

Basics of Tissue Integrity Management

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VA Polytrauma Rehab AT Grand Rounds
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Focus on immobile, wheelchair-dependent . . .

- ↓ plantar venous flow
- ↓ calf venous flow
- ↑ filtration
- ↓ lymphatic flow
- ↓ arterial flow
- ↓ muscle tissue pressure
- ↓ respiration
- ↓ oxygen consumption



Wheelchair-dependent person with lymphedema
Courtesy: J Macdonald, MD

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Categories of wheelchair users

- Progressive
- Spinal Cord Injury
- Orthopedic
- Cardiovascular
- Other CNS



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Profile of individuals who use wheelchairs as either their primary or secondary means of mobility. Some use 2 wheelchairs a manual inside and power outside.

Size of the problem . . .

~6 million in US
occasional WC users

- 4.8 million use a cane
- 1.8 million use a walker
- 566,000 use crutches



Iezzoni, 2003; Iezzoni, McCarthy, Davis, & Siebens, 2001; Jones, 1999

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Wheelchair importance and production (Kirby et al., 2002 ; Dudgeon, 2000)

Competitive half-billion dollar field (Russell et al., 1997)

Size of the problem . . .

~ 3 million in US
dependent on a wheelchair/scooter

- 1 million = institutional
- 1.8 million = non-institutional



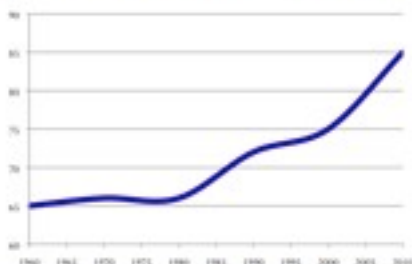
Kaye, Kang, & LaPlante, 2000; Kirby, Swaste, Dupuis, MacLeod, & Monroe, 2002

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Wheelchair importance and production (Kirby et al., 2002 ; Dudgeon, 2000)

Competitive half-billion dollar industry (Russell et al., 1997)

Significance of the problem . . .



- Life expectancy in individuals with disabilities has increased
- Individuals with disabilities are at high-risk for multiple co-morbidities

Kaye, Kang, & LaPlante, 2000; Kirby, Swaste, Dupuis, MacLeod, & Monroe, 2002

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Chronic conditions are currently responsible for 60% of the global disease burden-WHO Chronic Care Team, *Innovative Care for Chronic Conditions*, WHO, 2002

Fortunately, advances in biomedical and behavioral management have increased the ability to effectively prevent and/or control chronic conditions; complications of chronic conditions (secondary conditions) can also be prevented. In fact, growing evidence from around the world suggests that persons with chronic conditions improve when they receive effective treatments, regular follow-up, and self-management support in their living and working environments.

Significance of the problem . . .

The strongest predictor of premature death in individuals with spinal cord injury is the presence of multiple secondary complications such as chronic edema, wounds, infections, and depression

Krasac, Carter et. al. *Arch PM&R*, 2008

Likely similar predictors for other disabling diseases affecting the lower extremity



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Significance of the problem . . .

The first study to examine the occurrence of lymphoedema in the Spina Bifida population reports it may be over 100 times greater than in the general population

40% of all lower limb lymphoedema cases have wounds

Garcia and Dicianno, *Am Acad Ped*, 2009; Moffatt et al., *Journal of Lymphoedema*, 2003



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Chronic conditions . . .

Chronic conditions account for 60% of global disease burden

Evidence of increased ability to manage chronic conditions is mounting

- Effective treatments
- Regular follow-up
- Self-management support in living and working (natural) environments

Innovative Care for Chronic Conditions, WHO, 2002



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SB has a prevalence of over 70,000 and an incidence of 7 out of every 10,000 live births in the U.S².

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Tissue Integrity Management (TIM) Principles

1. Optimize health status
2. Screen for risks to tissue integrity
3. Treat the underlying conditions/risks
4. Optimize wound care when wounding occurs
5. Prevent loss of function and disability
6. Address patient and family concerns

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1. Optimize health status

- Nutritional support or weight loss
- Adequate hydration
- Smoking cessation
- Moderate alcohol intake
- Stress management
- Exercise
- Hygiene & skin care
- Optimal control of co-morbid diseases
- Glycemic control

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2. Screen for risk factors

- Arterial insufficiency
- Chronic edema/lymphoedema
- Abnormal pressure distribution
- Increased friction/shear
- Obesity or need for nutritional support
- Immobility
- Loss of sensation
- Immune suppression
- Poor hygiene, lack of skin/nail care
- Excessive moisture/dryness

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Arterial Perfusion

- Must be 1st consideration
- Oxygen & nutrients must reach tissue for repair & maintenance
- Impaired blood flow slows healing



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(anemia, smoking, ischemia, hypovolemia, low-blood pressure)

Arterial Disease—Signs and Symptoms

Impaired Circulation

- Decreased pulses
- Temperature- cool
- Delayed capillary and venous filling times
- Pallor on elevation
- Dependent rubor
(Basis for related tests)



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Peripheral Arterial Insufficiency: Signs and Symptoms

There are distinct characteristics of peripheral artery disease that enable the clinician to distinguish arterial ulcers from other etiologies.

The clinical presentation of arterial disease is the result of a decrease in delivery of oxygen to the tissues.

These include:

Impaired Circulation evidenced by: decreased pulses, temperature changes, delayed capillary and venous filling times, pallor on elevation, and dependent rubor.

Due to decrease perfusion the inflow of blood to the lower extremity is influenced/enhanced with gravity. When the leg is elevated the influence of gravity is removed and results in a decrease delivery of blood thus pallor develops.

Additionally, when the capillaries dilate in a compensatory attempt to increase the delivery of blood resulting there is a

Arterial Disease—Signs and Symptoms

Ischemic Skin Changes

- Atrophy of subcutaneous tissue
- Shiny, taut epidermis and thickened toe nails
- Hair loss



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The third sign is Ischemic Skin Changes which account for atrophy of subcutaneous tissue, shiny, taut epidermis, thickened toe nails and hair loss. Each of these can be attributed in part to a decrease in delivery and availability of oxygen to the tissue.

Arterial Ulcers

- History
- Physical Assessment
- Non-invasive testing
 - Ankle Brachial Index
 - Rubor dependency
 - Capillary refill time
 - Venous refill time



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Additional examples:

Note the lack of hair growth and classic punched out appearance of the ulcer on the right.



- > 1.2 Suspect vessel wall sclerosis or calcification
- 0.9-1.1 Normal
- 0.7-0.8 Mild occlusive disease. May have intermittent claudication
- 0.4-0.6 Moderate to severe occlusive disease. Wound healing impaired
- < 0.4 Severe occlusive disease, ischemia

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The ankle-brachial index is a bedside test that can be performed to provide an approximate value for the adequacy of arterial perfusion. It compares the ankle blood pressure to the brachial blood pressure.

Chronic Edema/Lymphoedema



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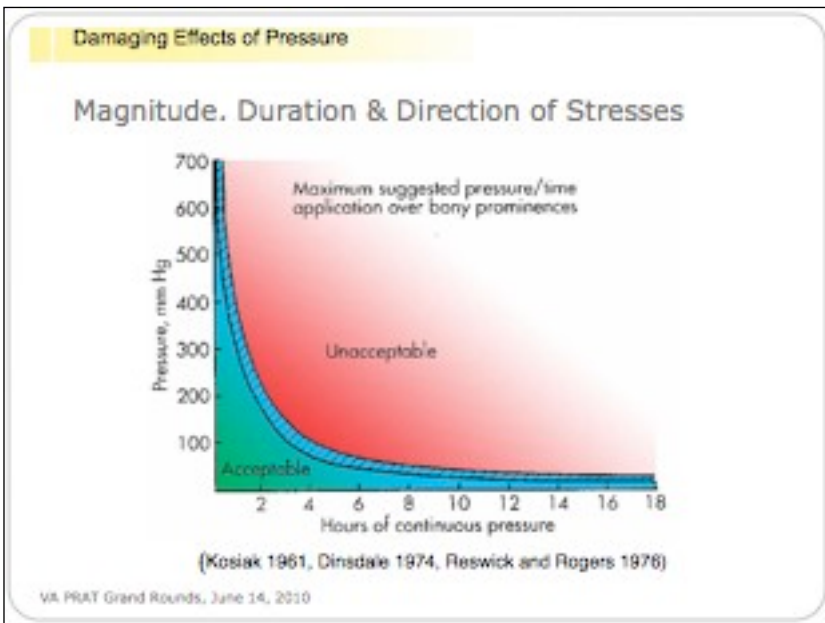


High pressure alone is not sufficient to cause tissue injury

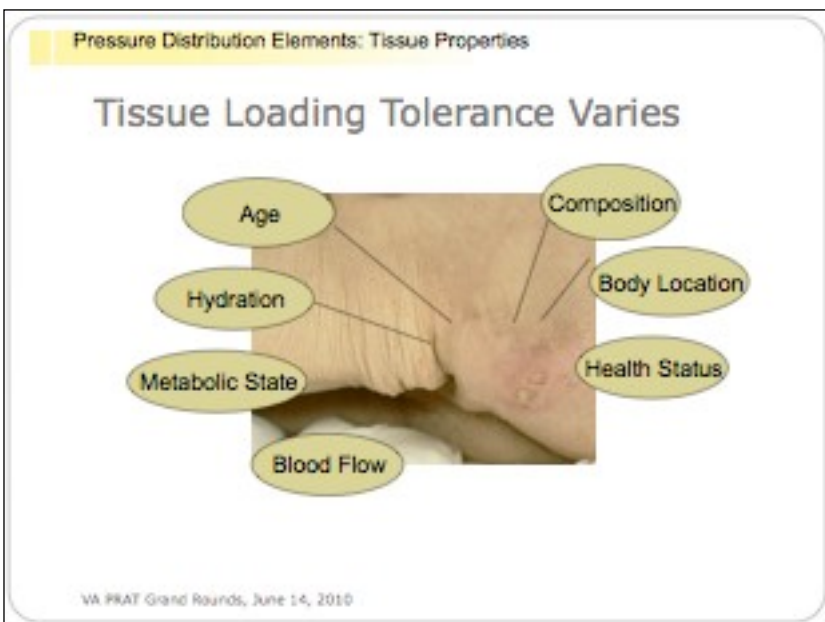
Tissues can withstand higher loads for only short periods of time

Effects depend on Magnitude, Duration (including number of times applied & rate of application) and Direction of stress either perpendicular or parallel (shear stress)

Pressure Gradient: change in pressure over a distance. If pressure across a surface is plotted on a graph, the slope of the curve is the pressure gradient = change in pressure over square cm or inches. Several investigators hypothesize that interstitial fluid flow caused by pressure gradients is the primary factor in development of pressure



Biomechanical properties linked to physiological and biochemical responses may be predictive of tissue loading tolerance



Injury Threshold is Patient Specific



- Tissue "quality" or tolerance
- Tissue site

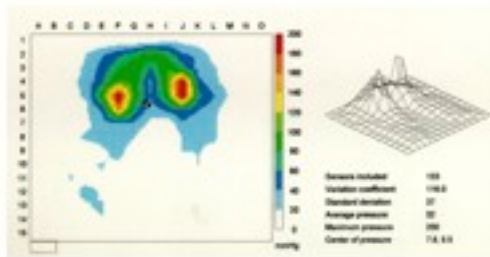
Research has failed to identify an injury threshold for tissue loads across
 1) populations 2) tissue sites

Pressure Gradient: change in pressure over a distance. If pressure across a surface is plotted on a graph, the slope of the curve is the pressure gradient = Change in pressure over square cm or inches. Several investigators hypothesize that interstitial fluid flow caused by pressure gradients is the primary factor in development of pressure ulcers. This theory is consistent with work of Kosiak, Dinsdale, Reswick & Rogers.

Despite significant gradients, boundary areas (e.g., edge of low pressure surface) are typically areas of lower risk for pressure ulcers. This suggests that pressure gradient only becomes an important factor when combined with high pressure.

Most researchers agree that prolonged exposure to

Pressure Mapping



- Peak Pressure
- Peak Pressure Gradient***
- Pressure Distribution

Immunosuppression

- Diminished immune response increases risk for skin problems and delays healing; e.g., HIV/AIDS
- Steroids suppress the immune system and adversely affect many tissue healing processes
- Chemotherapy and radiation therapy
- Chronic edema/lymphoedema
- Elderly patients

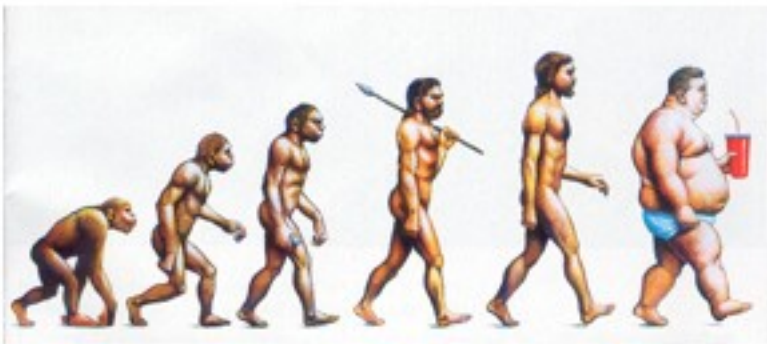


Nutritional Needs

- Assess nutritional needs for at-risk patients on a regular basis
- Weight loss and low albumin are significant risk factors for tissue breakdown
- Provide supplements as needed



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Additional considerations . . .

- ↓ ability to perform self-care
- ↓ cognitive function
- ↓ vision
- ↑ risk of lower limb injury with difficult transfers



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1. Optimize health status
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3. **Treat the underlying conditions/risks**
 - ☑ Optimize wound care when wounding occurs
 - ☑ Prevent loss of function and disability
 - ☑ Address patient and family concerns

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3. Treat underlying conditions

1. Improve blood flow and tissue perfusion
2. Apply compression for edema/lymphedema in the absence of arterial disease
3. Use pressure redistributing technologies and other methods to reduce friction and shear

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Improve blood flow, tissue perfusion

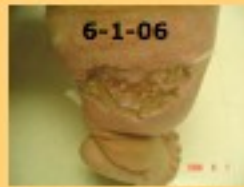
- Exercise
- Revascularization



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Apply compression for edema/lymphedema in the absence of arterial disease

- Bandages, garments, wraps



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Apply compression for edema/lymphedema in the absence of arterial disease

- Pneumatic compression



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Use pressure redistributing technologies and other methods to reduce friction and shear

- Support surfaces
- Therapeutic footwear and shoe orthotics
- Surgical intervention to correct deformities



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Assess the **WHOLE** patient

Before you evaluate the **HOLE**
in the patient

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4. Optimize wound care

Once the causes of tissue damage are removed,
MANAGE the wound

- G:** Identify the **GOAL** of care
- A:** Take evidence-based **ACTIONS**
- P:** Measure **PROGRESS** toward the goal

Hermans MHE, Bolton LL. Establishing a skin integrity program.
Remington Report, 2001; 9(6) Suppl. 1:6-8

YOU CAN CHOOSE... CARE FOR WOUNDS

DIAGNOSE,
CARE FOR
WOUND,
PATIENT



PROVIDE
CARE



MORE CARE...

OR

HEAL WOUNDS
using evidence-based practice

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By using evidence-based practice to supplement your expertise, you can move forward from traditional “caring for wounds” to accomplishing the goals of care, for example healing them or relieving wound pain.

Wound care starts with proper diagnosis
and removing causes of tissue damage....



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Sometimes it is a challenge to diagnose what you are looking at....

Diagnose!



...and remove the cause of tissue breakdown

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But once you know what you are dealing with, the course of action becomes clear.

Chronic wounds need a multidisciplinary team to diagnose & remove the cause

Local wound care practitioners can't do it alone!

- Vascular
- Nutritional
- Endocrine
- Immune
- Infectious
- Rehab specialists
- Etc . . .



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ID person-centered goals

The wound is attached to **A PERSON**

- Wound-related pain
- Wound odor
- Activities of daily life



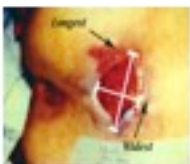
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To diagnose and remove the cause of tissue breakdown, start by looking up from the wound(s) to assess the whole patient.

The topical care you apply will work only if the cause of tissue breakdown has been removed.

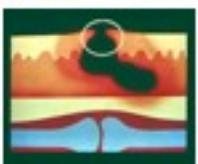
To do this you may need to consult with a vascular lab or surgeon or check blood metabolites to explore need for a nutritional consult or check for diabetes or thyroid deficiencies, working with endocrinology or explore the possibility of immunological complications of disease or the patient's anti-inflammatory medications which inhibit

Evaluate wound



Standardized measures² of

- Length
- Width
- Depth
- Tunneling
- Undermining



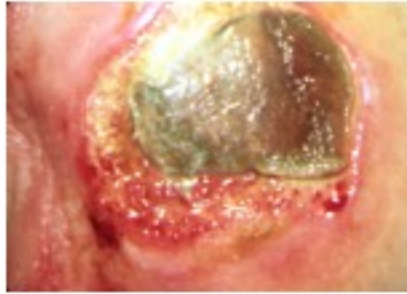
Longest length x longest perpendicular width identifies non-healing wounds in 4 weeks ($p < 0.05$; $n = 260$ patients)²

¹Bates-Jensen B, Vredevoe DL, Brecht M. *Diabetes* 1992; 5: 20-8.
²Kantor J, Margolis DJ. *Arch Dermatol* 1998; 134: 1571-1574.

If you can only make two measurements, measure the length (longest ulcer axis—not body axis) and width as the longest perpendicular to the length.

Evaluate wound bed

- Necrotic tissue
- Granulation
- Fibrin slough
- Epithelium
- Exudate
- Odor



Bates-Jensen BM, Vredevoe DL, Brecht ML. Decubitus 1992; 5: 20-8

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Wound bed ratings or colorimetric measurements can provide validated reliable quantitative assessments of wound surface, necrotic tissue, epithelization or granulation.

Evaluate surrounding skin

Look for Breakdown, Infection, Scarring

- Color
- Moisture
- Induration
- Suppleness



Bates-Jensen BM, Vredevoe DL, Brecht ML. Decubitus 1992; 5: 20-8.

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Reliable (i.e. repeatable), valid (i.e. measure what they say they measure) clinical assessments of the skin surrounding a wound can alert professionals to wound infection or scarring. Erythema or edema around the wound can also mean that the tissue is at risk of further breakdown due to the same factors that caused the chronic wound in the first place, so these assessments can alert you to ulcers at risk of further breakdown or recurrence.. These measures are described in detail in Barbara Bates-Jensen's Pressure Sore Status Tool(PSST) or its adaptation for all wounds, the Bates-Jensen Wound Assessment Tool (BWAT) available free online with her permission.

GOALS of care derived from patient and wound assessments

- Debridement
- Wound healing
- Reduced pain
- Fewer complications, e.g. infection
- Improved quality of life
- Restored function
- Restored mobility
- Prevention of recurrence

Adapted from Plackett, G. *Adv Wound Care*, 1995; 8:42

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Remember the patient and wound assessments we just covered? These are the patient and wound's only opportunity to tell you what they need: the GOALS to meet.

If you found a PU on the patient, a goal may be to heal it.

Or if the patient complained of pain, identify the source (e.g. infection or inappropriate dressing or materials etc.) and alleviate it

If the patient can't perform activities of daily living and wants to, have a PT or OT consult to help them achieve their goals—they'll move more and prevent PU from occurring or recurring

These GOALS of care lead straight to your ACTION plan. For example, ...next slide.

ACTIONS (EXAMPLES)

If the GOAL is . . .	The ACTION is . . .
Debride necrotic tissue	Hydrogel + moisture retention (autolytic)
Clean the wound	Safe, effective cleanser
Absorb excess exudate	Hydrofiber dressing
Control bleeding	Alginate
Hydrate a dry wound	Hydrogel + moisture retention

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EB ACTION: Wound Cleansing

- 4 to 15 pounds of pressure per square inch
- Safe non-toxic wound cleanser
- Do not use a *skin* cleanser or sterilizing agent

AHCPR Pressure Ulcer Treatment Guideline, 1994.

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The Old Adage.....

"Don't put into a wound
what you wouldn't put
into your eye"



Iodine

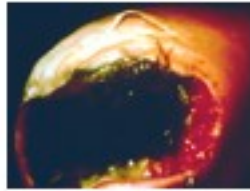
Acetic Acid

EB ACTION: Debride Necrotic Tissue¹

- Healing efficacy² only for autolytic gel debridement
 - Compared to saline gauze on diabetic foot ulcers
- Debriding efficacy
 - Autolytic as fast as enzyme on venous³ or pressure⁴ ulcers
- Be aware
 - Wounds will appear larger after necrotic tissue is removed

Debridement Methods

- Surgical/ Sharp
- Enzymatic
- Autolytic
- Mechanical



¹AHCPR Guidelines for Tx, Px of Pressure Ulcers

²Smith & Thow *The Diabetic Foot*, 2003; 6(1):12-16.

³Romanelli, *Wounds*, 1997;9:122-126.

⁴Burgos A et al. *Clin Drug Invest*. 19(5):357-365)

Autolytic Debridement

- The process by which a wound bed clears itself of debris
- Naturally occurring enzymes digest and liquefy necrotic tissue



Autolytic debridement

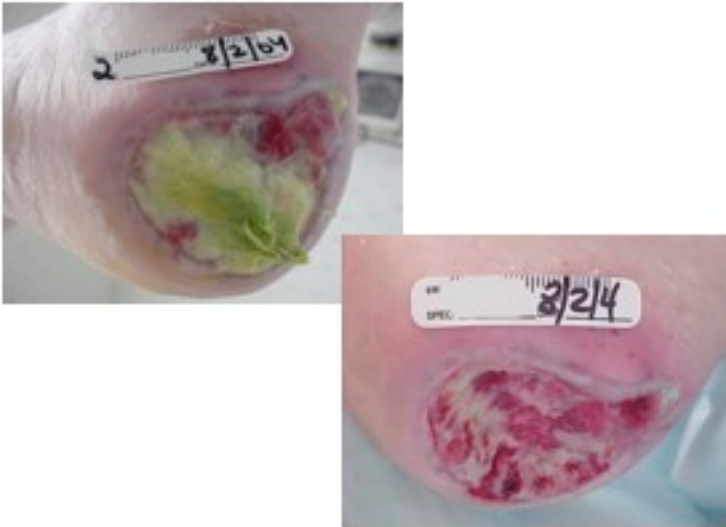


Autolytic:

Advantages: safe, physiologic, noninvasive. Uses body's own wound fluid as deriding agent (WBC's enzymes, etc). Must have a retention layer of wound fluid in contact with the wound surface and a host with adequate WBC's.

Disadvantages: slow process, must monitor for infection. Not appropriate for a leukopenic patient or for patient with an ischemic wound due to poor blood flow and deceased WBC's.

Sterile Sharp/Instrument Debridement



EB ACTION: Manage microbes

Passive Prevention

- Isolate and protect wound^{1,2}
- Reduce necrosis, foreign matter
- Debride necrotic tissue³



¹Hutchinson JJ, McGuckin M. *Amer J Infect Control* 1990; 18(4):257-268.

²Wilson P, et al. *The Pharmaceutical Journal* December 17, 1988; 787-788.

³Steed et al. *Wound Rep Regen*, (2006) 14 680-692

We'll address wound infection here because diabetic foot ulcers are at high risk of infection, due to impaired function of the host immune cells. In fact, Rubenstein reported in 1983 that infection is 5 times more likely in DFU than in non-diabetic chronic wounds. However, these principles apply to all types of infected wounds.

Passive mechanisms that minimize wound infections include isolating and protecting wounds. For example during an outbreak of Methicillin-resistant *Staphylococcus aureus* (MRSA) at their United Kingdom hospital, isolation rooms were all being used, so Wilson and Dunn isolated MRSA-contaminated venous ulcers by dressing them with a hydrocolloid dressing while

Moist wound healing reduces risk of infection



Hutchinson and McGuckin published a retrospective review of published literature from 1960 to 1990, comparing rates of clinical infections reported using different categories of dressings. Clinical infection was defined by the presence of classical clinical signs and symptoms of infection: edema, erythema, pain, odor, purulent exudate and unexplained fever.

The highest infection rate, 7.1%, was observed for wounds dressed with gauze or impregnated gauze dressings, and the lowest infection rate, 1.3%, was observed in wounds for which the moist environment was provided with hydrocolloid dressings

EB ACTION: Manage microbes

Active Management

- Topical antimicrobial agents
- If signs of infection are present,
 - Biopsy or quantitative swab to identify infecting organism
 - Prescribe correct systemic antibiotic



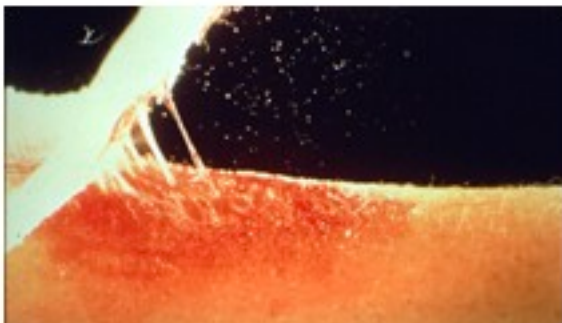
Consider active management when infection is likely. For example, 5x more likely in DFU than in non-diabetic chronic wounds⁴

⁴ Rubenstein, *Am. J. Med.* 1983; 75(1):161

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EB ACTION: ↓ cross-contamination



Fewer airborne organisms for up to 30 minutes after removing hydrocolloid dressing compared to gauze

Moreover, Lawrence and Lilly showed that about 1/3 the level of airborne organisms are released when changing a hydrocolloid dressing than when changing a gauze dressing. Moreover these levels stay high in the treatment room where the dressing was changed for up to 30 minutes, increasing the potential for cross-contamination with gauze.

Gauze Adherence to Wound



- Damages fragile epithelial cells
- Pain with removal
- Increased risk of infection
- Increased risk of cross-contamination



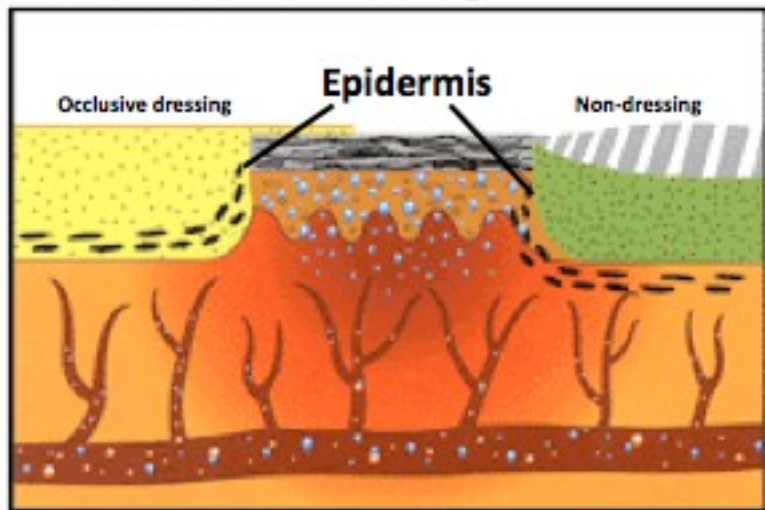
EB ACTION: Moist Wound Healing

- Abrasions (4)
- Amputation sites (1)
- Biopsy sites (6)
- Blisters (1)
- Burns (6)
- Circumcisions (1)
- Epidermolysis bullosa(1)
- Excoriations, trauma (1)
- Flap survival(1)
- Ischemic wounds (1)
- Hypospadias (1)
- Laser resurfacing (2)
- Mohs excisions (1)
- Pressure ulcers (2)
- Skin tears (1)
- Skin graft donor sites (6)
- Surgical incisions (1)
- Vein harvest incision site (1)
- Venous ulcers (2)

MEDLINE Search 1966-Jun,2007 found (N) controlled studies supporting Ffaster healing and reduced pain, scarring or infection rates using film or hydrocolloid than with gauze

Published evidence supports using moist wound healing on a variety of acute and chronic wounds. So far it has not been sufficient for certain EB websites to endorse moist wound healing with film or hydrocolloid dressings, but clinicians who need to make wound dressing decisions may benefit from knowing that these two kinds of dressings have the best available evidence in controlled studies.

Moist Wound Healing



Measure **PROGRESS** Toward Goal

Why measure?

- Support care decisions
- Encourage patient
- Early warning
 - of infection
 - of non-healing (< 20% ↓ in wound area)
- Benchmark outcomes
- Identify problems

What to Measure

- Wound dimensions
- Wound bed
 - Necrotic tissue
 - Granulation
 - Epithelization (resurfacing)
- Exudate
- Odor
- Pain

Once you have used research-based patient and wound assessment to identify the Goals of care, applied research-based Action plans or Algorithms to meet those goals of care, now its time to reap your rewards and measure the Progress toward the goal! You've heard of Pilgrims Progress--this is Patient's Progress! This is the fun part if you are using good research-based assessment tools to develop your goals and as action plans, because you'll thrill your patients, your management and yourself with the results. You can use these results to support your care decisions and convince authorities or prescribing physicians to allow you to do quality wound care And because there will always be some

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5. Prevent loss of function & disability

- Scar management
- Progressive tissue loading
- Exercise
- Assistive technology
- Protect and prevent recurrence



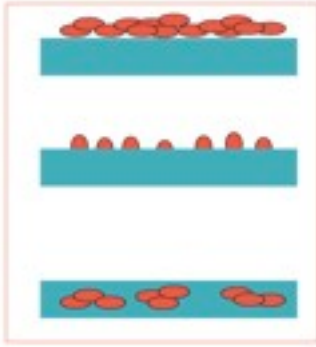
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6.0 Address patient & family concerns

- Provide education for self-care
- Address patient/client concerns
 - Pain management
 - Anxiety/depression
- Provide good follow-up care
 - Monitor adherence to treatment
 - Monitor for signs of infection

Recognizing Infection: Wound Bioburden Spectrum



Contaminated: bacteria present on a surface; no proliferation

Colonized: bacteria attached to surface and proliferates: balanced response from host (no symptoms); healing can occur

Infected: bacteria invades the healthy tissue and elicits response from the host; healing is hindered



Signs of Critical Colonization

- Granulation tissue
 - Color
 - Friability
 - Absent or abnormal
- Odor
 - subtle or dramatic change
- Increased/high exudate levels in the presence of granulation tissue
 - Wounds attempt to "flush out" foreign particles or chemicals



Infection: Clinical Picture

- Swelling
- Induration
- Erythema
- Warmth
- Pain
- Odor



Infection: Definition

"The presence of replicating microorganisms within a wound with subsequent host injury".

Wound infection is far less common than wound colonization and contamination".

