Pressure Injuries: Prevention and Treatment

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Why do you as a Physical Therapist need to know about Pressure Injuries?

○ It’s a diagnosis that can be seen in all treatment surroundings, whether you are actually treating the pressure injury itself or whether you are providing rehabilitation to the patient.
○ Anywhere from 1.3 to 3 million adults develop pressure injuries each year (Lyder, 2003).
○ 85% of patients with a spinal cord injury develop at least one pressure injury at some point in their lives (Somers, 2001).
○ Just like patients can experience heart failure, lung failure, or kidney failure, they can also experience skin failure.
○ Remember, skin is our biggest organ!
○ Need to be able to recognize Pressure Injuries and make other members of the medical team aware if you find one.
Pressure Injuries

- Huge cost to treat these wounds
  - "The average hospital treatment cost associated with stage 4 Pressure Injuries and related complications was $129,248 for hospital-acquired ulcers during one admission, and $124,327 for community-acquired ulcers over an average of 4 admissions" [Brem et al, 2010]
- Huge financial impact on facilities
  - According to the Agency for Healthcare Research & Quality (AHRQ), Pressure Injuries cost the US healthcare system an estimated $9.1-$11.6 billion annually*
  - Studies have shown that the development of a Pressure Injury independently increases the length of a patient's hospital stay by 4-10 days*
    - As those patients stay longer, they become more deconditioned, requiring more of our services
- Highly litigious society
  - There are more than 17,000 Pressure Injury related lawsuits filed annually (second only to wrongful death lawsuits)*
  - If we treated one of these patients, we could possibly be named in that lawsuit

*All data from Leaf Healthcare Inc. White Paper

Pressure Injuries

- The Centers for Medicare and Medicaid (CMS) decided in 2007, any condition that developed while a patient was in the hospital would NOT be reimbursed
  - Pressure Injuries
  - Urinary tract infections
  - Surgical site infections
  - Several more
  - So, huge need for hospitals to prevent Pressure Injuries from occurring or else risk losing thousands or even millions of dollars
- Also important that nurses do a thorough assessment at admission to capture any Pressure Injuries that are present on admission (POA) to allow for increased reimbursement

What is a Pressure Injury?

- Commonly referred to as a bedsore or a decubitus ulcer but most appropriately called a pressure ulcer or pressure injury
  - In April 2016, the National Pressure Injury Advisory Panel announced plans to change the names from Pressure Ulcer to Pressure Injury
- A better term for the cause is tissue load because it is more than just pressure that contributes to these wounds
  - "Tissue loading is caused by pressure, friction, shear, and exacerbated by moisture and temperature" [Irion, 2010]
- Important to remember that devices can cause pressure as well
  - Casts, orthotic devices, oxygen tubing, compression stockings, restraints, bed pams, toilet seats
Devices that Cause Pressure Injuries

- Cervical Collar
- ET Tube
- Knee brace
- Pulse Ox Probe

Pressure Injuries: Pathophysiology and Prevention
Pressure Injuries

- National Pressure Ulcer Advisory Panel (NPUAP) definition of a Pressure Injury: Any lesion caused by unrelieved pressure resulting in damage of underlying tissue
- The less soft tissue present, the more pressure that is exerted. So bony prominences where soft tissue is decreased are more prone to pressure injuries.
  - Ears, heels, sacrum, occiput
- Muscle and fat tissues are more metabolically active, therefore making them more susceptible to tissue ischemia as well
- Low pressures over long periods of time can produce as much damage as high pressures over shorter periods of time

Time vs. Pressure

![Graph showing skin ulceration over time vs. pressure](image)

Pressure Injury Gradient

![Diagram showing pressure gradient from bone to surface](image)

Pressure is the greatest at the bony prominence and gradually lessens in a cone-shaped gradient to the periphery.
Proof for the Pressure Injury Gradient

- As mentioned in Comprehensive Wound Management written by Glenn Irion, PhD, PT, CWS, with the use of high resolution ultrasonography, one study:
  - "Demonstrated 80% of patients with an abnormal appearance of subcutaneous tissue suggestive of injury did not have erythema documented"
  - "Which strongly suggests that injury occurs first in the deep subdermal tissue, progressing to superficial dermal tissue before injury can be appreciated at the epidermal layer"
  - Therefore it can be difficult to identify pressure injuries in the early stages therefore supporting why prevention is so important

Pressure results in tissue ischemia

- Pressure commonly thought to cause tissue ischemia
- The amount of pressure that is commonly cited is 32 mm Hg
- However, current research by Gefen is beginning to prove this wrong
- Video: 32 mm Hg is Old History
  https://www.youtube.com/watch?v=qK3ZJsCQKAA

Ischemia vs. Cell Deformation?

- New research is proving that it is actually cell deformation that is causing the deep tissue damage and not ischemia
- Research done on tissue-engineered musculature
  - Gefen developed bio-artificial muscle with the same fibers that real muscle has
  - No vascularity in this tissue
- When cells are deformed, it increases the cell membrane permeability, which in turn increases certain levels of molecules such as ions, nutrients and waste products, thus becoming cytotoxic and killing the cells
- Deformation: The Killer from Within
  https://www.youtube.com/watch?v=VdkQjFnp8aQ
Identifying Pressure Injuries

- Fairly easy to detect in lighter-pigmented people but often can be difficult to tell when damage is being done in darker-pigmented people

- Need to look for skin changes such as darkening of skin as well as changes in skin temperature and texture

Location of Pressure Injuries

- Anywhere there are bony prominences
- Ears, occipital, shoulder, scapula, elbow, iliac crest, sacrum, trochanter, ischium, medial malleolus, lateral edge of foot, lateral malleolus, great toe, heel
- More than 95% of Pressure Injuries occur over 5 locations: Sacral/coccygeal area, greater trochanter, ischial tuberosity, heel and lateral malleolus

Common Pressure Injury Locations
Other wounds often mistaken for Pressure Injuries

- This is a nice guide to help differentiate pressure injuries from other types of wounds

  https://healthinsight.org/Internal/docs/nursing/is_this_a_pressure_ulcer_or_another_wound.pdf

Examples of Pressure Injuries
Let's test your knowledge

http://www.slideboom.com/presentations/82699/Test-Your-Pressure-Ulcer-Staging-Skills

National Pressure Ulcer Advisory Panel (NPUAP) Pressure Injury Staging System

• New name reflects the fact that tissue can be intact but still have damage, therefore the change from “Pressure Ulcer” to “Pressure Injury”
• Depth of tissue injury observed; does not necessarily account for damage that cannot be seen
• Staging is ONLY TO BE USED FOR Pressure Injuries!!!!
• 4 Stages and then 2 classifications
  • With changes in name from pressure ulcer to pressure injury, the NPUAP also decided to change from Roman numerals to Arabic Numbers
    • Deep tissue injury
      • Stage I → Stage 1
      • Stage II → Stage 2
      • Stage III → Stage 3
      • Stage IV → Stage 4
    • Unstageable

Deep Tissue Injury (DTI)

• Purple or maroon localized area of discolored intact skin or blood-filled blister due to damage of underlying soft tissue from pressure and/or shear. The area may be preceded by tissue that is painful, firm, mushy, boggy, warmer or cooler as compared to adjacent tissue.

Further description:
Deep tissue injury may be difficult to detect in individuals with dark skin tones. Evolution may include a thin blister over a dark wound bed. The wound may further evolve and become covered by thin eschar. Evolution may be rapid exposing additional layers of tissue even with optimal treatment.
Deep Tissue Injury

Evolving Deep Tissue Injury
Treatments for DTI

- Standards of Care:
  - Increased pressure relieving support surface
  - Nutrition consult
  - Frequent turning/repositioning
  - Reduction of friction and shear

- Foam dressings: NPUAP recommends:
  - “Consider placing foam dressings on body areas and Pressure Injuries at risk for shear injury” (Strength of Evidence = B)
  - Typically have silicone borders which provide adhesion but are very gentle to the skin

Modalities for DTI

- Non-contact low frequency ultrasound (MIST) therapy
  - Study done by Honaker in 2009
    - Protocol: 6 DTIs received MIST therapy for 5 days and then every other day until healed.
    - Results: None of the DTI evolved into a more advanced stage Pressure Injury
    - Conclusion: MIST therapy is beneficial in preventing progression of the DTI when performed within 3-4 days of discovery

- Siddiqui theorizes that MIST works for DTI due to:
  - Decreased inflammatory and oxidative response
    - Up-regulation of TGF-b and KGF
    - Evidence of vasodilation and angiogenesis
MIST Therapy

Stage 1 Pressure Injury

Intact skin with non-blanchable redness of a localized area usually over a bony prominence. Darkly pigmented skin may not have visible blanching; its color may differ from the surrounding area.

Further description:
The area may be painful, firm, soft, warmer or cooler as compared to adjacent tissue. Stage 1 may be difficult to detect in individuals with dark skin tones. May indicate "at risk" persons (a heralding sign of risk)
Stage 1 Treatment Options

- Primary goal is to reduce the pressure over the area with repositioning/offloading
  - If pressure is relieved, should see stage 1 resolve
- Moisture management is important as well
- Can use a foam dressing to help with friction/shear

Stage 2 Pressure Injury

- Partial thickness loss of dermis presenting as a shallow open ulcer with a red pink wound bed, without slough. May also present as an intact or open/ruptured serum-filled blister. Can be painful
- Further description: Presents as a shiny or dry shallow ulcer without slough or bruising.* This stage should not be used to describe skin tears, tape burns, perineal dermatitis, maceration or excoriation.
  *Bruising indicates suspected deep tissue injury
Stage 2 Treatment Options

- NPUAP Recommends:
  - Hydrocolloid: “Use hydrocolloid dressings for clean Category/Stage 2 Pressure Injuries in body areas where they will not roll or melt” (Strength of Evidence = B)
  - Foam: “Consider using foam dressings on exudative Category/Stage 2 and shallow Category/Stage 3 Pressure Injuries” (Strength of Evidence = B)
  - Hydrogel: “Consider the use of hydrogel dressings on shallow, minimally exudating Pressure Injuries”. (Strength of Evidence = B)

Dressing Options

- Hydrocolloids
- Foam dressing
Stage 3 Pressure Injury

- Full thickness tissue loss. Subcutaneous fat may be visible but bone, tendon or muscle are not exposed. Slough may be present but does not obscure the depth of tissue loss. May include undermining and tunneling. Usually not painful as nerve endings are no longer intact.

Further description:
The depth of a stage 3 Pressure Injury varies by anatomical location. The bridge of the nose, ear, occiput and malleolus do not have subcutaneous tissue and stage 3 ulcers can be shallow. In contrast, areas of significant adiposity can develop extremely deep stage 3 Pressure Injuries. Bone/tendon is not visible or directly palpable.
Stage 4 Pressure Injuries

- Full thickness tissue loss with exposed bone, tendon or muscle. Slough or eschar may be present on some parts of the wound bed. Often include undermining and tunneling.
- Further description:
  The depth of a stage 4 Pressure Injury varies by anatomical location. The bridge of the nose, ear, occiput and malleolus do not have subcutaneous tissue and these ulcers can be shallow. Stage 4 ulcers can extend into muscle and/or supporting structures (e.g., fascia, tendon or joint capsule) making osteomyelitis possible. Exposed bone/tendon is visible or directly palpable.
Stage 4 Pressure Injury

Bone exposed

Stage 3/4 Treatment Options

• This is where you will see huge variability in the treatment of Pressure Injuries
• As the saying goes, “There’s more than one way to skin a cat!”

Stage 3/4 Treatment Options

• If debridement is required, this is first thing that needs to be addressed
  • Will cover debridement in future slides
• If there is any chance of infection, this needs to be addressed as well
  • Can accomplish this in various ways
    • Dressings
    • Topical Antibiotics
    • Systemic Antibiotics
• Once a healthy wound bed is achieved, this is where more advanced treatment techniques can come into use
Unstageable Pressure Injury

○ Full thickness tissue loss in which the base of the ulcer is covered by slough (yellow, tan, gray, green or brown) and/or eschar (tan, brown or black) in the wound bed.

○ Further description:
  - Until enough slough and/or eschar is removed to expose the base of the wound, the true depth, and therefore stage, cannot be determined.

○ Stable (dry, adherent, intact without erythema or fluctuance) eschar on the heels serves as "the body's natural (biological) cover" and should not be removed.

Unstageable

Examples of Eschar
Examples of Slough*

*Not Necessarily a Pressure Injury

Reverse or Back Staging of Pressure Injuries

- This is not acceptable practice, though some insurance companies used to require this to demonstrate wound healing
  - i.e. “Wound has improved from Stage 4 Pressure Injury to Stage 3”
  - Once an ulcer is staged, it cannot change
  - Correct terminology is “Healing Stage 3” or “Healing Stage 4”

Risk Factors

**Extrinsic Factors:**
- Pressure
- Shear: Parallel force that stretches tissues over bony tissue interface; keep head of bed at 30 degrees or less
- This explains why wounds are not just size of bony prominence they are over and why pressure injuries are usually oval, not truly round like the bony prominence
- Same effects as friction but also has blood vessel damage that can result in tissue ischemia and usually results in deeper tissue damage than friction
- Friction: When 2 surfaces move across one another
- Moisture: Incontinence; Causes removal of oils on skin, making skin more fragile. Also can lead to maceration of skin

**Intrinsic Factors:**
- Nutrition
- Used to consider Albumin/Prealbumin as being indicative of nutritional status; however, recent research has shown very little correlation
- Age
- Medical conditions and psychological factors
- Immobility, inactivity
- Decreased sensory perception
Shearing

- Caused by gravity and friction
- Decreases or stops blood flow through the vessels

Pressure Injury Size Increased due to Shearing Effects

Friction
Risk Assessment Scales

- Scales commonly used by nursing to identify a patient's risk of developing a Pressure Injury
  - Braden Scale: Looks at sensory perception, moisture, activity, mobility, nutrition, and friction and shear. Score of less than 18 is considered to be an indicator of risk to skin breakdown.
  - Norton’s scale: 5 subscales: physical condition, mental state, activity, mobility and incontinence
  - Gosnell’s scale: Added onto Norton’s.

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**Braden Scale**

<table>
<thead>
<tr>
<th>Subscales</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensory perception</td>
<td>Scored from 1 to 6, higher scores mean higher risk of skin breakdown.</td>
</tr>
<tr>
<td>Moisture</td>
<td>Scored from 1 to 4, higher scores mean increased risk of skin breakdown.</td>
</tr>
<tr>
<td>Activity</td>
<td>Scored from 1 to 4, higher scores mean increased risk of skin breakdown.</td>
</tr>
<tr>
<td>Mobility</td>
<td>Scored from 1 to 4, higher scores mean increased risk of skin breakdown.</td>
</tr>
<tr>
<td>Nutrition</td>
<td>Scored from 1 to 4, higher scores mean increased risk of skin breakdown.</td>
</tr>
<tr>
<td>Friction and shear</td>
<td>Scored from 1 to 4, higher scores mean increased risk of skin breakdown.</td>
</tr>
</tbody>
</table>

**Norton’s scale**

<table>
<thead>
<tr>
<th>Subscales</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical condition</td>
<td>Scored from 1 to 4, higher scores mean increased risk of skin breakdown.</td>
</tr>
<tr>
<td>Mental state</td>
<td>Scored from 1 to 4, higher scores mean increased risk of skin breakdown.</td>
</tr>
<tr>
<td>Activity</td>
<td>Scored from 1 to 4, higher scores mean increased risk of skin breakdown.</td>
</tr>
<tr>
<td>Mobility</td>
<td>Scored from 1 to 4, higher scores mean increased risk of skin breakdown.</td>
</tr>
<tr>
<td>Incontinence</td>
<td>Scored from 1 to 4, higher scores mean increased risk of skin breakdown.</td>
</tr>
</tbody>
</table>

**Gosnell’s scale**

- This scale is added onto Norton’s scale.

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**Reference**

- Frontline HealthCare Guide to Nursing: Assessments and Interventions.
Norton Plus Scale

Pressure Injury Risk

- Based on the subscores of these scales, interventions can be initiated to address each individual subscore.

- Extremely important to document any interventions provided because of the old medical adage "If it wasn't documented, it wasn't done."

- This will help in legal cases, especially to prove that a Pressure Injury may have truly been unavoidable.

- For example, moisture and incontinence may not be a problem for everyone but they still may be at increased risk for Pressure Injury development, therefore interventions would not need to include addressing incontinence.

Other Risk Factors

- Need to consider other aspects of the patient's history:
  - Were they found down at home on the floor?
    - Expect Pressure Injuries on the side that they were laying on.
    - Most likely will present as bruises that could be easily overlooked as just trauma from the fall; most likely though they are deep tissue injuries.
  - Were they in the emergency department for several hours on a non-pressure relieving stretcher mattress?
    - Need to collaborate with the emergency department to acquire better stretcher mattresses or if someone is at high risk and will be in the emergency department for an extended period of time, may arrange to have a pressure relieving bed from one of the inpatient units brought to ED until transfer is possible.
  - Were they in the operating room for several hours at a time?
    - Need to coordinate with the operating room staff to ensure that bony prominences are being well-padded and offloaded during surgery.
  - Are they refusing care?
    - Sometimes patients refuse to be on the correct surface or refuse to be turned; this needs to be thoroughly documented that patient was explained the risks and benefits but patient still chose to refuse.
Early Interventions: A Summary

- Prevention is key! Team effort involving nursing, therapy, dietary
- Nutrition needs to be addressed
- Passive repositioning by caregiver
  - Should be done at least every 2 hours with a bedbound patient, every 15 minutes with a chair bound patient
  - Example of turning schedule:
    - Supine → left sidelying → right sidelying → supine → left sidelying → right sidelying
- Pillow bridging
  - Place pillow flat under patient from patient’s shoulder to hip, no more than a 30-degree angle
- Use of pressure-relief or pressure-reduction support surfaces for chair and bed
- Donut Pillow devices are not recommended as they can cause increased pressure to surrounding areas
- Prevalon or Heel-lift boots

30 Degree positioning: Not placing patient directly on opposite hip but still getting pressure off sacrum

NO! NO! NO!
Heel Relief Devices - Prevalon

Heel Lift Boots

Medline Heel Suspend Pillow

Inappropriate Pillow Usage

Figure 1A, B: Inadequate pillow support provides no heel pressure relief. Note that the heels are not elevated in the first picture, despite the presence of the pillow.
Use of Pressure Relief Surfaces

- Tissue interface pressures: Calculated by using capillary closing pressures (generally considered to be 12 to 32 mm Hg) as a measure to calculate support surface effectiveness.
- Pressure reducing surfaces: Help lower tissue interface pressures but do not eliminate them; interface pressures between 26-32 mm Hg
- Pressure relieving surfaces: Consistently reduce tissue interface pressures in any position and in most body locations; interface pressure less than 25 mm Hg
- Pressure redistribution: Better term to use

* "As a general rule, the softer, more pliable materials provide better pressure reduction but decreased stability, while the firmer surfaces provide better stability" (Blagg, "Preventing Pressure Injuries," 2009).

Ideal Support Surface Characteristics

- Reduces/relieves pressure under bony prominences
- Controls pressure gradient in tissue
- Provides stability
- No interference with weight shifts
- No interference with transfers
- Controls temperature at interface
- Controls moisture at skin surface
- Lightweight
- Low cost
- Durable

Terminology

- Static devices: Do not move, reduce pressure by spreading load over large area. Pressure reducing. Typically just a foam mattress
- Dynamic devices: Move, require motor to operate. Pressure reducing.
- Low air loss: Series of connected air-filled pillows with surface fabrics of low-friction material. Pressure redistribution
- Fluidized: Silicone-coated glass beads and incorporates both air and fluid support. Provides best pressure relief
- Overlays: Goes over foam or regular bed found in hospital or home.
- Bariatric beds: Used for morbidly obese patients; can have any of devices mentioned above on reinforced frame
Fluidized

Silicon beads that with use of air becomes a fluid

Overlays

Static Overlay

Dynamic Overlay

Bariatric Beds

These often have rotation devices and many handles to aid in positioning and mobility of these morbidly obese patients and also to help prevent staff injuries. Can also install trapeze above these beds to assist mobility.
When to use what type?

- **Static support surface**: If patient can assume variety of positions without bearing weight on existing Pressure Injury
- **Dynamic support surface**: If patient cannot assume a variety of positions without bearing weight on Pressure Injuries, if patient fully compresses static support surface or if Pressure Injury not healing
- **Low air loss or fluidized air**: Large stage 3 or stage 4 Pressure Injuries on multiple turning surfaces; When excessive moisture on intact skin; Can dry skin and prevent Pressure Injuries

The Seated Patient

- Remember, Pressure Injuries can also be acquired from sitting
- So, with patients in wheelchairs, specialized cushions should be used to prevent pressure
- Many different options available
- Must be careful that the patient is not bottoming out on the surface and that the surface receives regular maintenance
- Also must consider the patient’s posture when deciding on the proper cushion because the same cushion will not work for everyone

The Seated Patient

- One must also consider what a Pressure Injury’s effect will be on the wheelchair-bound patient, especially young, active patient living with spinal cord injuries
- “Dressing changes, close monitoring of skin, limited sitting time, and restriction of normal activities—including lost time from work—can disrupt daily life for days, weeks, or even months. Complications such as wound infections can occur, which increase healing time and can lead to other medical issues. Dealing with a Pressure Injury can be discouraging, even depressing, especially if you worked very hard to take good care of your skin.”

Wheelchair Cushion and Cover Materials

- Technological advances have been made in cushion materials
  - Best type is static air: "Allow movement of air among channels to redistribute pressure and, to some extent, shear." Downsides include "potential for over- or underfilling, potential for seams to fatigue and leak, and accidental puncture" (Irion, 2010)

- Also new materials that cover these cushions serve two purposes:
  - Protecting the cushion to preserve its integrity and pressure-relieving ability
  - Protecting the patient's skin from moisture.
  - Materials can provide a waterproof barrier for the cushion and can also wick moisture away from the skin. Some cushion covers are designed with several layers of materials that are separated to allow for increased airflow next to the skin (Blagg, 2009)

Examples of Wheelchair Cushions

Cushions may have gel, foam, or air bladders that help with pressure redistribution. More common cushion manufacturers include Roho and Jay.

Example of how same cushion in different patients provide completely different pressure relief

http://sci.washington.edu/info/forums/reports/pressure_map.asp
Medicare Part B Support Surface Guidelines

- Very strict guidelines established by Medicare for reimbursement of support surfaces. Need a written order from the physician as well as a comprehensive plan of care.
- For reimbursement, divided into 3 categories: Group I, II or III
  - Group I: Alternating air pressure mattress and overlays, gel mattress or overlay, and water pressure mattresses and overlays
  - Group II: Low-air-loss beds; Indicated for multiple stage II Pressure Injuries on trunk or pelvis and the patient has tried a Group I with deterioration or no improvement of wound over last month or multiple stage 3-4 Pressure Injuries on the trunk or recent flap or skin graft
  - Group III: Air-fluidized beds; Indicated for stage 3 or 4 Pressure Injury, patient is bed- or chairbound, patient would require institutionalization without the bed or failure of conservative treatment (Irion, 2010)

Pressure Injury Assessment and Interventions

A.S.S.E.S.S.M.E.N.T.

- Things that are important to note when evaluating a Pressure Injury:
  - A= Anatomic location, age of ulcer
  - S= Size, stage
  - S= Sepsis
  - E= Exudate type and amount, erythema
  - S= Surrounding skin color, swelling, saturation of dressing
  - S= Sinus tracts (undermining)
  - M= Maceration
  - E= Edges, epithelialization
  - N= Nose (odor), necrotic tissue type and amount, neovascularization
  - T= Tenderness to touch, tension (induration), tautness, tissue bed (granulation tissue)
Measuring A Pressure Injury

- **Length and Width**
  - Always document length 1st
  - In centimeters
  - Clock method: 12-6 is length; 3-9 is width
  - Can also measure greatest length and greatest width
  - Can determine area by multiplying length x width
  - This is only an approximation though because wounds are typically irregularly shaped

Measuring Wound Depth

- **Depth**: “Distance from visible skin surface to wound bed”
- Use cotton tip applicator
- Can do at center of wound or at deepest point of wound
  - Can also use clock method, taking depths at 12:00, 3:00, 6:00 and 9:00
- Decreasing depth is indicator of increasing granulation tissue
- Partial thickness wounds have depth of less than 0.2 cm; anything with greater than 0.2 cm depth is considered full thickness
Measurement of Tunneling and Undermining

- **Tunneling**: “Linear erosion extending from a wound”; Extension of wound bed into adjacent tissue; also known as a sinus tract. “Commonly used when erosion of subcutaneous tissue from an abscess occurs” (Irion, 2010)
- **Undermining**: A tunneling effect or pocket under the edges of a wound; “Can be visualized as a cliff caused by necrosis of tissue more susceptible to hypoxia than skin is”. Commonly associated with Pressure Injuries due to shear (Irion, 2010)

Measurement of Undermining and Tunneling

- Several different methods to measure
  - Can gently probe undermined areas and measure deepest point, identifying this in notes
  - Undermining and tunneling can add to overall size and area of wound

Measurement of Undermining and Tunneling

- Two areas of undermining documented
Undermining
Wound Tracings

- Can record changes throughout healing stages
- Use of standard anatomic landmarks and method to transfer tracing to medical record
- Several types of tracing kits available
- Can indicate areas of eschar or slough with different markings

Pressure Injury Treatment

- Those things that were important in preventing Pressure Injuries continue to be important once a Pressure Injury has developed
  - Nutrition
  - Pressure reduction/redistribution
  - Offloading/Turn schedules
- Many different options for treatment of Pressure Injuries
  - Depends on appearance of ulcer
  - Necrotic vs. healthy tissue
  - Infected vs. not infected
Debridement

- Many forms of debridement available
  - Reasons to choose one from another: quickness of debridement, pain level of patient, coagulopathy/blood thinners, overall health of patient
- Forms include:
  - Mechanical
  - Sharp
  - Enzymatic
  - Surgical
  - Autolytic
  - Biologic

Mechanical Debridement

- The use of some outside force to remove necrotic tissue
- Wet-to-dry, pulsatile lavage, whirlpool
- Advantages: Familiar to most health care practitioners; effectively decrease bacterial burden in wound, thus decreasing chance of infection
- Disadvantages: Nonselective; wet-to-dry not used appropriately, painful on removal and more costly in regards to labor and supplies; delays normal healing time; maceration to surrounding tissue may occur; possible chance of cross-contamination between patients if whirlpool not adequately cleaned.
- Typically used on wounds with large amounts of necrotic tissue in an attempt to loosen necrotic tissue and make it easier for sharp debridement to be performed

Sharp Debridement

- Can be performed as a one-time procedure or can be ongoing with more necrotic tissue being debrided at each treatment session
  - New recommendation is that sharp debridement be an ongoing process to keep wound free of microscopic debris
- Can convert chronic wound to an acute wound
- Removal of loose nonviable tissue with scalpel, forceps and/or scissors
So your patient has necrotic tissue...what can or should you do?

- It is important to understand our role as PTs in the sharp debridement of Pressure Injuries
  - There is certainly a level of skill required
  - Competency in this area should be evaluated regularly
  - It is also important to know and understand your state’s practice act and what it says in regard to sharp debridement
  - Depending on state practice acts, both physical therapists and nurses can perform sharp debridement
  - The APTA put out a position statement several years ago saying that PTAs should not do sharp debridement due to the need for ongoing reassessment during debridement
  - Individual states are allowed to make their own decision on whether to let PTAs debride

Consent for Sharp Debridement

- Some facilities include this consent as part of their overall consent to treat
- Other facilities have a separate consent to debridement form that must be reviewed with the patient prior to the patient signing
- Imperative to explain all the risks and benefits of sharp debridement and make sure the patient has a clear understanding of what the goal is
  - This includes telling the patient and family member that the Pressure Injury may look worse or bigger before it looks better
  - This is normal and to be expected

Sharp debridement

- **Advantages:** Selective, quick and effective; Can be used with other types of debridement techniques; less invasive; can be performed at bedside
- **Disadvantages:** Requires level of skill or expertise to be performed safely; questionable reimbursement when performed by non-physicians; can be painful
- **Contraindications:** Coagulopathy
Sharp debridement

- The use of enzymatic topical agents to remove nonviable tissue
- **Collagenase Santyl**: As name describes, it works by breaking down collagen; works at interface of necrosis and wound base. Can use topical antibiotic powder with it if wound infected; Not to be used with silver dressings
- Useful with patients who can’t tolerate sharp debridement
- Physician’s order is required as the agents are obtained from pharmacy
- Not active in dry environments
- Dry eschar must be cross-hatched and wound maintained with moist environment for enzymatic debridement to be effective
- Best used on large wounds with >50% necrosis
- **Advantages**: Selective, works only on non-viable tissue, can be used in conjunction with other debridement options
- **Disadvantages**: Slower form of debridement, inflammation can occur to surrounding skin due to pH changes

Enzymatic debridement

- Much the same as sharp debridement but performed by surgeon
- While our goal as physical therapists is to debride only necrotic, nonviable tissue and leave viable tissue intact, surgical debridement may involve going into viable tissue to produce a healthy, bleeding wound edge
Autolytic Debridement
- Use of body’s own mechanisms to debride wound
- Use of moist wound healing to allow macrophages and phagocytes to clean wounds
- Must use occlusive or semi-occlusive dressing to maintain moist wound environment
  - Cannot be used on infected wounds because it will allow infection to proliferate

Biological Debridement
- Use of larvae therapy to debride wounds
  - Larvae secrete a fluid into the necrotic tissue, this breaks down the necrosis and then the larvae ingest the liquefied necrosis
  - Left in place for 3-4 days
  - A current product is called Bio Bag

Negative Pressure Wound Therapy (NPWT)
- Negative pressure distorts/stretch cells
  - Causes mitosis and granulation tissue formation
  - Stimulates growth of new blood vessels
- Lowers bacteria count in wound bed
  - Removes wound fluid which could provide medium for bacterial proliferation
- Vacuum removes excess fluid from interstitium
  - Pulls excess interstitial fluid from surrounding tissues
  - Removes pressure from blood vessels and improves flow of oxygen and nutrients to wound
Negative Pressure Wound Therapy (NPWT)

- System uses special open-cell polyurethane ether foam dressing cut to size of wound.
- Foam then placed in wound and covered by film.
- Tube placed over sponge and then attached to pump which generates negative pressure between 50-200 mmHg.
- Drainage is collected in canister in pump.

**Indications:**
- Stage 3 and 4 Pressure Injuries
- Split thickness meshed skin grafts
- Muscle flaps
- Non-surgical candidates

**Contraindications:**
- Presence of eschar and necrotic tissue (must be less than 25% necrotic)
- Untreated osteomyelitis

**Precautions:**
- Active bleeding
- Difficult wound hemostasis
- Patients on anti-coagulants
Types of Foam

- 3 different types:
  - Black, sterile, polyurethane foam has large pores and is more effective for stimulating granulation tissue and wound contraction.
  - White, sterile, polyvinyl alcohol soft foam is denser with smaller pores and is recommended when growth of granulation tissue is less needed or when patient can’t tolerate polyurethane foam due to pain.
  - Silver: Similar to black foam but has silver in it for its antimicrobial effects.
Silver Foam

Rationale
- Negative pressure distorts/stretches cells
- Causes mitosis and granulation tissue formation
- Stimulates growth of new blood vessels
- Lowers bacteria count in wound bed
- Removes wound fluid which could provide medium for bacterial proliferation
- Vacuum removes excess fluid from interstitium
- Pulls excess interstitial fluid from surrounding tissues
- Removes pressure from blood vessels and improves flow of oxygen and nutrients to wound

Negative Pressure Wound Therapy on a Sacrum
Ultrasound

Theory: Cells close to stable bubbles are subject to bubble-associated microstreaming that has been shown to increase their plasma membrane permeability to calcium ions temporarily acting as a stimulus to cell activity such as cell migration and proliferation as well as synthesis and release of growth factors.

Thermal and non-thermal effects

Electric Stimulation for Tissue Repair

- NPUAP recommends: “Consider the use of direct contact (capacitative) electrical stimulation (ES) in the management of recalcitrant Category/Stage II, as well as Category/Stage 3 and 4 Pressure Injuries to facilitate wound healing” (Strength of Evidence = A).
- American College of Physicians (ACP) in March 2015 released guidelines for treatment of Pressure Injuries which supported use of EST.
  - “Moderate-quality evidence supported the use of electrical stimulation in conjunction with standard treatment to accelerate the healing rate of stage 2 to 4 ulcers. Evidence was insufficient, however, to determine its effect on complete wound healing.”

Rationale:
- liquefies or softens necrotic tissue
- reduces pain and edema
- antibacterial effects
- increase ATP generation and improve membrane transport
- increase collagen synthetic capacity
- organizes collagen matrix to increase wound tensile strength
Application of ESTR

- **External Electrode Placement**
  - Place electrodes along side of wound
  - Called “Bipolar” technique
  - Closer together the electrodes, the more superficial the result

- **Internal Electrode Placement**
  - Place moist 4x4 in wound with aluminum foil over moist 4x4 hooked to e-stim machine with alligator clip
  - Called “Monopolar” technique
  - Must use dispersive

**What Polarity to use?**

- Depends on desired effect
- Use negative electrode if you want:
  - Increased blood flow
  - Decreased edema
  - Debridement
  - Thrombolysis
- Use positive electrode if you want:
  - Tendon repair
- Use alternating or both if you want:
  - Increased oxygen
  - Wound contraction
  - Bacteriostatic effects

**Aluminum foil with Electrode**
Bipolar technique

Monopolar Technique
Muscle Flaps

- Used for many different diagnoses, not just Pressure Injuries, i.e. breast reconstruction after cancer and mastectomy
- Indicated for:
  - Defects requiring filling of dead space
  - Coverage of exposed vital structures
  - Treatment of osteomyelitis
  - Functional reconstruction of muscle loss or absence in congenital conditions
  - Coverage of exposed orthopedic hardware

- Issues with muscle flaps:
  - Require absolute bed rest for 6-8 weeks after surgery
    - Also requires the patient to be on an air-fluidized bed such as Clintron during this time
  - Any friction/shear/pressure can damage flap and cause it to fail
  - If wound is not properly debrided and free of infection, flap will fail

Muscle Flaps

http://www.microsurgeon.org/muscleflaps

Muscle Flap for Ischial Tuberosity Pressure Injury
How to Determine How Well Your Facility is doing with Preventing Pressure Injuries

- Many facilities do Prevalence Studies, either quarterly or monthly
  - This is done by looking at the number of patients with Pressure Injuries or the prevalence of Pressure Injuries as well as the number of patients with facility-acquired Pressure Injuries or the incidence
  - Typically a team of 2 nurses or a nurse and aide; must do whole hospital on same day
  - Survey ALL patients in the hospital, not just those at risk
  - Problem with prevalence studies:
    - Only give a “snapshot” of how well you are doing
    - Cannot do anything about patients who come in with Pressure Injuries
  - Best indicator is incidence: Number of patients with hospital acquired Pressure Injuries divided by the census of the facility
  - Can visit the National Database of Nursing Quality Indicators for more information:

Example

- In a 300 bed hospital, 290 patients were surveyed
- Out of the 290 patients, 20 had Pressure Injuries
  - Prevalence: 20/290 x 100 = 6.89%
  - 5 of these were acquired in the hospital
  - Incidence: 5/290 x 100 = 1.72%
- Ideally facilities would like a 0% incidence and often this is set as a goal for the facility
  - This is not always achievable, depending on the acuity of the patients

How to Determine How Well Your Facility is doing with Preventing Pressure Injuries

- Many facilities take photos of wounds at time of admission, upon discovery and at time of discharge to photodocument wound
  - “Especially important for wounds containing vast amounts of necrotic tissue. In these cases wounds frequently become much larger before they can heal. A good quality photograph can show changes in the quality of the wound, and demonstrate complications that may not have been foreseen by others (Irion, 2010).
  - Typically digital cameras are used; some facilities starting to use iPods that can be sent to medical records and the picture is placed directly into the electronic medical record
  - Important to have ruler, location, patient’s name, medical record and the date in the picture
  - This is to demonstrate that no manipulation of the picture was done after taking it, as can easily be done with digital photos
Wound Photography

- Can be used to prevent litigation
- Wounds should be documented with photos upon admission to facility or when acquired as well as on discharge
- Consent should be acquired before taking photos
- Permanent part of medical record
- Affected by light
  - Flash gives blue tone to wounds, incandescent light gives yellow tone
- Can be used to measure wounds
  - Special film with grid to assist in calculating wound dimensions
- Series of several pictures can be used to document improvement of wound
- Can be stored in computer for future use

Team Effort

- As mentioned previously, prevention and treatment of Pressure Injuries is truly a team effort with every member of the team, from the nursing aide to nutrition to the physician and of course, the PT, having an important role to play
- Also, all the expensive mattresses and support surfaces do not prevent Pressure Injuries by themselves
  - One study demonstrated “The prevalence of Pressure Injuries was only reduced 5% with pressure reduction mattresses alone, but a combination of pressure reduction mattress and a multifaceted education strategy reduced the incidence of Pressure Injuries by 15%” (Krasner et al, 2007)
- Therefore it is imperative that staff as well as the patient and their caregivers are educated in techniques to prevent Pressure Injuries

Role of Physical Therapy in Patients with Pressure Injuries

- May not play a role in the actual treatment of the Pressure Injury
- We serve a huge function in many other aspects of the patient’s care
  - Exercise
  - Improved range of motion and strength
  - Bed Mobility/Repositioning
  - Gait training
  - Use of assistive devices
  - Edema management
  - Education of patient, family, and other staff
  - All things we already do with all of our patients
- Thus should we considered an integral part of the Pressure Injury Team
What Deficits Will We See in Patients with Pressure Injuries?

- Reduced foot and ankle range of motion
- Reduced hip and knee strength
- Reduced core strength and flexibility
- Reduced balance and coordination
- Reduced endurance
- Reduced mobility

What can Physical Therapy Do?

- Full functional assessment should be performed initially
- Once deficits noted, tailor the treatment plan to the patient
  - Make sure to include the patient in the decision making and goal setting
- May start as simple as range of motion and strengthening exercises in conjunction with bed mobility training

Conclusion

- Not all Pressure Injuries are preventable, sometimes patient’s overall health is so poor that a Pressure Injury is inevitable.
- However, a large majority of Pressure Injuries can be prevented with proper care of patient.
- Remember, prevention is key!
- For more information on Pressure Injuries, visit the National Pressure Injury Advisory Panel (NPUAP) website at [www.npuap.org](http://www.npuap.org)