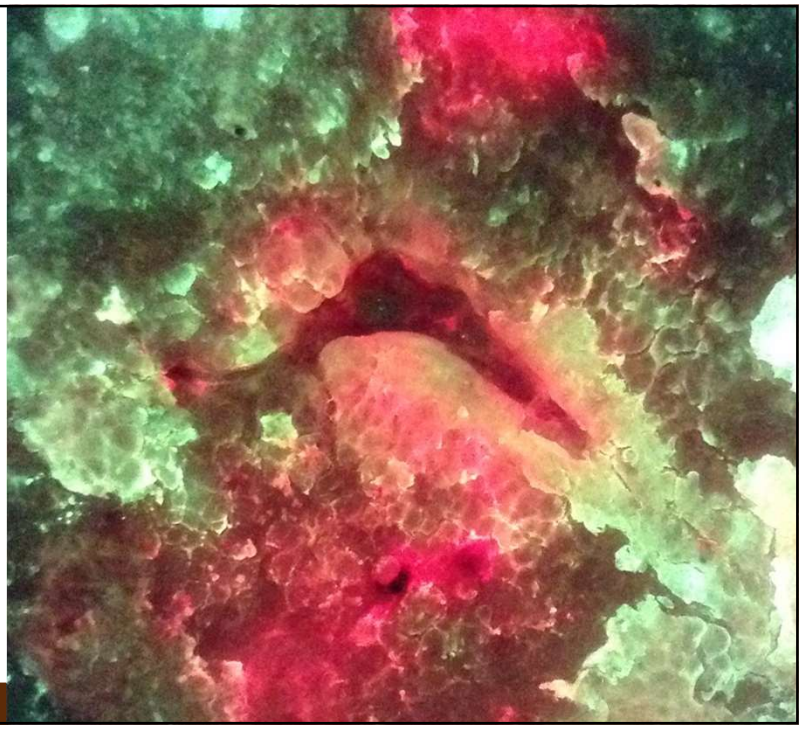
You can't treat what you can't see



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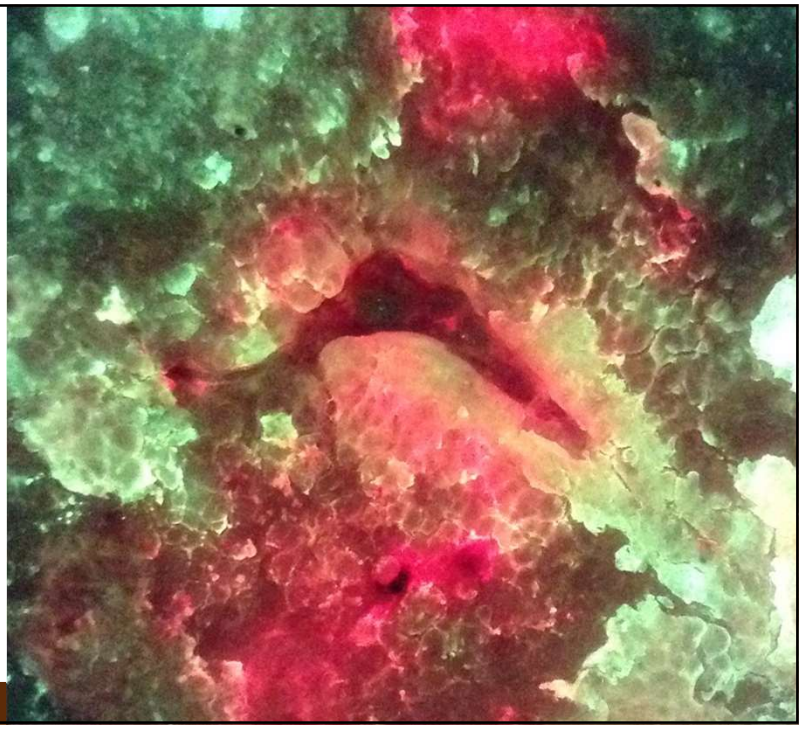
You can treat what you assume to be there!



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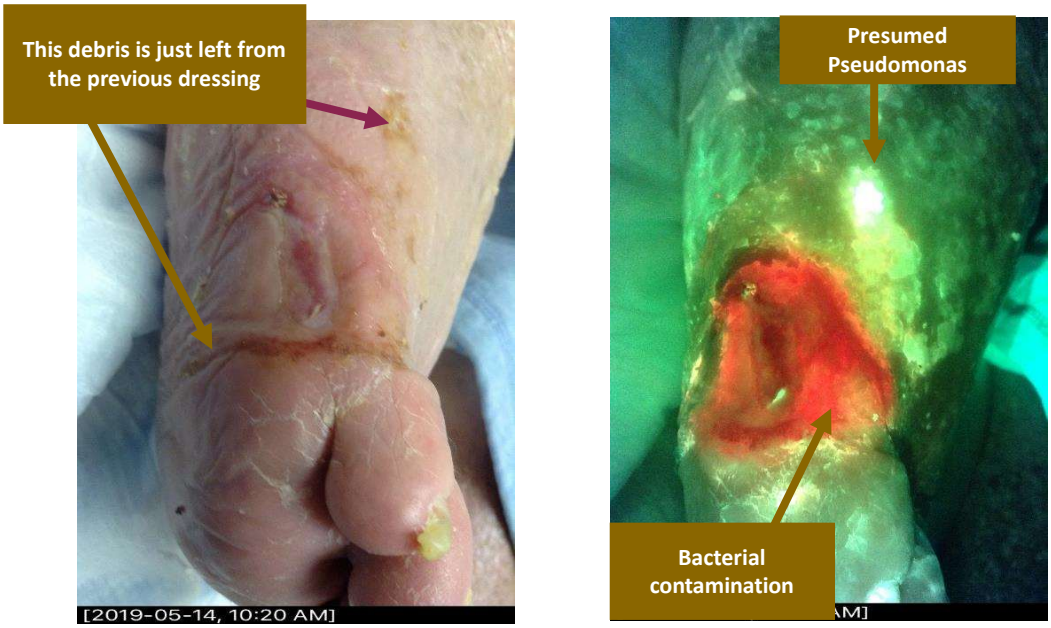
This debris is just left from the previous dressing
[2019-05-14, 10:20 AM]
Presumed Pseudomonas
Bacterial contamination

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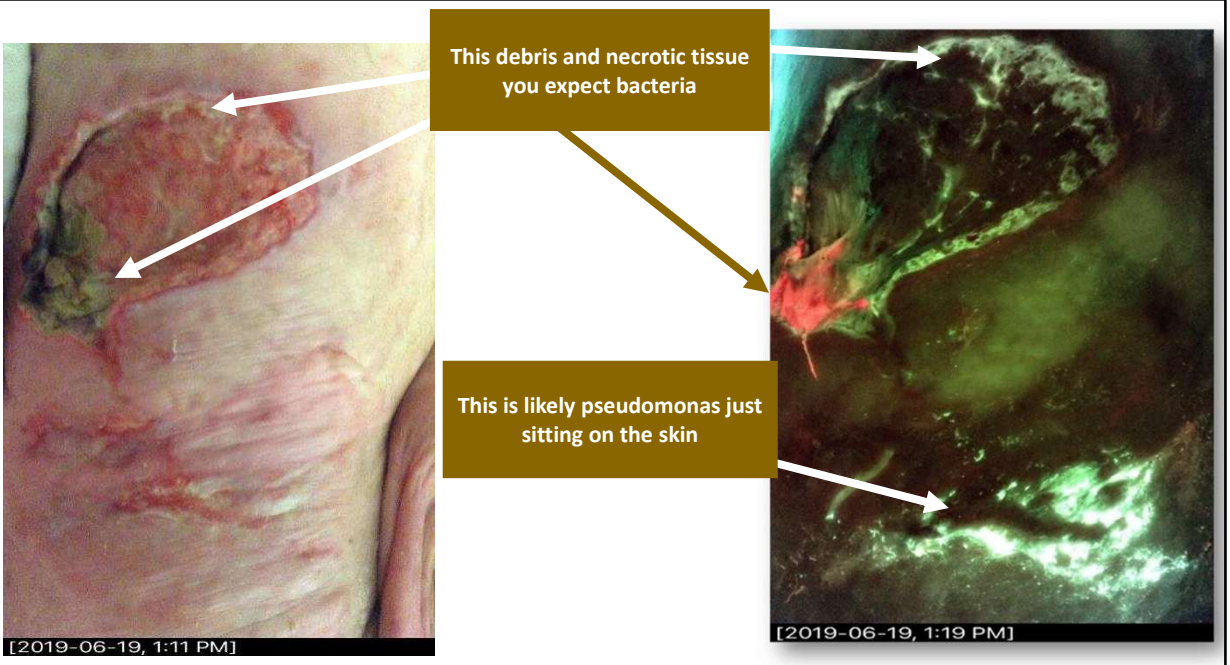
This debris and necrotic tissue you expect bacteria
This is likely pseudomonas just sitting on the skin
[2019-06-19, 1:11 PM]
[2019-06-19, 1:19 PM]

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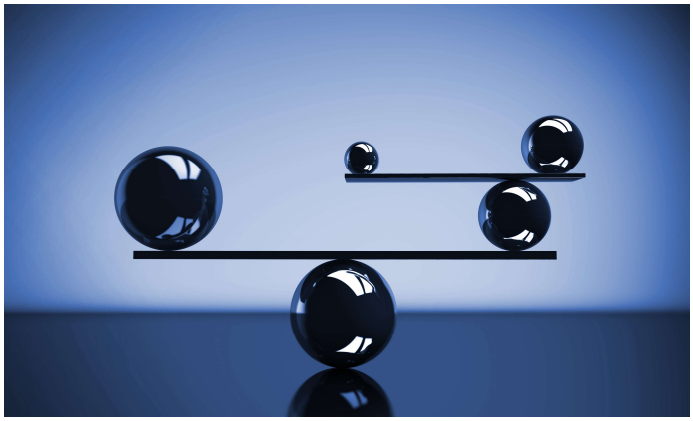
What to clean with?

Ideal Fluid Agent

- Non-irritating
- Non-cytotoxic
- pH slightly acidic (4.0 – 6.0)
- Effective
- Controls Odor



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What to Clean With?

- Isotonic Saline (0.9%)
  - On clean uncomplicated wound usually the right answer on test ☺
  - Must be used with enough psi to make a difference
  - No impact on microbes and biofilm
  - Best used with monofilament or gauze
- Potable water
  - 2012 Cochrane Review concluded no difference in healing or infection rates in using saline vs tap water
  - Concern of water borne pathogens such as pseudomonas, and known growth of biofilm in pipes

Wound cleansing, topical antiseptics and wound healing. Atiyeh B, Dibo S, Hayek S. *Int Wound J.* 2009;6(6):420-430.

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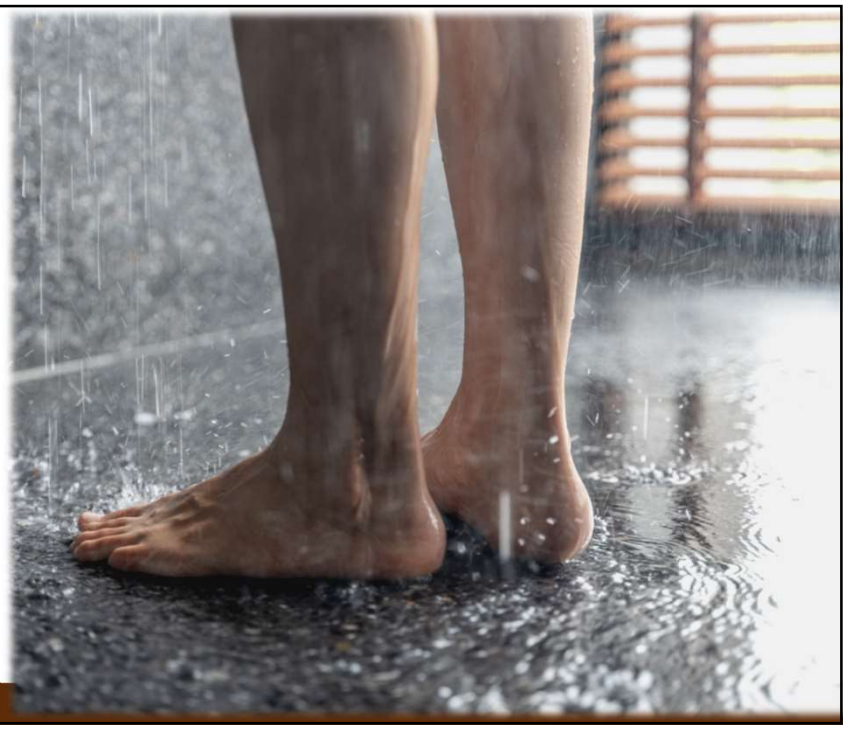
What about showering? Tap Water?

- Priority is getting the wound cleansed
- Literature very weak on recommendations related to tap water
  - Uncertainty in data review
- Used frequently in the community and lower resource settings
  - Rarely in acute care, LTC or outpatient settings



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What to Clean With?

- Commercial Cleansers
  - Remove debris and bacteria with less force required
    - Enhanced wound cleaning due to surface active agents, which break the bonds of foreign bodies on wound surface
  - Typically contain preservatives to extend effective shelf life
  - Strength of their chemical reactivity directly proportional to their cleansing capacity and toxicity to cells
    - Differentiate skin cleansers and wound cleansers
    - Those for skin can be highly cytotoxic to healthy cells and granulating tissue
  - Single patient use

Wound cleansing, topical antiseptics and wound healing. Atiyeh B, Dibo S, Hayek S. *Int Wound J.* 2009;6(6):420-430.

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What to Clean With?

- Povidone Iodine
  - Broad-spectrum antimicrobial activity
  - Cytotoxic to healthy cells and granulating tissue in higher-percentage concentrations
  - May irritate periwound skin
  - Consider Cadexomer iodine for dressing

Wolcott R, Fletcher J. The role of wound cleansing in the management of wounds. *Wounds International*. 2014;1(1):25-31.

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What to Clean With?

- Hydrogen peroxide
  - One time cleansing for dirty acute injury may be appropriate
  - Naturally occurring ROS
  - 3% commercial solution cytotoxic to healthy cells and granulating tissue
  - Ineffective in reducing bacterial counts in vivo; in vitro evidence of effectiveness
  - Effervescence visually changes wound surface
  - Does not impact biofilm

Zhu, G., Wang, Q., Lu, S., & Niu, Y. (2017). Hydrogen Peroxide: A Potential Wound Therapeutic Target?. Medical principles and practice : international journal of the Kuwait University, Health Science Centre, 26(4), 301–308. doi:10.1159/000475501

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What to Clean With?

- Polyhexamethylene biguanide (PHMB) 0.1%
  - One commercially available cleanser also contains betaine, a surfactant, to lift microbes and debris and suspend them in solution to prevent wound recontamination
  - Has an increased ability to penetrate difficult-to-remove coatings, lifting debris, bacteria, and biofilm from the wound
  - Broad spectrum of activity against bacteria, viruses, and fungi
  - No evidence of toxicity or resistance

Wolcott R, Fletcher J. The role of wound cleansing in the management of wounds. Wounds International. 2014;1(1):25-31

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What to Clean With?

- Hypochlorous Acid
  - Released from neutrophil during oxidative burst
  - Broad-spectrum antimicrobial activity
  - Non-irritating, non-sensitizing, non-toxic
  - Can be used to loosen encrusted dressings in addition to irrigating loose debris and bacteria from the wound bed
  - Has rapid antimicrobial activity at concentrations safe for human cells
  - Concentration and pH important 3.5 – 5.5
  - In vitro evidence of effect on biofilm

Seal A, Robson M. The influence of pH on chronic wound healing and the antimicrobial activity of chlorine. Ostomy/Wound Management 2018;64 (10):10-11.
Wolcott R, Fletcher J. The role of wound cleansing in the management of wounds. Wounds International. 2014;1(1):25-31

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What to Clean With?

- Acetic Acid 0.25%
  - Shown effectiveness against many Gram-positive and Gram-negative organisms, especially *Pseudomonas aeruginosa*
  - Does not kill bacteria, creates an acidic environment unfavorable for bacterial growth
  - Acetic acid in 1% and 5% concentrations has been widely used to reduce pH but toxic at those levels
  - pH = 3!!
  - Effective against odor
  - In vivo studies have shown safety for short periods (4-7 days) to control bacterial levels without compromising the healing process

Nagoba B, et al. Acidic environment and wound healing: A review. *Wounds*. 2015;27(1):5-11.

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What to Clean With?

- Dakin's Solution
  - Dilute hypochlorite (bleach) solution that shows effectiveness against Gram-positive bacteria such as strep and staph, as well as a broad spectrum of anaerobic organisms and fungi
  - Kills micro-organisms, but also harms healthy cells in most concentrations
  - It can be sprayed on the wound, poured as a wound irrigant, or used in a wet compress
  - Confusing concentrations
    - 0.5% = Full strength
    - 0.25% = Half strength
    - 0.125% = Quarter strength
    - 0.0125 % = Safe strength

Keyes M, Jamal Z, Thibodeau R. Dakin Solution. [Updated 2023 Jan 26]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-

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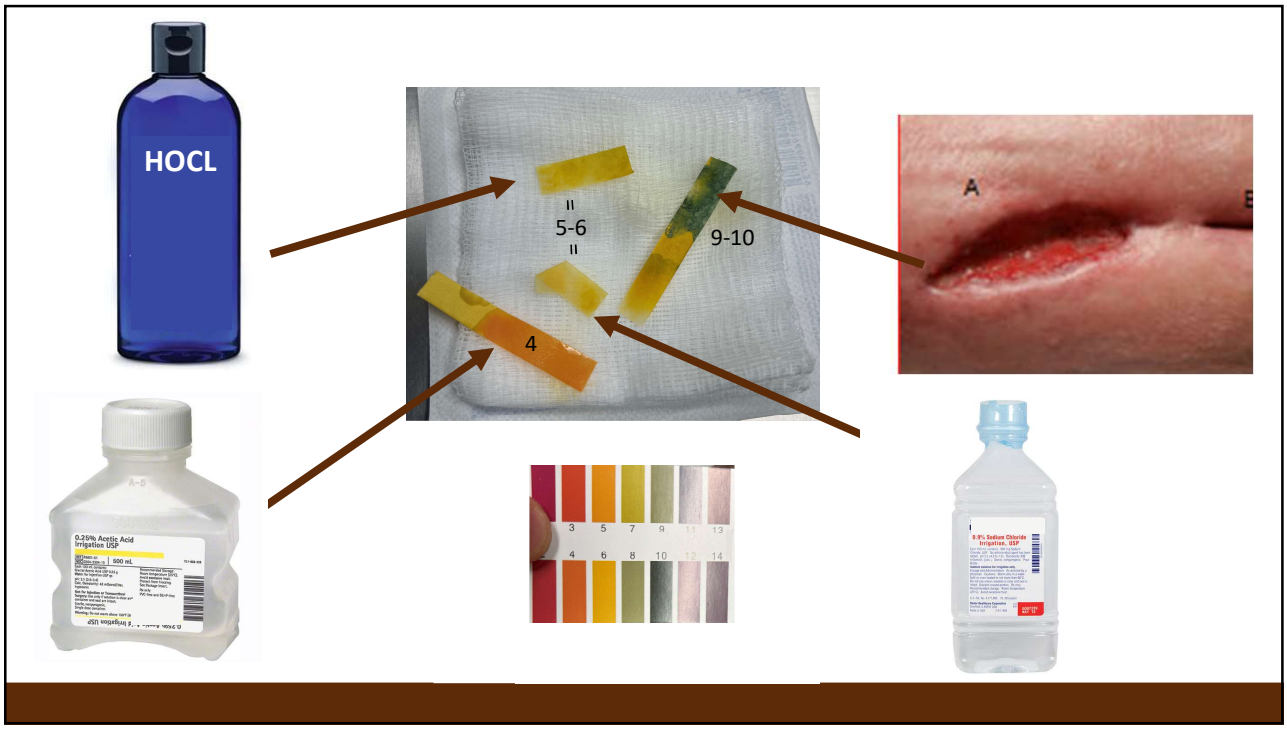

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Making Cleansing/Antimicrobial/Antiseptic Solutions: Recipes from Dr. Google

- Normal saline
  - 8 teaspoons of salt
  - 1-gallon boiled water
- Acetic acid
  - To make
    - 1 quart: 3 tablespoons white vinegar + 1-quart lukewarm water
    - 1 gallon: ¾ cup white vinegar + 1-gallon lukewarm water
- Dakin's solution
  - 32 ounces of boiled tap water
  - Boil for 15 minutes with lid on the pan
  - Add ½ teaspoon baking soda to the boiled water
    - Bleach should be non-scented, non-ultra (concentrated)
      - 3 ounces = full strength
      - 3 tablespoons plus ½ teaspoon = ½ strength
      - 1 tablespoon plus 2 teaspoons = ¼ strength
      - 2 ½ tsp = 1/8 strength

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CAUTION: Educate on Making Solutions at Home!

- Provide written as well as verbal instructions
- Advise patients to follow the instruction/proportions *exactly*
- Advise patients to keep unused portions in the refrigerator, remove prior to use, and bring to room temperature
  - Or make smaller quantities

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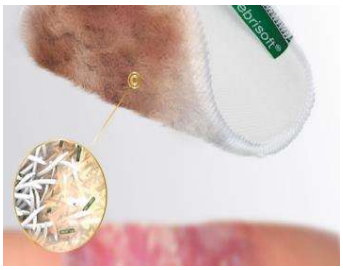
Is Mechanical Cleansing the same as debridement?



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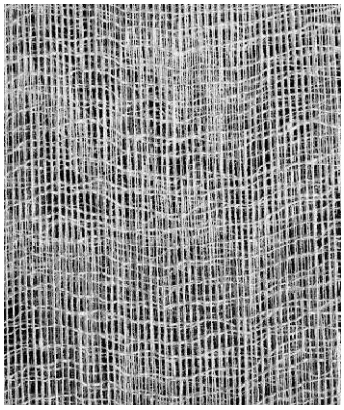
Using gauze…



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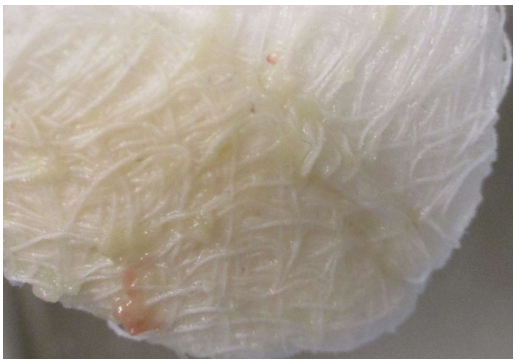
Using Gauze…



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Transfer of Bacteria
Change your gauze!

- Bacterial transfer can occur inadvertently, risking recontamination of the wound bed

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Cleansing illuminated

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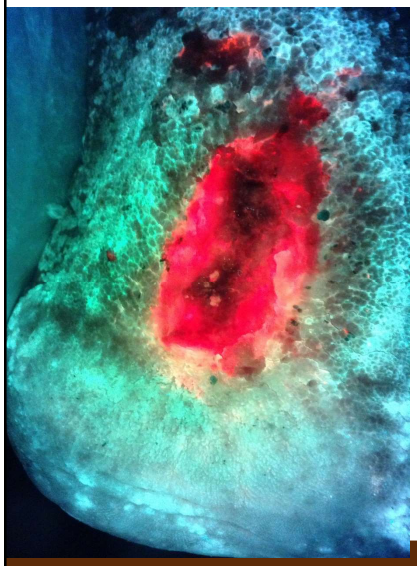
Cleansing illuminated

Before cleansing



After cleansing

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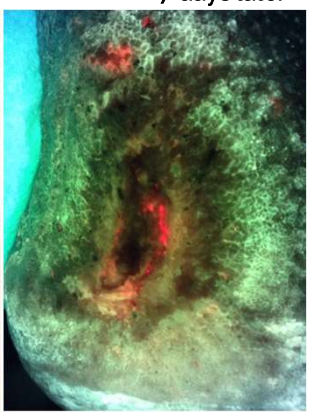
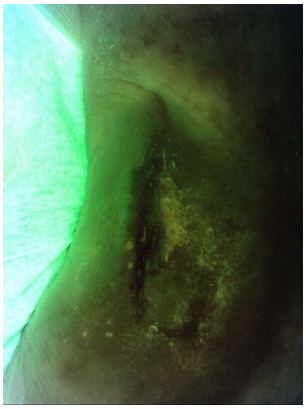
Gauze cleansing illuminated – follow up

7 days later



20 days later



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Toe web spaces

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Toe web spaces

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Toe web spaces

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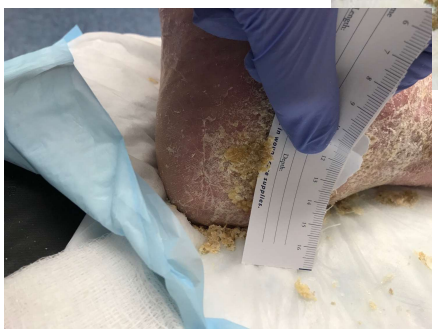
Who Removes Scales?



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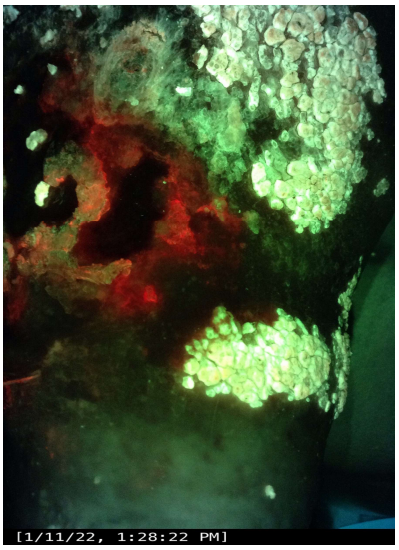
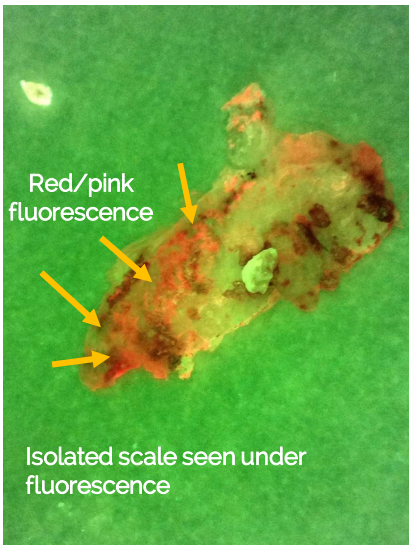
Standard image

Fluorescence images





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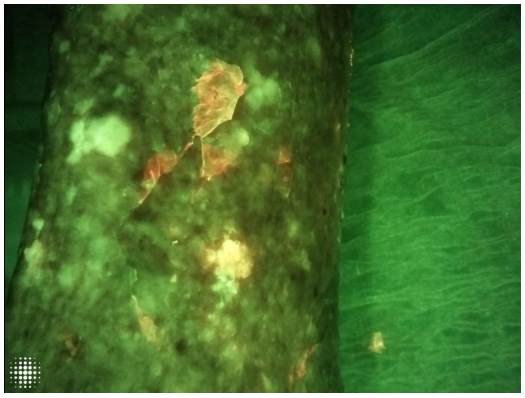
Dry, scaled skin



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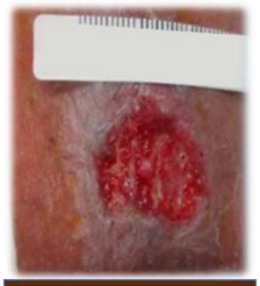
Components of Wound Hygiene



Cleanse the wound and peri-wound skin

Debride

Refashion the wound edges

Dress the wound

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	Method / Pain Potential	Indications	Considerations	Challenges /Adverse Effects	
Mechanical	Wet to Dry	Short term; temporary	Non-selective	Pain, trauma	Significant, Moderate
	Scrubbing	Loose debris, exudates	Significant pain	Pain, trauma	
Biologic	Autolytic	Necrotic tissue; painful wounds, healthy immune system	Infection, urgency	Maceration, infection	None
	Enzymatic	Devitalized/necrotic tissue	Sensitivity, high exudate, cost/coverage	Maceration, sensitivity	None
	Larval / MDT	Necrotic tissue	Exposed vessels, ischemic or malignant wounds	"yuck" factor	Moderate, Minimal
Adjunctive Devices	Hydrosurgery	Infected/Necrotic/Need for shorter OR time	Non-surgical specialty	Aerosolization, cost of equipment, need for OR	Significant
	High-frequency Ultrasound	Necrotic/bedside/chairside	Requires debridement competency	Aerosolization, cost of equipment, time	Moderate, Minimal
	Negative pressure	Dwell/cleanse dressings acute care	Cleanse/dwell primarily acute care	Equipment, skill level	Significant to None
Surgical/ Instrument	Bedside/chairside	Necrotic tissue, adherent exudates, hypergranulation, senescent cells	Uncontrolled pain, bleeding	Uncontrolled pain, bleeding	Significant to None
	Operating Room	Emergency/urgent	Medically unstable	Surgical risk, under/over excision	Significant to None

Pain levels: Significant Moderate Minimal None

Adapted from Anghel et al.

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Components of Wound Hygiene

Cleanse the wound and peri-wound skin

Debride

Refashion the wound edges

Dress the wound

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Managing Wound Edges

- Rolled/epibole/thickened usually needs to be excised
  - Depending on goals of care
- Minor epibole relatively easy to abrade off
- Denser rolled edges need to be removed
- Minor hyperkeratotic / thickened edges can often be teased off with a curette

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Components of Wound Hygiene

Cleanse the wound and peri-wound skin

Debride

Refashion the wound edges

Dress the wound

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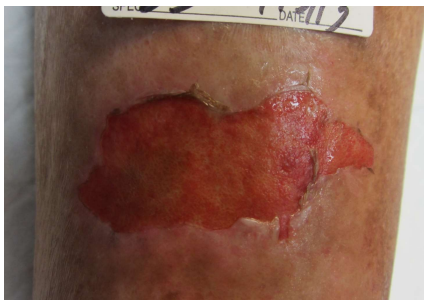
Addressing the Dressing

- Is the wound bed dry?
  - Hydrate it
- Is the wound draining?
  - Absorb it
- Is there space?
  - Fill it
- Is it filled in?
  - Cover it



- **Hydrogel impregnated gauze, amorphous or sheets**
- **Concentrated surfactants**
- **Hydrocolloids**
- **Film dressings**

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Addressing the Dressing

- Is the wound bed dry?
  - Hydrate it
- Is the wound draining?
  - Absorb it
- Is there space?
  - Fill it
- Is it filled in?
  - Cover it

- **Calcium alginates**
- **Gelling fiber dressings**
- **Foams**
- **Superabsorbers**

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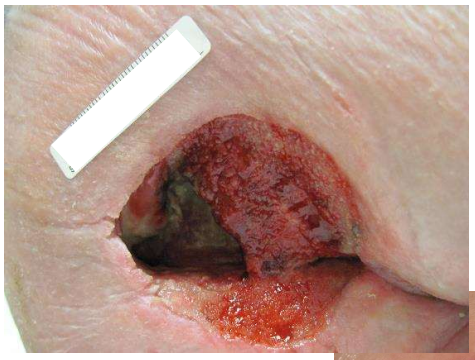
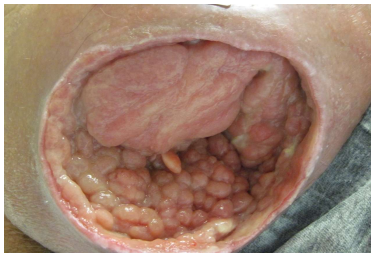
Addressing the Dressing

- Is the wound bed dry?
  - Hydrate it
- Is the wound draining?
  - Absorb it
- Is there space?
  - Fill it
- Is it filled in?
  - Cover it

- **Moist gauze packing (temporarily)**
- **Calcium alginate / Gelling fiber**
- **Superabsorber**
- **Negative pressure wound therapy**





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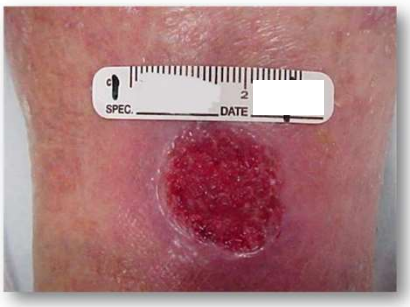
Addressing the Dressing

- Is the wound bed dry?
  - Hydrate it
- Is the wound draining?
  - Absorb it
- Is there space?
  - Fill it
- Is it filled in?
  - Cover it and meet moisture needs



- **Calcium alginate / Gelling fiber**
- **Hydrocolloid**
- **Film Dressing**

- **Foam**
- **Superabsorber**
- **Collagen**

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Louis Pasteur:

Chance Favors The Prepared ~~Mind~~ Wound

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Thank You!

QUESTIONS?

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