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Clinician's Pocket Guide to Advanced Wound Care

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The information contained within this guide is for educational purposes only and is the result of the authors' individual and collective knowledge derived from research and their clinical experience and expertise.

Introduction

The Wound Healing Society in the United States defines a chronic wound as a wound that "fails to progress through a normal, orderly and timely sequence of repair, or wounds that pass through the repair process without restoring anatomic and functional results". While variations of this definition exist in different parts of the world, it is generally agreed that if a wound does not show any visible or significant progress towards closure, in two weeks after injury or after initiation of appropriate care, with good control of intrinsic and extrinsic factors affecting healing, the wound is chronic. The same consideration may be applied to the selection of appropriate treatment. If the wound is not responding to the selected treatment modality within a two week period, the patient and the wound should be re-examined to determine if any factor affecting healing has been missed, the wound etiology reconsidered and the treatment changed. Pressure, venous and diabetic ulcers are the most common chronic wound etiologies although arterial, vasculitic and other types of wounds are not uncommon. Wounds may present an expensive and complex problem for patients and clinicians while imposing a significant financial burden on society.

The Pocket Guide

The intent of the Pocket Guide is to provide a quick reference for the treatment of chronic and problematic wounds for all clinicians, including but not limited to physicians, nurses, podiatrists, rehabilitation specialists and all those involved in treating wounds that will not heal. The Pocket guide is meant for initial wound assessment and treatment with the intent of optimizing safe and cost

sustainable care. The reader is referred to more detailed and complex texts for more in-depth information. The material contained within this booklet is current and designed to be updated every two years. The Pocket guide has integrated to work for leading internationally recognized clinicians to provide a concise multidisciplinary collaboration, providing information which we hope will assist with more rapid and desired wound healing. Finally, this publication is not intended as a final or definitive source of information. All the authors hope you enjoy this reference and provide feedback for future publications.

Disclaimer

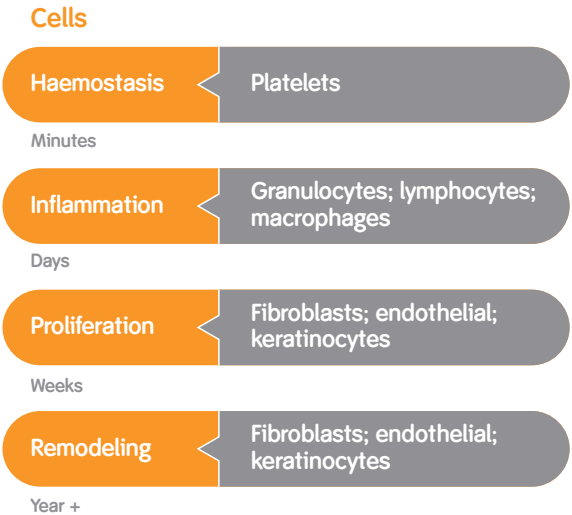
This Clinician's Pocket Guide to Advance Wound Care is provided for informational and educational purposes only. Smith & Nephew does not provide medical advice and this pocket guide is not intended to serve as medical advice. The information contained within is the product of the authors listed on page 3 and is based upon their professional study and clinical experience and expertise. Ultimately, it is the responsibility of physicians, clinicians and other healthcare providers to determine and utilize the appropriate treatments, products and techniques, according to their own medical training and clinical judgment, for each of their patients.

Contents

Chronic vs. Acute Wounds

Wounds are initiated by damage to tissue which may result in injury below the surface of the skin (as in deep tissue injury), a break in the skin or a combination of both. Normal or uninterrupted wound healing initiates the moment tissue is injured, resulting in defined and predictable phases as illustrated in the following diagram.

Normal Wound Healing



Different cells, cytokines, chemical mediators, growth factors and signaling molecules are activated during each of the phases of wound repair. The normal repair process is expected to occur in healthy individuals, whether in

cases of acute tissue injury or trauma. The time to reach wound closure may vary depending on the person's age, nutritional and general medical status. During the first two weeks of the repair process, an acute wound may regain up to one half of the original skin's strength and up to 80% of tensile strength by the third month. Following wound closure, remodeling of the wound may continue for a year or more. However the maximum tensile strength of 80% stresses the need to protect areas for further breakdown, especially during the first 3 month following closure. Maintaining skin integrity is important as the skin protects against the external environment, retains fluids and electrolytes, regulates temperature, and has numerous other functions. Requirements for normal wound healing include:

- Healthy cells
- Receptors on cells to communicate with other cells
- Normal enzyme activity (matrix metalloproteinase activity – MMP)
- Release of signaling factors

A clean viable wound bed with normal cell activity is needed for a wound to proceed to closure in the expected sequence or fashion. Wound cleansing, debridement, appropriate dressing selection, nutrition and control of medical diseases are all necessary for healthy healing.

Chronic Wounds are those that fail to follow the expected sequence of repair in an orderly and timely manner to re-establish normal skin integrity. Chronic wounds may

also fail to close due to intrinsic and extrinsic factors. It is important to eliminate factors contributing to wound chronicity, address the patient's medical conditions and control nutrition in order to optimize wound repair. Following are four major wound categories and factors affecting closure:

- **Diabetic ulcers:** control diabetes, remove pressure and repeated trauma from wound site (off-load foot), cover and protect wound
- **Venous ulcers:** address venous return through appropriate compression, select optimal dressing
- **Pressure:** Remove source of pressure, address general medical status
- **Arterial:** Provide adequate blood supply, usually through revascularization procedures

In all cases, the wound bed needs to be as free from debris as possible, as non-viable tissue may impede normal cell and physiological activity, is a source for bacterial proliferation, and may contribute to on-going inflammation (see section on information below).

The following chart illustrates the difference between healing and chronic wounds and stresses the importance of a clinician converting a chronic wound to acute.

Wound Repair

Healing Wounds	Chronic Wounds
• ↑ Cell mitosis	• ↓Mitogenic activity
• ↓ Pro-inflammatory cytokines	• ↑ Pro-inflammatory cytokines eg IL-6, NFa (self stimulate & inflammation)
• ↓ MMPs	• ↑ MMPs
• ↑ Growth factors	• ↓↑ Growth factors
• Cells capable of rapid response	• Necrotic tissue (slough)
	• Non-functional tissue (senescent cells)

Schultz GS & Mast BA (1998)

Once a wound bed is prepared for healing, it must be protected by appropriate dressing selection (see chapter on dressing selection).

Inflammation

Inflammation may be the result of a vascular or cellular response. Determining the cause of the inflammation is important for choosing the correct approach to wound treatment. The process of inflammation is a fundamental protective response and may be a complex reaction to injurious agents. Inflammation is also closely intertwined with the process of repair. It may be prolonged by the presence of high levels of bacteria, repeated trauma and injury or foreign materials in the wound. It may also be an autoimmune response as in vasculitis. Prolonged

inflammation may lead to on-going tissue destruction. The following table summarizes the differences between acute and chronic inflammation.

Acute vs. Chronic Inflammation

	ACUTE	CHRONIC
VASCULAR CHANGES	Vasodilatation ↑ Permeability	Minimal
CELLULAR INFILTRATES	Primarily neutrophilia	Monocytes Macrophages Lymphocytes
STROMAL CHANGES	Minimal oedema & separation of tissue layers	Cell proliferation Angiogenesis Fibrous Scarring

Optimize wound healing by

- Debriding all non-viable tissue (check vascular status before debriding – see chapter 2) and create a clean viable wound bend
- Control inflammation
- Choose appropriate wound dressings and treatment modalities
- Consider adjunctive modalities with recalcitrant wounds
- Attempt to create an acute wound from a chronic wound

Assessment and Documentation

Evaluation of the patient and wound, which includes a thorough history and physical exam, results in an accurate diagnosis, which then guides the treatment plan. Findings and plan of care can be documented in a concise manner that uses a systematic method designed to assure that no pertinent medical issues are missed. This chapter will present how to assess the wound patient in a documentation format that starts with the chief complaint and ends with the treatment plan.

Chief complaint

Why the patient has presented for care, e.g., "non-healing leg ulcer."

History of Present Illness

This is a chronological account of the presenting problem, which includes wound onset, past and current treatments, and symptoms. When was the wound first noticed? Did the wound develop suddenly as a result of a traumatic injury? or did it develop over time, for e.g., as a rash, callus, or bruise (purpura)? Is the wound the result of surgery, and if so, is there a possibility of infected mesh or hardware? Ask the patient how the wound is cleansed, what dressings are being used, if compression devices, custom shoes, pressure reduction devices are being used. What about adjunctive modalities (NPWT, HBO, arterial

or venous pumps, growth factors, bioengineered tissue, etc.)? Have there been any surgeries related to this wound (skin grafts, flaps, revascularization, amputation, debridement, venous ablation). Note success or failure of any treatments and the patient's perception of this. Is there pain related to the wound or surrounding tissue? Note quality, severity (scale 0-10), duration, timing, and any modifying factors (what makes it better or worse).

Past Medical History

Pay special attention to any disorders that can either cause wounds or lead to non-healing of any sustained wound.

Illnesses

- Diabetes mellitus
- Peripheral arterial disease (PAD)
- Cerebrovascular or cardiovascular disease and risk factors for same – increases risk for PAD
- Chronic venous insufficiency (CVI)
- Hypercoagulable disorders/thrombophilias (antiphospholipid syndrome, Factor V Leiden mutation, etc.)
- Hematologic disorders (sickle cell anemia, polycythemia vera, cryoglobulinemia)
- Autoimmune disorders
- Vasospastic disorders (Raynaud's)
- Malignancies and associated treatments

- Renal insufficiency/failure
- Liver disease (hepatitis C associated with cryoglobulinemia)
- GI disorders (inflammatory bowel disease, malabsorption, nausea)
- Infections (viral hepatitis, HIV, TB) – can lead to immune complex formation and vasculitis
- Neurological disorders (neuropathy, paresis, paralysis)
- Musculoskeletal disorders
- Previous wounds (and how they were treated)

Surgeries

(unrelated to current wound)

- Reconstructive (flaps, graft)
- Revascularization (bypass, angioplasty, stenting)
- Vein stripping/ligation/ablation
- Amputation
- Joint resection (foot)

Accidents/injuries to lower extremity

(may lead to vein damage and/or abnormal calf muscle pump function and CVI)

- Paralysis
- Abnormal gait

- Retained hardware
- Unresolved osteomyelitis

Current Health Status

- Medications that may impair wound healing (corticosteroids, chemotherapy)
- Allergies
- Habits (smoking, alcohol and illicit drug use)
- Diet (appetite/daily intake, special needs)

Family History

- Age and general health of living relatives
- Age at death and cause of death within the immediate family

Social History

- Marital status and/or living arrangements
- Availability of caregiver to provide wound care, if needed
- Occupation and leisure activities – how does wound affect these?

Review of Systems

An inventory of body systems to identify signs/symptoms that the patient is experiencing or has experienced in the past that may have been missed in the history of present illness. Examples include fever, weight changes, edema,

etc. This can be completed by the patient on a check-off list on a history form.

Physical Examination

This may be a full examination or a focused exam, pertinent to wound healing that includes constitutional, cardiovascular, lymphatics, musculoskeletal, neurologic, and skin/wound.

Constitutional

Vital signs, height, weight, and general appearance (grooming, nutrition, affect, etc.).

Cardiovascular

Focus on lower extremity arterial and venous flow.

- Lower extremity arterial circulation
    - Auscultate abdominal aorta, iliacs, and femorals note presence of bruit, which indicates turbulent blood flow, frequently secondary to stenosis
    - Palpate femoral, popliteal, dorsalis pedis, and posterior tibial pulses:
      4+ bounding
      3+ bounding
      2+ normal
      1+ diminished
      0 absent
    - Auscultate pulses with Doppler with 8-10 MHz probe. Normal pulses are triphasic (3 sounds),

with forward flow during systole (a on figure 1), reverse flow during diastole (b), forward flow during late diastole (c). Pulse sounds become biphasic (2 sounds) and then monophasic (1 sound) as arterial flow diminishes. Arterial sounds correspond with heart rate whereas venous sounds vary with respiration and sound like the blowing wind. Squeezing the distal limb will augment venous sounds, while arterial sounds will not be affected by this maneuver

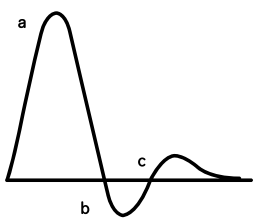


Figure 1

- Skin changes – temperature may be cooler, tissue may be atrophic, and there may be dependent rubor in the presence of arterial disease. Arterial ulcers tend to occur on the distal extremities and are deep, full-thickness, punched out without granulation tissue, with pale and/or necrotic tissue

- Lower extremity venous circulation: assessed via the **CEAP** classification system

Clinical signs of venous disease:

Class 0 No visible or palpable signs of venous disease

Class 1 Telangiectasias (red dermal veins < 1 mm in diameter), dilated reticular veins (blue dermal veins 1-3 mm in diameter), presence of malleolar flare (telangectasias and dilated reticular veins inferior to the malleoli, commonly on medial side)

Class 2 Varicose veins (palpable subcutaneous veins ≤ 4mm in diameter)

Class 3 Edema without skin changes

Class 4 Skin changes – hyperpigmentation, dermatitis, atrophie blanche (ivory- colored stellate scars), lipodermatosclerosis (induration of fat and skin)

Class 5 Skin changes with healed venous ulcer

Class 6 Skin changes with active venous ulcer. Venous ulcers are superficial without deep structure exposure, irregularly shaped, with ruddy granulation tissue, no necrotic tissue without coexisting arterial disease or trauma, and have high exudate, especially when edema not controlled

Etiology: congenital or acquired (history and ultrasound findings)

Anatomic distribution: superficial, perforating and/or deep veins (ultrasound findings)

Pathophysiologic condition: reflux and/or obstruction (ultrasound findings)

Lymphatics

Palpate lymph nodes in area of wound (e.g., inguinal nodes for leg ulcers) and note enlargement and/or tenderness

Lymphedema occurs when the body in unable to drain lymphatic fluid from tissues. It is most commonly seen in one extremity, but can be symmetrical edema of lower extremities when the pelvic lymph system is involved. Lymphedema typically occurs after surgical removal, radiation damage, infection, trauma or congenital malformation of lymph nodes or lymphatic vessels. It can also occur due to the blockage of the lymphatic system (such as occurs with filariasis parasitic infection or tumor/malignancy). In addition, lymphedema may occur as a resuly of chronic venous insufficiency, complicating the edema already present due to venous insuffenciency. If not addressed adequately, the edema will continue to progress and may result in significant disfigurement and functional limitations. The clinician should be aware of diagnostic and screening tools for edema seen in upper or lower extremities. The stemmer sign is a quick screening tool accomplished by attempting to pinch a fold of skin at the base of the 2nd finger or 2nd toe. If unable to pinch a fold of skin (skin is inflexible), this is positive for lymphedema. Other diagnostic tools include lymphoscintigraphy and color Doppler ultrasound. Differential diagnoses for unilateral lower extremity edema includes acute deepvein thrombosis (DVT), post-thrombotic syndrome, presence or recurrence of tumors, arthritis and baker's cyst. Other differentials for

symmetrical edema include hepatic dysfunction, renal dysfunction, heart failure, stasis edema, hypothyroidism/ myxedema and lipedema. When lymphedema in suspect, prompt referral to a certified lymphedema therapist is recommended, as early treatment may be able to prevent many complications.

Musculoskeletal

- Gait and station: Ambulatory? Use of assistive devices? Activates calf muscle pump during ambulation? Able to transfer to exam table and reposition self as needed? If wheelchair bound, assess positioning in chair and adequacy of w/c cushion to reduce pressure
- Extremity joints, bones, muscles
    - Deformities, defects, tenderness
    - Range of motion – limited ankle joint mobility impairs calf muscle pump, also common in diabetics – contributes to higher forefoot pressure during walking
    - Muscle strength and tone

Neurological

- Deep tendon reflexes
- Semmes-Weinstein monofilament testing – a nylon wire that bends when 10 grams of pressure exerted on it when pressing against multiple areas on the foot. Tell the patient to say “yes” whenever they feel the touch of the monofilament on their foot

Inability to feel 4/10 sites on a foot indicates loss of protective sensation

- Vibratory sensation – use a 128 Hz tuning fork to see if the patient can identify vibration when it is held against foot
- Proprioception – with patient's eyes closed, move great toe up or down and ask patient where toe is

Skin

Note location of wound(s), size, depth, extent of undermining, and describe tissue in wound.

- **Undermining:** ledge of skin with dead space underneath
- **Granulation tissue:** beefy red tissue composed of extracellular matrix, new blood vessels, and many cells. Generally connotes healing tissue, although friable and/or exuberant granulation (growing up over the level of the skin) can indicate poor bacterial and/or moisture control or malignancy
- **Eschar:** full thickness tissue necrosis, presents as smooth, dry black or brown tissue
- **Slough:** liquefying adherent necrotic tissue, usually yellow to gray, must be removed
- **Fibrin:** Gelatinous exudates across wound bed, can be curetted off
- **Exposed structures:** note tendon, bone, joint exposure
- **Exudate:** note color and amount

When necrotic tissue is present, the question must be asked, "why has tissue died?" If this is not determined, the underlying cause of the tissue death may be missed and inadequately treated. Common causes of tissue death are PAD, pressure, trauma (either accidental or surgical), or necrotizing infection. Less common causes include dermal occlusion due to vasculitis, vasculopathy secondary to hypercoagulable states, or microemboli.

Classification systems exist to document depth/extent of tissue damage for pressure ulcers and diabetic foot ulcers.

Wagner Classification of Diabetic Foot Ulcer

Grade 0:	No ulcer; may have deformity
Grade 1:	Superficial ulcer of skin or subcutaneous tissue
Grade 2:	Ulcer extending into tendon, bone, or capsule
Grade 3:	Deep ulcer with osteomyelitis or abscess
Grade 4:	Localized gangrene
Grade 5:	Extensive gangrene involving the whole foot

University of Texas (UT) Diabetic Wound Classification System

	Grade 0	Grade 1	Grade 2	Grade 3
Stage A	Pre or post ulcerative lesion completely epithelialized	Superficial wound, not involving tendon, capsule, or bone	Wound penetrating to tendon or capsule	Wound penetrating to bone or joint
Stage B	Infection	Infection	Infection	Infection
Stage C	Ischemia	Ischemia	Ischemia	Ischemia
Stage D	Infection and Ischemia	Infection and Ischemia	Infection and Ischemia	Infection and Ischemia

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

- **Category/Stage I:** Non-blanchable erythema of intact skin in a localized area, usually over a bony prominence. Darkly pigmented skin may not have visible blanching; its color may differ from the surrounding area. The area may be painful, firm, soft, warmer or cooler as compared to adjacent tissue. Category I may be difficult to detect in individuals with dark skin tones. May indicate “at risk” persons.
- **Category/Stage II:** 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 or sero-sanguineous filled blister. Presents as a shiny or dry shallow ulcer without slough or bruising. This category should not be used to describe skin tears,

tape burns, incontinence associated dermatitis, maceration or excoriation

- **Category/Stage III:** 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. The depth of a Category/Stage III pressure ulcer varies by anatomical location
- **Category/Stage IV:** Full thickness tissue loss with exposed bone, tendon or muscle. Slough or eschar may be present. Often includes undermining and tunneling. Osteomyelitis or osteitis likely to occur. The depth of a Category/Stage IV pressure ulcer varies by anatomical location
- **Category/Stage IV:** Full thickness tissue loss with exposed bone, tendon or muscle. Slough or eschar may be present. Often includes undermining and tunneling. Osteomyelitis or osteitis likely to occur. The depth of a Category/Stage IV pressure ulcer varies by anatomical location
- **Suspected Deep Tissue Injury** – depth unknown. 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. 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

Wounds can also simply be classified as partial thickness (damage involving the epidermis and possibly part of the dermis), or full thickness (damage extending to subcutaneous tissue and possibly deeper).
After assessing the wound, note the condition of the surrounding skin:

Erythema: redness of the surrounding skin. Indicates inflammation

Induration: hardness of tissue. Induration and erythema are signs of cellulitis, a skin infection

Rash: note quality, macular or popular, and it's association to product used. Rashes are blanchable as any erythema is from dilated vessels

Callus: may indicate ongoing repetitive pressure when seen around the diabetic foot ulcer

Purpura: bleeding into tissue, non-blanchable as blood is outside the vessels. Indicate tissue damage and may progress to tissue necrosis

Maceration: overhydrated skin – appears white and wrinkled. Macerated skin is more prone to friction injury

Livedo reticularis: a net-like discoloration of skin. Can be

normal finding, but in association with necrotic leg ulcers, can indicate interruption in dermal blood flow

Once the physical examination is completed, the clinician should order any investigational studies to further identify underlying pathology. This may include non-invasive arterial and venous studies, radiologic studies and laboratory work.

Tissue biopsy is crucial to identify atypical wounds such as vasculitis, vasculopathy, microemboli, bullous disorders, unusual infections, and malignancies. When ruling out vasculitis or vasculopathy, biopsy newest purpuric lesions, not the necrotic wound.
Further documentation includes the assessment/ diagnosis, and plan. Refer to other chapters for this information.

Wound Infection

Wound infection is perhaps the most common complication of having a wound, and if not managed quickly and correctly can have devastating consequences for both the patient and the service provider.

Development of wound infection can in extremis lead to loss of life or limb, but more routinely causes pain and increased symptoms such as exudate and malodour. For the service provider the costs are increased for antimicrobials (topical dressings or systemic antibiotics), increased length of stay or delayed discharge and additional analgesics.

Wound infection is therefore a situation to be avoided, and it is necessary to understand what factors predispose to infection and how infection may be diagnosed within a wound. Should an infection occur appropriate management should be initiated as quickly as possible.

Defining Infection

All wounds contain pathogens. However it is the number and virulence of the pathogens which are relevant. Many authors have attempted to describe the continuum by which a wound progresses from containing pathogens, but being healthy and healing through, to a state of infection. Most recently this has been described by Gottrup et al 2013.

Contamination

When conditions within a wound do not favour the multiplication of any of the contaminating microbes present, their persistence is short term and wound healing may not be affected.

Colonisation

Occurs when a stable equilibrium is reached by microbes that successfully evade host defences and grow without eliciting a systemic immune responses or overt clinical symptoms.

Infection

When an imbalance arises because host immunological competence is compromised and/or microbes manifest virulence factors, overt wound infection results and microbial invasion into host tissues leads to cellular damage, immunological responses, and the development of clinical signs and symptoms.

Other authors add in additional categories such as critical colonisation, and break down actual infection into discrete categories: local infection (which may include critical colonisation), spreading infection and systemic infection (International Consensus 2012)

The Infection Continuum:

Contamination	Colonisation	Localised infection*	Spreading infection	Systemic infection
Vigilance required		Intervention required		

*Localised infection may or may not be accompanied by tha classical signs and symptoms of inflammation. When it is not, various terms have been used, e.g. critical colonisation (see main text)

WUWHS (2008) Principles of best practice: Wound infection in clinical practice. An international consensus. London, MEP Ltd

Identifying Infection

Certain characteristics may increase the risk of developing a wound infection.

Acute wounds	Chronic wounds
• Contaminated surgery • Long operative procedure • Trauma with delayed treatment • Necrotic tissue or foreign body*	• Necrotic tissue or foreign body* • Prolonged duration • Large in size and/or depth • Anatomically situated near a site of potential contamination, e.g. anal area
*Particularly in the presence of hypoxia	

WUWHS (2008) Principles of best practice: Wound infection in clinical practice. An international consensus. London, MEP Ltd

Any patient may develop infection. It is important to recognise the signs and symptoms of infection, most commonly described as heat, redness, pain, swelling and loss of function. However different more specific signs and symptoms may be seen in different wound

aetiologies and some wounds, particularly those in patients who are immunosupressed, may exhibit few if any signs.

Signs and symptoms of wound infection

WUWHS (2008) Principles of best practice: Wound infection in clinical practice. An international consensus. London, MEP Ltd

<table>
<tr><th colspan="2">ACUTE WOUNDS
e.g. surgical or traumatic wounds or burns</th></tr>
<tr><td>Localised Infection</td><td>Spreading Infection</td></tr>
<tr><td>• Classical signs and symptoms:
- new or increasing pain
- erythema
- local warmth
- swelling
- purulent discharge
• Pyrexia - in surgical wounds, typically five to seven days post-surgery
• Delayed (or stalled) healing
• Abscess
• Malodour</td><td>As for localised infection PLUS:
• Further extension of erythema
• Lymphangitis
• Crepitus in soft tissues
• Wound breakdown/dehiscence</td></tr>
<tr><td colspan="2">Notes
• Burns – also skin graft rejection; pain is not always a feature of infection in full thickness burns
• Deep wounds – induration extension of the wound, unexplained increased white cell count or signs of sepsis may be signs of deep wound (i.e. subfascial) infection
• Immunocompromised patients – signs and symptoms may be modified and less obvious</td></tr>
<tr><td>SYSTEMIC INFECTION</td><td>Sepsis – documented infection with pyrexia or hypothermia, tachycardia, tachypnoea, raised or depressed white blood cell count
↓
Severe sepsis – sepsis and multiple organ dysfunction
↓
Septic shock – sepsis and hypotension despite adequate volume resuscitation
↓
Death

NB: Other sites of infection should be excluded before assuming that systemic infection is related to wound infection</td></tr>
</table>

CHRONIC WOUNDS e.g. diabetic foot ulcers, venous leg ulcers, arterial leg/foot ulcers or pressure ulcers	
Localised Infection	Spreading Infection
• New, increased or altered pain* • Delayed (or stalled) healing* • Periwound oedema • Bleeding or friable (easily damaged) granulation tissue • Distinctive malodour or change in odour • Wound bed discoloration • Increased or altered/purulent exudate • Induration • Pocketing • Bridging	As for localised infection PLUS: • Wound breakdown* • Erythema extending from wound edge • Crepitus, warmth, induration or discoloration spreading into periwound area • Lymphangitis • Malaise or other non-specific deterioration in patients general condition
Notes: • In patients who are immunocompromised and/or who have motor or sensory neuropathies, symptoms may be modified and less obvious. For example, in a diabetic patient with an infected foot ulcer and peripheral neuropathy, pain may not be prominent feature • Arterial ulcers – previously dry ulcers may become wet when infected • Clinicians should also be aware that in the diabetic foot, inflammation is not necessarily indicative of infection. For example, inflammation may be associated with Charcot's arthropathy	
* Individually highly indicative of infection. Infection is also highly likely in the presence of two or more of the other signs listed	

Few if any clinicians now use clinical swab results to diagnose the presence of infection although they may be used to guide treatment by suggesting the causative organism.

Biofilms

A biofilm is a complex poly microbial community in which the microorganisms synthesis and secrete a protective matrix that attaches firmly to a surface. This matrix also protects the biofilm resulting in them being highly tolerant of hosting antibodies, inflammatory cells antibiotics and many antiseptics (Schultz and Dowd 2013), meaning that a biofilm is very difficult to address. The presence of biofilm in wounds is a relatively new concept however it is now widely accepted that they are present in a significant number of chronic wounds and contribute considerably to delayed healing (Philips et al 2010). It is not possible

to see biofilm with the naked eye, but some clinicians describe a shiny surface to the wound and wounds that are failing to heal without other signs of infection, these wounds may be described as critically colonised. As biofilms are not susceptible to antimicrobials it is important to disrupt them by regular maintenance debridement.

Management of infection

Once infection is identified an appropriate antimicrobial regimen should be commenced. If the infection is systemic this must be with systemic antibiotics unless contraindicated. Treatment of an infected wound should follow a clear decisive plan, prompt effective management of wound infection can reduce the time to healing and prevent a host of complications. Localised wound infection may be managed in many cases with the use of topical antiseptics. The use of topical antibiotics is rarely if ever recommended. In addition to use of antimicrobials it is also important to optimise the host response, ensuring the patient's health is optimised for example maintain good glycaemic control, and also make sure that any factors which may precipitate or prolong infection such as the presence of necrotic tissue, are removed.

It is important to understand the different definitions:
Antimicrobial: a method of reducing or removing microbes, it includes the use of antibiotics and antiseptics.

Antibiotic: a substance which kills or inhibits bacterial growth or replication. Generally specific to particular species or strain of bacteria although some have a broader spectrum of activity. There is concern about increasing resistance to antibiotics.

Antiseptics: Are used to eliminate or reduce bacterial numbers in or around the wound, they have a broad spectrum of activity against bacteria, protozoa, fungi and viruses.

The mainstay of managing most wound infections is the use of antimicrobial dressings with a variety of active ingredients including those with:

- Silver
- Iodine
- PHMB (Polyhexamethylene biguanide)
- Oxtenidin
- Honey

Research to indicate the superiority of any one product over another is currently lacking with most, if used correctly exhibiting an antimicrobial effect (International Consensus 2012, Gottrup et al 2013). In reality many antimicrobial dressings are selected for other properties relating to the carrier product, for example the ability to absorb or to stick or not stick.

Vowden et al (2011) recommend that antimicrobial dressings should be used for:

- Prevention of infection in patients at increased risk of wound infection
- Treatment of localised wound infection
- Local treatment of wound infection in cases of spreading or systemic wound infection in conjunction with systemic antibiotics

Any antimicrobial should be used for a fixed period of time (usually no longer than 2 weeks) and its effect on the wound carefully evaluated, a second 2 weeks may sometimes be necessary but it would be unusual to consider treatment for longer.

Recent experience with biofilms has highlighted the importance of debridement and cleansing (some antiseptic solutions contain a surfactant to facilitate cleansing) to allow penetration of the active agent into the wound bed, and it may be beneficial to use a different antimicrobial agent for a second course of treatment. (Leaper et al 2012, Schultz and Dowd 2013).

Conclusion

Wound infection is costly to both the patient and the healthcare service. Wherever possible steps should be taken to prevent it occurring. When wound infection is diagnosed it must be dealt with quickly and decisively and the treatment regularly evaluated. Pain control should also be considered as should other associated symptoms such as increased exudate and odour when selecting a wound dressing.

Nutrition

A brief nutritional assessment is important for optimal wound healing. Many patients with non-healing wounds, particularly diabetics, may suffer from some type of nutritional deficiency. Whenever a nutritional abnormality is suspected, the patient should be referred to a specialist. Recognizing signs of poor nutrition is important.

High-risk patients in outpatient clinics include:

- Patients on hemodialysis
- Morbidly obese patients
- Patients weighting less than 80% of their ideal body weight
- Patients with greater than 10% body weight loss in past 6 months (unless patients have been on a specific dieting regimen)
- Elderly patients
- Alcoholic patients
- Patients with malabsorption syndrome

Obese patients require nutritional assessment as obesity per se is not an indicator of good nutrition. The diet of the patient should be questioned and consulting initiated.

A weight-height reference chart for adults may be referred to, based on values established in different countries.

A brief nutritional screening may be initiated in the out-patient wound clinic. This screening includes:

- Reviewing recent weight loss which is greater than 10% of body weight
- Reviewing history of patients weighing less than 85% of ideal body weight
- Unexplained edema
- Unexplained loss of hair
- Low serum albumin level (based on local laboratory values)

Wound edema may be caused by various etiologies including congestive heart disease, venous disease, lymphedema, as well as malnutrition. In patients with protein calorie malnutrition, it is due to low serum colloid osmotic pressure which results in accumulation of interstitial fluid. Edema may contribute to delayed healing by increasing hydrostatic pressure in the lower extremity, decreasing nutrient delivery and inhibiting normal cellular activity.

Serum protein levels may be an indicator of protein availability. Serum albumin is frequently used as an assessment of immediate protein levels. When hypoalbuminemia is suspected, the patient should be referred to a nutritionist.

Low protein levels may be present in elderly patients on limited diet as well as patients with chronic heavily draining wounds. Recommendations for an improved diet may be suggested by a clinician; however diet control should be the role of a nutritionist.

Some general information relevant to Nutritional Support includes:

- 30-35 calories/kg/day
- 1.25-1.5 grams of protein per kg per day
- Vitamin and mineral support as needed

Nutrients may play a critical role in wound healing

Nutrient	Wound Healing Function	Result of Deficiency
Proteins	Wound repair Wound remodeling Cell proliferation Collagen Synthesis Cellular Activity White blood cell production and migration Cell-mediated bacterial killing	Poor wound healing Hypoalbuminemia Edema Impaired cellular immunity Lymphopenia

Fats	Cellular energy Supply of essential fatty acids Prostaglandin production Cell membrane development	Poor wound healing
Carbohydrates	Cellular energy Spare protein in times of caloric need	Capillary fragility Scurvy poor wound healing
Vitamin C	Integrity of membranes	Poor wound healing
Zinc	Cofactor for enzymes Cell proliferation	Slow wound healing Anorexia

The exact role of vitamin and mineral supplementation, excluding patients where there is a deficiency, has not been well defined. Elderly patients and those with unreliable diets are frequently given a daily vitamin supplement although addition of specific vitamins and mineral is usually based on vitamin and mineral assays. Over prescribing and adding empiric vitamin therapy may be expense and cause adverse effects including vitamin or minimal toxicity, nausea, and stomach upset.

Always perform a general nutritional assessment of the patient and determine their need for referral to a nutrition specialist.

Pathophysiology

The pathophysiology of pressure ulcers, inappropriately referred to as “bedsores” and “decubitus ulcers,” is implied in the word “pressure”. There are, however, numerous contributing etiologies in addition to pressure, including friction and shear. Each of these factors contributes to tissue necrosis either through direct occlusion of vessels (pressure) and/or by kinking/breaking of vessels (shear). Neuropathy, arterial disease, decreased local tissue perfusion, nutrition, fecal and urinary incontinence, immobility, inactivity and mental state of the patient all contribute to the damage caused by pressure.

Risk Assessment

The primary purpose of this manual is to provide guidelines for the treatment of wounds including pressure ulcers. However, patients with and without pressure ulcers should always be assessed for risk. The most common scale used for this is the Braden Scale.

Prophylaxis

Measures to prevent pressure ulcer occurrence as well as re-occurrence must be considered even when treating an open lesion. Pressure reducing devices and products are described in the section on wound care products. Patient

positioning is important with all surfaces. The following must be considered when treating patients that are immobilized for prolonged periods of time:

- Prevent atelectasis and pneumonia by turning all patients
- The head of the bed should not be positioned at an angle of greater than 30 degrees for prolonged periods of time if compatible with patient care goals. Excessive angling will produce shearing forces at the sacral and ischial areas, which may contribute to ulcer formation
- Patients who are wheelchair bound should be encouraged to shift positions as frequently as possible, with a minimum of every 15 minutes. If they are unable to shift their own weight, they should not be seated for more than one hour at a time
- Patients in beds should be repositioned every two hours at a minimum. High-risk patients need to be repositioned more frequently. Keep in mind that most initial tests on pressure and resulting ulcerations, were performed on healthy young volunteers. Severely debilitated patients may develop wounds in shorter than expected time frames and may require more frequent turning.
- Patients should not be positioned directly on an ulcer
- Patients should not be “rolled” from side to side, rather, they need to be positioned in the 30-degree side-lying position

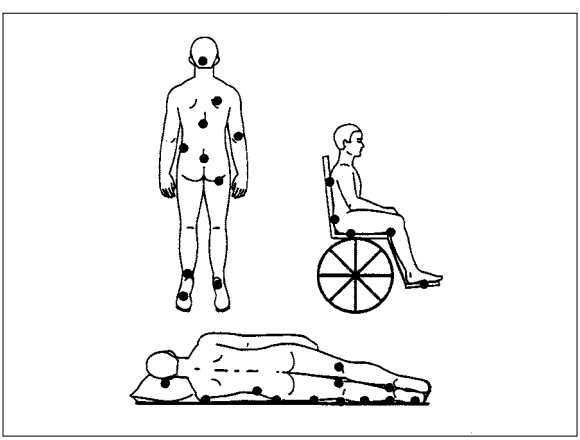
Ancillary Treatment Measures

- Provide adequate pressure reduction
- Assess and improve patient's nutritional status
- Protect areas exposed to urine and feces
- Protect areas of fragile and friable tissue

Treatment Guideline

- Assessment of the parient and the ulcer
- Tissue load management
- Ulcer care
- Management of the bacterial load and infection
- Operative repair
- Education and quality

Pressure Points

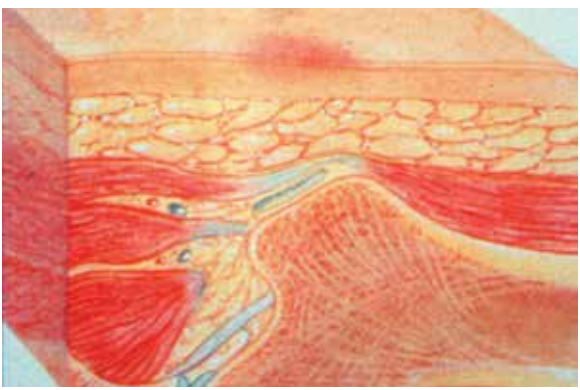


CLINICAL NOTE:
Pressure ulcers will not heal despite the best treatment, unless pressure reduction is addressed.

Treatment

Stage 1

An observable pressure related alteration of intact skin whose indicators as compared to an adjacent or opposite area on the body may include changes in one of more of the following: skin temperature, tissue consistency, and/or sensation. The ulcer appears as a defined area of persistent redness in lightly pigmented skin, whereas in darker skin, the ulcer may appear with persistent red, blue or purple hues.



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Objective

Protect area, reduce pressure, cover with appropriate dressing as needed.

Products

- Creams, moisturizers - need to be applied two to three times a day. Do not massage, apply gently

- Utilize barrier ointments or pastes to protect the skin of incontinent patients
- Transparent films as needed. These dressings will reduce friction, while allowing for direct observation of the skin

CLINICAL NOTE:
Avoid Hydrocolloids as they hide the area from observation. Dressings that are unable to stay in place for up to 48 hours should be replaced by more cost effective treatment.

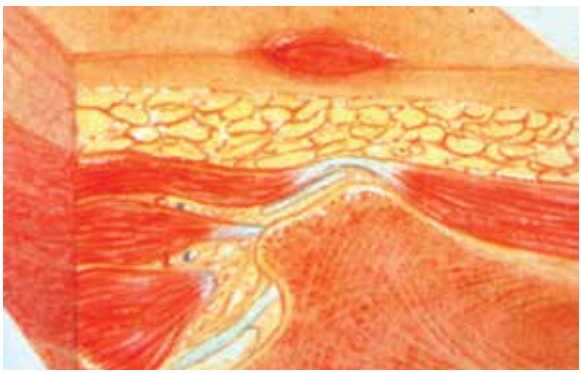
Particular care needs to be taken not to "tent" the gluteal fold area as this leaves a tunnel for penetration of contaminants and fecal materials while decreasing the effectiveness of the dressing. It is recommended that the dressing be applied first in the center of the fold area, then gently pushed down on either side.

Procedures

- Properly position patient
- Cleanse skin gently with cleanser
- Apply skin sealant/barrier to intact skin to be covered with dressing and allow to dry
- Select dressing that allows a 3-5 cm margin beyond the area of the wound
- Apply dressing; avoid wrinkling of dressing.
- Date day and time of application

Stage II

These are partial thickness wounds with skin loss involving the epidermis and/or dermis, but not including deeper tissue. These may present as an abrasion, blister or shallow wound.



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Objective

Prevent further tissue trauma via pressure reduction and proper positioning, provide an environment optimal for wound closure and prevent excessive maceration in highly exudative wounds.

Products

- **Transparent films**: more suited choices for low exudate abrasions and shallow wounds. They should be able to remain in place for at least three days
- **Foams**: recommended for shallow wounds, which are exudative. With Stage II wounds, these may remain in place for three to seven days
- **Hydrocolloids**: good on most Stage II wounds. These should stay in place for three to seven days
- **Hydrogels (sheets)**: also good on most low exudating Stage II wounds. These may stay in place for three to seven days. Amorphous hydrogels do not perform well on shallow wounds with depth < 0.5 cm because the thin layer tends to dry out
- **Alginates**: may be used on more highly exudative wounds; not a primary choice with Stage II lesions

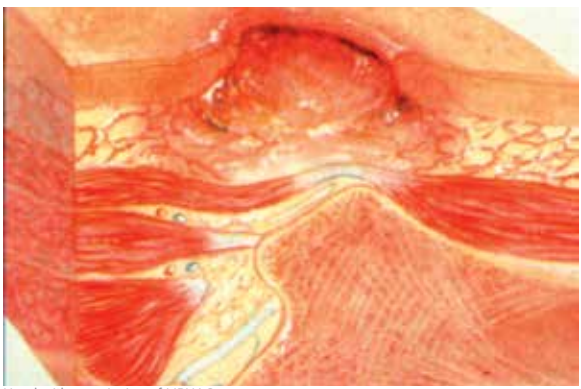
Procedure

- Properly position patient
- Cleanse skin with gentle cleanser
- Apply skin sealant/barrier to intact skin to be covered with dressing. Allow to dry
- Select dressing that allows a 3-5 cm margin beyond the area of the wound (some dressings such as alginates are cut to the size of the wound)
- Apply dressing, avoid wrinkling of dressing
- Date day and time of application

CLINICAL NOTE:
Dressings should be changed before leakage occurs. When hydrocolloid dressings are removed, care should be taken to remove all dressing residue before applying a subsequent dressing. Wound fluids may appear turbid and may be malodorous when hydrocolloid dressings are removed. All dressing residue should be flushed with saline or sterile water prior to assessing wound odor or appearance.

Stage III

These are full thickness wounds extending to the level of subcutaneous tissue, but not through the underlying fascia. These wounds may present with or without undermining.



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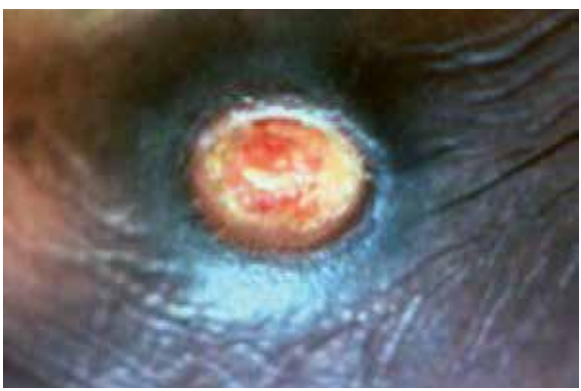


Objectives

- Reduce pressure
- Position properly
- Protect wound
- Prevent wound desiccation
- Prevent excessive maceration
- Cleanse wounds
- Promote/Increase granulation and re-epithelialization

Products

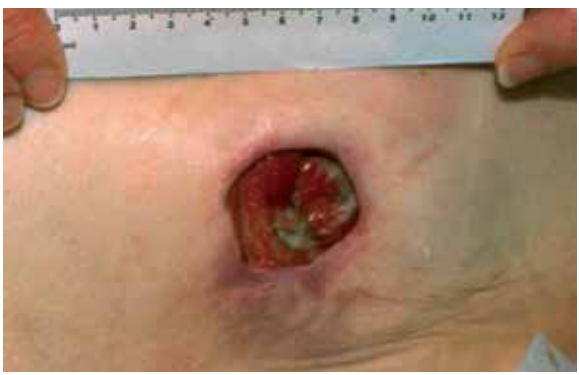
- **Hydrocolloids** - may be used on low to moderate exudate wounds with or without necrotic tissue. They are not the best choice for deep or crater wounds, wounds with undermining and tunneling, or those with high amounts of exudate. They are not optimally effective in promoting autolytic debridement in wounds with large amounts of eschar, although they are ideal for promotion of autolytic debridement of yellow slough. Remember to educate the family that wounds with eschar or debris may appear bigger after the first seven to ten days of hydrocolloid use as a result of autolytic debridement
- **Amorphous hydrogels** - may be useful in filling the defect greater than 0.5 cm deep while promoting autolytic debridement. They are not effective on highly exudative wounds. The gel is applied often enough to keep wound moist, but not liquid. A small amount of amorphous hydrogel applied under a transparent film is ideal for softening eschar

- **Hydrogel sheets** - are effective in low draining Stage III-IV wounds that are not cavitated, i.e. leg ulcers which may have tendon or muscle exposure but are not as deep as most sacral and ischial Stage III-IV lesions
- **Foams** - are very useful with this type of wound. Foams are changed per package instructions. Usual wear is 2–7 days
- **Moist gauze** - may be used. Caution should be taken not to let the gauze dry and adhere to tissue unless one is attempting aggressive wet-to-dry debridement
- **Alginate/collagen dressings/fiber dressings/ wound fillers** – used to absorb excess exudate. Require secondary dressing

Note: Negative pressure wound therapy may be used to assist with granulation and wound closure in deep wounds.

Stage IV

These are full thickness wounds extending down to and including fascia, muscle, tendon and/or bone.



Objectives

- Protect
- Reduce pressure
- Position properly
- Prevent desiccation of tissue
- Insulate
- Absorb excess fluid
- Remove all necrotic tissue
- Fill dead space
- Promote granulation

Products

- Same as Stage III

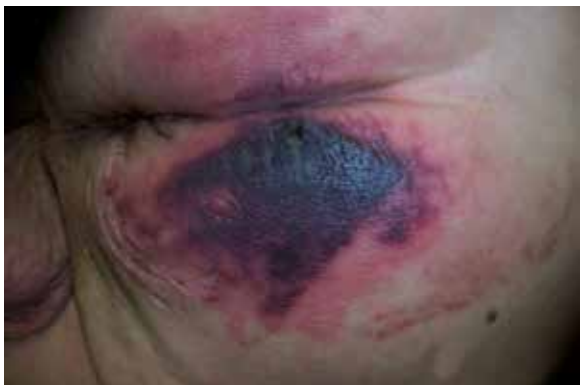
Procedures

- Properly position patient
- Cleanse skin with gentle cleanser
- Apply skin sealant/barrier to intact skin to be covered with dressing. Allow to dry
- Select dressing that allows a 3-5 cm margin beyond the area of the wound
- Apply dressing; avoid dressing or skin wrinkling
- Date day and time of application

Deep Tissue Injury

A pressure related injury to subcutaneous injury under intact skin. This injury may extend down to the bone.
Suspected Deep Tissue Injury – depth unknown
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. 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.



Unstageable/Unclassified:

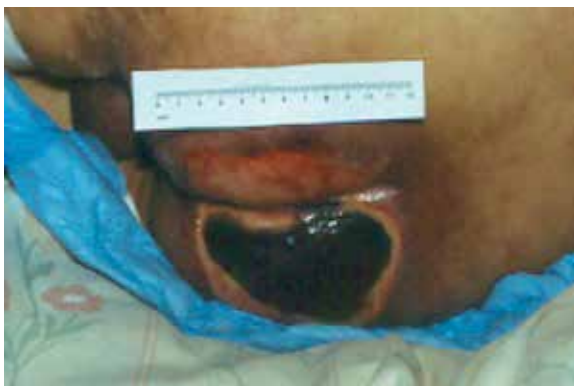
Full thickness skin or tissue loss – depth unknown
Full thickness tissue loss in which actual depth of the ulcer is completely obscured by slough (yellow, tan, gray, green or brown) and/or eschar (tan, brown or black) in the wound bed. Until enough slough and/or eschar are removed to expose the base of the wound, the true depth cannot be determined; but it will be either a Category/ Stage III or IV. 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

This is an ulcer completely covered with eschar, making it difficult to determine the depth of the underlying tissue damage.

Kennedy Terminal Ulcer

A Kennedy Terminal Ulcer is a pressure ulcer people get



when they are dying. These ulcers develop at the end of life due to skin failure. As the life expectancy of the patient may be less than 6 months, the goal of treatment is provided comfort and the best quality of life for the patient, rather than expecting the ulcer to heal.

Other Considerations in Pressure Ulcer Care

- When tape is used to picture frame a dressing, particularly in the sacral, heel or elbow area, a skin sealant should be used on skin which will be covered with tape. This will assist in skin protection

- Wounds may be thoroughly flushed by using a 19g needle with a 35 ml syringe. Care should be taken not to touch the needle/syringe to the wound surface
- Stage IV ulcers are frequently associated with underlying osteomyelitis. X-rays should be considered on all patients with these lesions
- Stage IV ulcers require the removal of all possible necrotic tissue and wound debris. The wound should then be kept moist and clean to promote closure
- Sinus tracts and cavities should be explored for fistulas as well as deep space abscesses and necrosis
- Surgical consult and intervention is frequently necessary in patients with Stage IV pressure ulcers

Adjunctive Modalities

Consider a physical therapy referral for patients with pressure ulcers to aide in mobilization and for evaluation of w/c cushion needs. Physical therapists also utilize electrical stimulation, ultrasound, and/or pulsed lavage to facilitate healing of Stage II, III, and IV pressure ulcers.

The Kennedy Terminal Ulcer

Kennedy Terminal Ulcer is a pressure ulcer developed by certain patients during the dying process. Two similar, but different presentations have been described; one acute and the second chronic. In 1983 when one of the first skin care teams was established in in a 500 bed long term care facility during the pressure ulcer rounds, Karen Kennedy and her team noticed a select subset of pressure ulcers. These ulcers had a different presentation, course of progression and final result. These phenomena became known as the "Kennedy Terminal Ulcer" for the chronic process and the "3:30 syndrome" for the acute process. Unknown at the time, this process had been described by Dr. Jean-Martin Charcot, "Father of Modern Neurology" in 1877. Dr. Charcot described the chronic presentation as "Decubitus Ominosus" and the acute as Decubitus Acutus."

A Kennedy Terminal Ulcer is different than a "typical pressure ulcer," in its onset, early presentation, progression, colors, borders, duration, shape, location, patient population and outcome. The progression of the ulcer tends to follow a different process.

Onset: Usually sudden. What was there yesterday is not what is there today. Often the nurse or care giver will say, "Oh, my gosh.... that was not there yesterday." In the 3:30 syndrome or acute presentation it can progress in size by the hour.

Early presentation: Is often a superficial discoloration of intact skin. Much like a deep tissue injury, superficial shallow ulceration, blister or abrasion often resembling incontinent associated dermatitis (IAD). The KTU and Decubitus Ominosus are usually bilateral while the 3:30 syndrome or Decubitus Acutus tend to be unilateral.

Progression: Tends to be much more rapid than other pressure ulcers. Ulcers are usually more superficial and can develop rapidly in size and depth.
In the 3:30 syndrome or Decubitus Acutus the discoloration of intact skin if witnessed, often starts off as a very small area which can resemble a small fleck of dried feces or a black ink spot and tends to increase in size by the hour. The superficial epidermis often is blistered looking and can be opened up by the minor rubbing of a washcloth cleansing the skin over the discolored area.

Colors: Initial presentation colors of superficial ulceration tends to be red, yellow and turning to black, brown or purple. The acute presentation of the 3:30 syndrome most often is black or purple discoloration resembling a suspected deep tissue injury presentation.

Borders: Most often are irregular.

Shape: Can be pear shaped, butterfly or horseshoe and in the KTU presentation is mostly bilateral however with the acute presentation most often is unilateral.

Location: Most often is the sacral coccygeal area but has been reported in other locations such as the ischium, knee, elbow, ankle and others.

Duration: The duration depends on various factors including age, unintentional weight loss, co-morbidities and abnormality of lab values such as hemoglobin, total lymphocyte count, blood sugar, serum albumin and increasing total number of abnormalities in lab values such as a CBC or Medical or Chemistry profile.

Patient Population: Most often is seen in the elderly or patients suffering from a debilitating terminal process. This phenomena has not been reported in the pediatric population.

Treatment: The treatment for a Kennedy Terminal Ulcer is the same as if would be for any other pressure ulcer with the same characteristics.

What causes a Kennedy Terminal Ulcer?

Further research needs to be done on this subject. However, one idea is it may be a blood profusion problem exacerbated by the dying process. The skin is an organ, as are the heart, kidneys, lungs and liver. It is the largest of the body organs and is the only one that is on the outside of the body. It can reflect what is going on inside the human body. One theory is that as people are approaching the dying process, the internal organs may begin to slow down and go into multi organ failure. This is where the internal organs start to slow down and not

function efficiently. No particular symptomatology may be detected other than the skin over bony prominences starts to show the effect of pressure in a shorter time frame. Where as turning a patient every two hours may be enough in somewhat of a normal situation, with this population, it may cause superficial tissue damage.

Can a Kennedy Terminal Ulcer get better?

Uncertain

The majority of them do not. This process occurs most often during the skin changes at life's end. However, it has been reported for a patient to be at or near the end of life and develop what looks like a Kennedy Terminal Ulcer even after the family decided they did want all available interventions such as IV's or tube feedings or transferred to the hospital or ICU for additional modalities. Some clinicians have called that the "Resuscitated Kennedy Terminal Ulcer." On rare occasions, this phenomena reversed.

Recognized by CMS

CMS LTCH Quality Reporting Program Manual states: Skin ulcers that develop in patients who have terminal illness or are at the end of life should be assessed and staged as pressure ulcers until it is determined that the ulcer is part of the dying process (also known as Kennedy ulcers). Kennedy ulcers can develop from 6 weeks to 2 to 3 days before death. These ulcers present as pear-shaped purple areas of skin with irregular borders that are often found in the sacrococcygeal areas. **When an ulcer has been determined to be Kennedy Ulcer, it should not be coded as a pressure ulcer.**

	Kennedy Terminal Ulcer	3:30 Syndrome
Onset	Sudden	Sudden
Early Presentation	Intact discolored skin or superficial ulceration resembling a blister, abrasion or incontinent associated dermatitis	Intact discolored skin, often dusky, purple, gray or black.
Progression	Rapid	Rapid
Colors	Red, yellow, brown, black, green	Red, purple, black
Borders	Often Irregular	Often Irregular
Shape	Pear, butterfly, horseshoe	Irregular unilateral patch
Duration	Weeks to months	Most often 24-48 hours
Location	Most common is sacral coccygeal but can be other places	Most common is buttocks but can be other places
Etiology	Unknown – thought to be skin changes at life's end	Unknown – thought to be skin changes at life's end
First Described	1983 – Byron Health Center, Fort Wayne, Indiana	1983 – Byron Health Center, Fort Wayne, Indiana
First Presented	1989 – 1st National Pressure Ulcer Advisory Panel Meeting, Washington DC.	1989 – 1st National Pressure Ulcer Advisory Panel Meeting, Washington DC.
Other Names	"Decubitus Ominosis" – Dr. Charcot	"Decubitus Acutus" – Dr. Charcot

Pathophysiology

Arterial, also known as ischemic, ulcers fail to heal due to peripheral arterial disease (PAD). These wounds are frequently precipitated by trauma, either accidental or surgical, and they do not heal because coexisting PAD contributes to decreased blood flow and tissue oxygenation. Risk factors for arterial ulcers are the same as those for PAD: family history, smoking, diabetes, hypertension, hyperlipidemia, advanced age, etc. The keys to diagnosing arterial ulcers include history, examination of arterial circulation, the ulcer, and surrounding skin, and arterial studies.

Refer to chapter 2 (Assessment and Documentation) for history and exam findings in arterial disease. In taking the history, pain should be assessed. Typically, patients with severe PAD sufficient to interfere with healing will have rest pain, or pain with leg elevation that is relieved with leg dependence. If severe enough, the patient will not be able to sleep in a bed at night, preferring to be in a chair with the legs dependent. Rest pain indicates critical limb ischemia, and if not addressed, can lead to amputation.

Diagnosis

If the clinical exam is suspicious for arterial disease, noninvasive arterial studies should be ordered. These tests are done in a vascular lab with the patient supine and include the following tests:

Doppler waveform analysis

A qualitative test for PAD in which a strip recording of peripheral pulses is obtained and analyzed. This test identifies PAD, but does not specifically quantify its severity.

Segmental pressures

Systolic blood pressures are taken with cuffs on the high thigh, low thigh, high calf and ankle. Gradients greater than 20 mmHg either between cuffs on the same leg or between legs at the same level are indicative of PAD. **Ankle-brachial indices (ABI)** are obtained as part of this test. The ankle pressure should normally be the same or 10-20% higher than the brachial pressure. The ankle pressure is divided by the brachial pressure to arrive at an index:

ABI	Interpretation
> 1.0	Normal
0.9 – 1.0	Minimal arterial occlusive disease
0.5 – 0.9	Significant arterial occlusive disease
< 0.5	Severe arterial occlusive disease

Be aware that ABI's may be falsely elevated in the presence of calcified arteries (medial calcification). An ABI > 1.3 may indicate this, or a seemingly normal ABI in a patient with clinical signs of PAD, and/or monophasic waveforms. Further testing is warranted if this is suspected.

Toe pressures

Obtained with a toe cuff placed around the toe, and a photoelectrode placed distally to the cuff. Useful to

predict healing, and rarely affected by medial calcification, toe pressures > 40 mmHg indicate adequate flow for healing. Below 20 mmHg, chance of healing is poor. There is a gray zone between 20-40 mmHg in which some wounds may heal slowly, and some will not, especially if associated with comorbidities.

Duplex Imaging

This ultrasound technique is used for assessing both anatomic and physiologic status of the peripheral vessels. Changes in peak systolic velocity around and within stenotic lesions provide data to quantify extent of PAD. Waveform is also analyzed.

Transcutaneous oxygen monitoring (TCOM)

A sensor, placed on the skin and heated to cause local vasodilatation measures oxygen level at the skin. Normal TCOM is over 40 mmHg, good potential to heal > 30 mmHg (> 40 mm in diabetic is preferred), gray zone is 20-30 mmHg, and < 20 mmHg is predictive of poor healing potential.

Skin perfusion pressure

A cuff with a laser Doppler flow sensor is placed around the toe, foot, ankle, calf, or thigh. Measures blood flow as cuff is deflated, converting it to pressure. Good potential to heal if result is over 30 mmHg, gray zone is 20-30 mmHg, and poor potential to heal if <20 mmHg.

If, based on noninvasive testing, it is determined that the patient has PAD, the next question is whether or not he is

a candidate for revascularization based on comorbidities and desire of the patient to undergo procedures. If he is an angiogram will be done to assess for feasibility of revascularization. If possible at the time of the angiogram, endovascular procedures to restore blood flow will be performed. In case the PAD is not amenable to endovascular revascularization, then bypass surgery will be scheduled.

Treatment

Referral to a vascular surgeon and revascularization are the keys to treatment of patients with arterial ulcers. Other treatment modalities include:

- **Modification of risk factors** – smoking cessation, control of hypertension, diabetes, and hyperlipidemia, exercise and weight loss
- **Avoid trauma** – as any traumatic wound may not heal, the patient should be educated on proper shoe gear and avoidance of injuries to the feet
- **Local care** – dry eschars on avascular feet should be left clean and dry. If the patient undergoes successful revascularization, debridement and moist wound healing can be considered. Arterial ulcers that are moist should be treated with local antibacterial agents, dressings to contain exudate, and possibly enzymatic debriding agents. Wet slough can be gently debrided, remembering that significant tissue trauma in the setting of poor blood flow can cause extension of necrosis

- Pain management – patients with ischemic rest pain need narcotic analgesia
- If a patient cannot be revascularized, other medical interventions may result in eventual healing. Cilostazol has been reported to ease rest pain and improve wound healing. Use of arterial pumps, one hour three times a day, have been proven to decrease claudication and may decrease rest pain and improve healing

Pathophysiology

In order to understand the pathophysiology of venous ulcers, a brief review of the venous system is essential. The venous system can be divided into three parts: (1) the superficial system which consists of the greater saphenous and lesser saphenous veins; (2) the deep venous system which includes the femoral, popliteal and tibial plexes; and (3) the perforator or communicating veins that connect the deep and the superficial systems.

All three parts of the system contain valves that prevent backward flow into the distal veins while returning blood flow back to the heart. The calf pump in healthy individuals aids in the return of blood flow back to the heart during walking and exercise. (Hurley, J.P. "Chronic Venous Insufficiency: Venous Ulcers and Other Consequences")

The essential function of the venous system is the return of venous blood from the capillary beds in the lower extremities to the heart. This is accomplished by three mechanisms of action: (1) intrinsic leg muscles with competency of venous valves; (2) capillary pressure; and (3) of least importance, intrathoracic pressure associated with respiration, in an erect position.

Poor venous return resulting in venous stasis can be caused by numerous medical conditions, including

congestive heart failure, obesity, low serum protein levels, pregnancy, postphlebitic syndrome, incompetent valves, and immobility (e.g., wheelchair-bound). All these medical conditions have a tendency to increase venous hydrostatic pressure, which may overcome the osmotic pressure gradient and result in edema.

Diagnosis

The patient's history and clinical presentation are key in the diagnosis of venous ulcers. Classic signs of venous insufficiency, including hyperpigmentation and varicosities are commonly found. Venous ulcers vary in size and location, although they are most commonly found on the medial side of the ankle in the area where the greater saphenous vein is located. Venous ulcers are usually irregularly shaped and may be associated with a high level of exudate.

Characteristics

- Most commonly on medial aspect of leg (40%)
- Vary in size, predominantly large size
- May be associated with lipodermatosclerosis and atrophie blanche
- Pain often relieved by leg elevation
- May be found in association with tortuous, engorged veins
- Painful when infected, desiccated, or with co-existing arterial disease

- Edema can contribute to pain; usually relieved with leg elevation
- May be associated with high to moderate exudate with surrounding skin maceration
- Tend to be superficial
- Eczema and dry scaly surrounding skin

Vascular Examination

Non-invasive vascular examinations should be considered for confirming the diagnosis of vascular ulcers. Diagnostic findings may indicate vascular complications, which will directly influence treatment choice.

Non-invasive vascular exams may be performed in a variety of ways in a wound care clinic from limited resources and limited access to a larger institution. These may include but are not limited to the exams listed below.

Manual Examination

Palpation of a patient's dorsalis pedis and posterior tibial pulses is the most basic form of determining arterial flow to the lower extremity. Palpation is also the most unreliable form of determining flow and results in a subjective finding that may be questioned if future complications resulting from vascular disease occur. False readings may be obtained when one mistakes one's own pulse with that of the patient. A similar palpation/examination of the popliteal artery should be performed. Pulses may be present, but not located, as a result of anatomical anomalies. Presence of dorsal ulceration

and other extrinsic dermatological complications may also interfere with finding a pulse. Manual examination is not recommended as one's primary choice of vascular examination.

Doppler Examination and Plethysmography

Use of Doppler is described in this guide. The reader should refer to that section for a complete description of this device. Plethysmography is also described in greater detail in the section on complete vascular examinations. Plethysmographic studies are often used to confirm the results of a Doppler study. The results are high quality and easy to obtain.

Treatment

Compression Therapy

The purpose of compression therapy in the treatment of chronic venous insufficiency is to increase the venous return from the legs to the heart. This will result in the reduction of lower extremity edema and venous distention. Effective compression must be applied in a gradient fashion. A minimum pressure of 20-30 mmHg should be present at the ankle, decreasing as it ascends the leg, to approximately 15-20 mmHg at just below the knee. To prevent the formation of edema above or below the compression device, stockings/wraps must be applied from just behind the toes and continue to just below the knee (level of tibial tuberosity).

Choice of dressing will affect the wound environment and ultimately wound repair. However, without compression,

the cause of the ulcer is being neglected, resulting in continued chronicity. Compression therapy must be continued for the remainder of the patient's lifetime, as the pathophysiology is difficult to resolve and usually remains after the wound has closed.

Compression therapy is contraindicated in patients who have lower extremity peripheral arterial disease and/or infection. Patients with active wound and soft tissue infections (cellulitis) should be taken off compressive therapy until the infection is resolved.

Compression therapy is considered to be either high or long stretch (elastic) and low or short stretch (inelastic). High stretch compression modalities include stocking, elastic wraps and 3- and 4-layer wraps. These devices have high resting pressure and moderately high ambulatory pressure. In other words, they exert significant pressure on leg at all times. Elastic compression is more effective on people that are wheelchair-bound and/or have poor calf muscle pump function. However, they may exert too high of pressure on patients with co-existing arterial disease. Low stretch compression modalties include non-stretch wraps), the paste portion of the Unna boot, and multi-component leggings. These devices have low resting pressure,
but very high ambulatory pressure. In fact, the sub-bandage pressure under the multi-component strap devices has been measured at 60-70 mmHg during ambulation, mimicking a compression pump. Low stretch devices are ideal for the ambulatory patient to actively pump fluid out of the legs during walking. Because of their

low resting pressure, they tend to be more comfortable (and safer) for the patient with co-existing arterial disease. They are ineffective in the non-ambulatory patient, as a competent calf muscle pump is essential to their success.

Multiple factors must be assessed when choosing the most appropriate form of compression for a particular patient. The following considerations need to be reviewed:

Patient's overall vascular status with particular attention to arterial disease

Constant compression is contraindicated in patients with severe arterial disease and occlusion (ABI less than 0.7) The ABI is the ration of the ankle to brachial systolic pressure whereby the ankle pressure is divided by the brachial pressure. Caution should be used with ABI between 0.7-0.9. This does not necessarily rule out the use of foot pumps which do not apply circumferential lower extremity pressure, or mild compression stockings. For instance, a patient with mixed venous and arterial disease, and an ABI between 0.6 and 0.7, may tolerate a mild 15-20 mmHg compression stocking during the day.

Patient's age

Elderly patients may be unable to tolerate high levels of compression. Decreased strength and manual dexterity may make application of certain stockings and wraps difficult, if not impossible.

Younger patients and working adults may not be compliant if the modality selected is considered socially unacceptable in appearance. Many women are unable to wear their daily shoegear as a result of bulky wraps and secondary dressings. The latter further results in noncompliance on the part of the patient.

Daily activities

Active individuals may require a compressive device that may be changed daily so that routine daily hygiene is not impaired. Patients may require a dressing that can be easily changed when under conditions where soiling may occur. Clothing required for professional reasons may also influence choice of compression. Ambulatory status affects the choice of high or low stretch devices.

Mental status

Patients' mental status may be such that they are constantly trying to remove or disrupt the compression modality and/or the wound dressing. Selection of a product should be determined by materials that are neither easily removed nor disrupted.

Medical status

Vascular considerations were mentioned above. Other medical considerations include the dermatological status of the surrounding skin. Friable and fragile skin both demand compression that will not cause further damage to the skin. Unna boots may peel off periwound and lower extremity tissue, thereby inflicting greater damage. Stockings which provide high levels of compression

(greater than 25 mmHg) require great force to be pulled over the leg. The resulting excessive friction may damage both fragile and friable tissue. Although compressive wraps as ace wraps may not provide the most reproducible or ideal compression, they are less traumatic to the above-mentioned patient.

Patient sensitivity or allergy to products is of primary importance in individuals with venous disease. Sensitizing agents include, but are not limited to parabens, propylene glycol, wood alcohols, and adhesives. Parabens are found in most Unna's boots.

Caution is required when applying compressive modalities to patients with severe dermatitis and/or infection. Compression may be contraindicated in acute infection and/or with severe dermatitis. The patient should be instructed in leg elevation while the acute problem is being treated. Once the infection has resolved, or the dermatitis is improved, compression therapy should be instituted.

Patient's tolerance of compression modality

Individual pain tolerance levels vary greatly. Individual variations must be taken into account based on patient feedback.

Anatomy of leg

Consider areas at risk for skin breakdown when applying compression and apply supplemental padding to protect skin area over bony prominencies

Number of dressing changes required per week

Wounds vary in size, appearance and amount of exudate. All of the latter factors will determine appropriate dressing selection. The ease of application and removal of a compressive modality must be considered in relationship to the wound dressing selected. Foam dressings or highly absorbent dressings designed for up to seven days retention, may be the best option under compression wraps left on for up to seven days. Depending on the level of bacterial burden and exudate, antimicrobial dressings should be considered. Highly exudating wounds requiring more frequent dressing changes may require a compression wrap that may be changed daily (e.g. elastic wrap).

Stockings

High quality compression stockings, made of a mixture of nylon, spandex, and/or lycra, are an effective, reproducible means of increasing venous return and decreasing lower extremity edema. They facilitate drainage of the superficial veins into the deep veins, but in most cases, do not affect deep vein hemodynamics. In addition, they may promote coaptation of the venous valves. They range in pressure at the ankle from 20-60mm Hg. Stockings can be removed for bathing and for dressing changes. In an attempt to make compression stockings more cosmetically acceptable to patients, manufacturers now provide the stockings in a variety of colors. Most stockings can be machine-washed on a gentle cycle, but must be air-dried. Because the stockings take many hours to dry, patients must have at least two pairs of stockings - one to wash and one to wear. Contact with ointments on the skin under the stocking should be avoided as this may weaken the elastic in the stockings.

For elderly or frail patients, especially those with arthritic hands, stocking application may be impossible. Many stocking manufacturers include a nylon “under-stocking” which facilitates the application of the compression stocking. Wearing rubber utility gloves may assist patients in obtaining a better grip on the stocking itself during application. Plastic-coated metal frames are available from stocking manufacturers over which one can stretch the compression stockings, slip the foot into the frame, and then pull the stocking off the frame and onto the leg. Other devices to assist with application and removal of stockings may be available

Most patients will fit into these pre-made stockings based on their ankle and calf measurements. Occasionally, a patient with a disproportionate leg will require the more expensive custom-made stockings. In either case, a knee length stocking is sufficient to address chronic venous insufficiency (thigh high stockings are more difficult to apply and thus may decrease patient compliance, and do not make a measurable difference in treatment of chronic venous insufficiency). Due to the eventual loss of elasticity, stockings must be replaced at least every six months.

Advantages	Disadvantages
• Reproducible compression • Washable/reusable • Apply frequently • Allow high levels of compression • May be worn with minimal effect on daily clothing/ shoegear • Are available in numerous sizes and varying colors • Patient able to remove and bathe	• Costly • Are easily soiled and must be frequently washed • Are not designed to act as wound dressings • Are difficult to apply over wound dressings • Have to be replaced every 4-6 months • Will not fit morbidly obese
Indications	**Contraindications**
• Venous disease • Edema of the lower extremity • Weeping dermatitis • Increase lower extremity comfort in cases of prolonged standing • To improve venous return	• Significant arterial disease • Infection • Friable and very fragile tissue

Elastic Wraps

One of the most widely used forms of compression are elastic bandages (wraps). They are inexpensive, widely available without prescription, and do not require extensive training to apply. However, they are frequently incorrectly applied by both patients and caregivers resulting in lack of uniform compression. Reproducible compression is difficult to achieve with the majority of elastic wraps.

Elastic wraps which are designed to help apply controlled and reproducible pressure, are now available. They are imprinted with shapes that change their form when stretched.

Elastic bandages are easy to remove for bathing and for wound care. They may be hand washed and dried, but lose their elasticity after repeated laundering. They must be replaced frequently (weekly or more frequently in cases of high exudate wounds). Patients must be relatively flexible and dexterous to apply their own compressive wraps. Special consideration is needed when prescribing wraps to the elderly, arthritic and those with impaired dexterity.

Advantages	Disadvantages
• Relatively inexpensive • Well accepted by majority of patients • Relatively easy to apply • Can be removed at night for bathing	• May be inappropriately applied by the clinician and/or patient • Level of compression is unpredictable and not reproducible • Frequently becomes unraveled and slips down the leg • Many wraps lose elasticity with washing • Difficult to keep in place • Do not act as wound dressing • Are bulky and may interfere with shoes, stockings, and clothing
Indications	**Contraindications**
• Patients unable to tolerate Unna boots and compression stockings • Patients requiring freq. changes	• Significant arterial disease • Infection • Use caution with friable and very fragile tissue

Medicated Compression Wraps/Paste Bandages

These wraps, commonly referred to as "Unna Boots," are composed primarily of a woven cloth/gauze wrap, which has been impregnated with gelatin, zinc oxide and/or calamine. Because they contain potential sensitizing ingredients, consider a patch test on the extremity prior to use. They function as a compressive cast wrap, however, will only sustain compression for about 48 hours. For this reason, the addition of a self-adherent compression wrap on top of the paste bandage will provide sustained compression for up to one week, and will conform to the leg better as the edema decreases. The combination of

the paste bandage and Coban™ provides both low and high stretch compression, and averages 30-30 mmHg of pressure at the ankle.

Advantages	Disadvantages
• Generally not removed by patient, therefore it is difficult for the patient to come in contact with and disrupt the wound dressing • Moderate to low in cost • May be applied in a multi-layered fashion with other materials including a wound dressing, gauze wrap, and self-adherent elastic wraps • Stays in place up to one week, depending on the amount of exudate	• Can easily be incorrectly applied, thereby aggravating the wound and possibly resulting in wound deterioration • May be messy when not used with overlying dressings • Potential for contact sensitivities • Limits bathing and daily hygiene • May be uncomfortable to wear • When applied without secondary compression, may lose compression in 72 hours or less • Limited absorptive capacities • Does not offer reproducible means of applying pressure • Bulky • Must be applied by trained health care professional

Indications	Contraindications
• Patients where compliance is minimal • Wounds that the clinician wants left undisturbed for extended periods of time • Situations where patients are unable to administer self care • Significant arterial disease	• Friable and fragile skin • Infection/cellulitis • Sensitivity to components in paste bandage • Highly exudating wounds (unless used in a multi-layered bandage application) • Use with caution with peripheral neuropathy

Compression Wraps - Multi-layered

Multiple layered non-medicated wraps introduced during the last decade have become more popular as they are used in place of the paste bandage (Unna Boot). These wraps consist of three or four layers of elastic and woven materials applied over each other as instructed in the product indications. These products are designed to provide sustained compression (up to 40 mmHg at the ankle and decreasing as the wrap ascends the leg) for up to one week. These wraps are not medicated, thereby overcoming the problem of contact sensitivity and discomfort sometimes associated with paste bandages. They appear to be well tolerated by the majority of patients. Advantages over paste bandages include: greater comfort, ease of application (less messy than paste bandages), greater acceptance by the patient, and sustained compression for up to a week. Disadvantages include: dressings may be too bulky to fit into most shoes, dressings may be uncomfortable in warm climates, and these wraps tend to sag and slip more frequently than paste bandages.

Advantages	Disadvantages
• Applies high level of compression for up to one week • Non-medicated • Usually well tolerated • Relatively inexpensive • Very absorptive	• May be inappropriately applied • Must be applied by trained health care professional • May be bulky • Limits bathing and daily hygiene • May slip and sag, causing pressure areas on leg from wrinkles
Indications	**Contraindications**
• Wounds not requiring dressing change for one week • In place of Unna Boot	• Significant arterial disease • Infection

Wound Dressings And Treatments

The majority of wound dressings should not be considered as primary treatment for venous disease. Dressings and topically applied pharmaceuticals are designed to assist and/or expedite wound repair. They should be used to promote re-epithelialization and granulation. Following are guidelines for assisting in the selection of the appropriate wound treatment material.

Pre-Ulcerative

With venous ulcers, this may also include areas of hyperpigmentation or areas of atrophie blanche, which are hypopigmented. Areas of oozing and/or stasis dermatitis may also be consistent with pre-ulcerative lesions.

Objective

Protect area and apply appropriate dressing.

Products

- Creams, ointments and moisturizers. Avoid topical steroids unless indicated for dermatitis
- Products should be selected keeping in mind the choice of compression

Procedures

- Gently cleanse tissue and blot dry
- Apply selected material and hold in place with gauze wrap or, when periwound tissue is intact and not fragile or friable, with hypoallergenic adhesive covering
- Select appropriate compression

A pre-ulcerative lesion in a patient with venous disease may be a sign on inadequate compression. A pre-ulcerative lesion may be confused with lesions that are not of venous origin. The differential diagnosis should be reviewed.

Partial Thickness/Full Thickness

These venous ulcers vary in their clinical presentation. They may include but are not limited to:

- Dry to high exudate wounds
- Clean to highly fibrotic wounds

- Wounds with intact periwound tissue to very fragile periwound tissue
- Granulating and non-granulating wounds
- Wounds with obvious re-epithelization and those with indurated margins

Treatment selection should be based on the above considerations.

Objective

- Absorb exudate
- Prevent wound desiccation
- Promote and maintain granulation tissue
- Protect wound
- Close wound
- Prevent damage to ulcer and periwound tissue

Products

- Hydrocolloids - suitable for low to low-moderate exudate wounds with intact periwound tissue. When periwound tissue is friable or excessively macerated, any dressing with an aggressive adhesive may cause damage to the surrounding tissue or increase the ulcer size
- Hydrogels (sheet) - are suitable for low exudate wounds. They may be preferable when available without adhesive margins as they tend to traumatize wounds less than hydrocolloids. Most forms also

tend to be transparent or translucent, thus allowing visualization of the wound without disruption of the dressing

- Amorphous hydrogels - may be used on full thickness wounds with minimal exudate, but tend to be more difficult to use on venous ulcers and require an overdressing
- Alginates - are recommended on moderate to high exudate wounds. They tend to desiccate on lower exudate wounds, and therefore are avoided on these wounds. They must be secured with an overdressing
- Foams - are excellent on all types of venous ulcers, particularly those which absorb under compression. In addition to exudate absorption, they provide local compression under the compression device, which helps decrease local edema. Dressing change frequency depends on the amount of drainage from the wound. Some foams must be secured with an overdressing

Procedures

- Gently cleanse the wound following appropriate debridement
- Examine periwound tissue to determine skin's ability to tolerate adhesives and different dressings
- Apply product of choice and change as follows:
    - High exudate: daily or more frequently
    - Moderate exudate: every two to three days
    - Low exudate: every three to seven days

Full Thickness (with bone or tendon exposure)

The same guidelines listed for Partial Thickness/Full thickness venous ulcers may be followed for these lesions. However, because these are ulcers that extend down to, and possibly include tendon, capsule, muscle, and/or bone, a surgical consult may be required.

Objectives

Remove all necrotic and non-viable tissue, and foreign bodies. Particular care must be given to protect exposed joint, capsule, tendon, muscle and/or bone and to prevent desiccation of the latter tissues. Immobilization of the lower extremity may be necessary to prevent muscle motion. If wound closure is to occur, muscle motion must be prevented to stop disruption of any granulation tissue. This may entail using a splint or other form of immobilization to prevent motion of the tendons of the lower extremity.

Products

Non-adherent materials are the most suitable for these types of wounds. This would exclude any type of petrolatum-impregnated mesh gauze or hydrogel. The best material would be a hydrogel dressing as this prevents desiccation and does not adhere to tendon.

Procedure

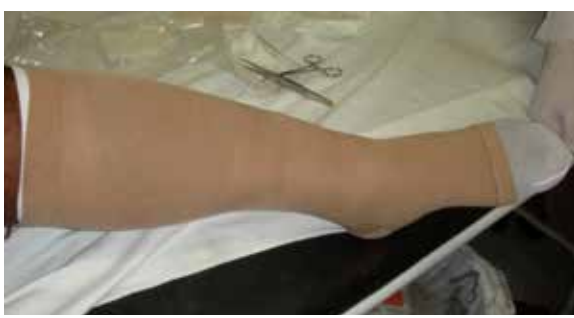
These wounds should be cleansed of all necrotic and desiccated tissue. The wound should be treated with a dressing (i.e., hydrogel) that will maintain a moist environment. The dressing should be changed as

infrequently as possible with the exception of higher exudate wounds.

Treatment Of Venous Ulcers Vs. Venous Disease

The clinician must note that while dressings assist in providing an environment which is conducive to wound healing, dressings do not reverse or prevent the underlying pathophysiology of venous disease. The clinician must attempt to assist venous return to the extent possible, then select a dressing to promote wound closure.

When the underlying pathophysiology has not been adequately addressed, venous ulcers will either not heal or will recur within months following closure. Wound closure should not be interpreted as being an indication of venous disease resolution. The clinician must seriously consider the indefinite use of a compression modality (i.e., stockings and compression devices) as a means of ulcer prophylaxis.



Venous Ulcers: Differential Diagnosis

Ulcers of the lower extremities include numerous etiologies in addition to, or present with, venous ulcers. A careful differential diagnosis must be established prior to concluding that venous disease is the primary etiology. The following list is a brief differential of some of the additional lesions of the lower extremity that may be confused with venous ulcers.

- Vasculitic Ulcers
- Raynaud's Phenomenon/Disease
- Antiphospholipid syndrome (APS)
- Cholesterol Embolization
- Cryoglobulinemia
- Cryofibinogenemia
- Thromboangiitis Obliterans (Buerger's Disease)
- Sickle Cell Disease
- Pyoderma Gangrenosum
- Necrobiosis Lipoidica
- Cutaneous Malignancies

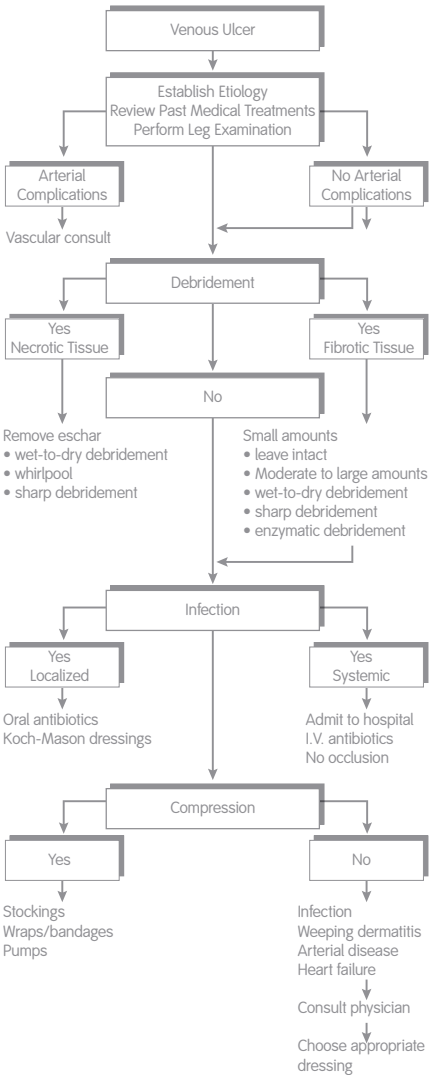
Noninvasive Vascular Testing: Venous

Test	Procedure	Results	Advantages	Disadvantages
Color Duplex Scanning	A transducer is held over the vessels to be examined and ultrasound technology (B-mode and pulsed doppler) is used to provide anatomic and functional data regarding the presence and severity of venous disease. The use of color easily indicates direction of flow	Locates areas of valvular incompetence and venous reflux in the deep, superficial, and perforating veins Quantifies severity of reflux. Blood flow at peak reflux > 10-15 ml/sec has been associated with a high incidence of skin changes and ulceration Identifies obstruction 2° to acute and chronic deep vein thromboses, as well as recanalization	Excellent test to detect and quantify anatomic abnormalities and venous reflux Commonly used preoperatively before the SEPS (Subfascial Endoscopic Perforator Surgery) procedure to identify incompetent perforating veins	Requires expertise to perform test and interpret findings Moderately long exam time (although use of color vs. black and white scanning is faster)

Air Plethysmography (APG)	A 14-inch long tubular air chamber with a capacity of approx. 5 liters surrounds the entire leg from the knee to the ankle. It is inflated to 6 mm Hg and connected to a pressure transducer, amplifier and strip recorder. The leg is elevated at 45° to empty the veins and a baseline recording is made. The patient then stands on the opposite leg and calf venous volume and venous filling time of the cuffed leg is recorded. Further changes in venous volume are measured during single and multiple calf muscle contractions. APG provides a quanitative assessment of calf venous reflux and calf muscle pump function	Normal calf venous volume: 100-150 ml Abnormal: 100-350 ml When using APG, the venous filling index (VFI) is the best determinant of the clinical severity of venous disease. VFI = the ratio of 90% of the venous volume divided by 90% venous filling time (the time to fill the calf veins). VFI parameters: < 2 ml/sec: no significant reflux 3-5 ml/sec: edema and minor skin changes 5-10 ml/sec: moderate risk of edema, skin changes, and ulceration >10 ml/sec: high risk of edema, skin changes, and ulceration	Excellent test to assess efficacy of the calf muscle pump and the global venous function in the calf Assists in identifying patients that are suited for venous reconstruction Used to assess the effects of therapeutic interventions such as compression and surgical treatment	Time consuming Patient must be able to stand Does not provide information about venous status above the knee

Photoplethysmography (PPG)	A photoelectrode (PPG probe) is placed on the dorsum of the foot and connected to a strip recorder. PPG measures blood flow and blood volume changes in the skin at rest and following calf muscle exercise to determine venous refill time (VRT)	Normal VRT: > 18 seconds If VRT < 18 seconds, a narrow (2.5 cm) cuff is applied at the ankle and inflated to 80 mmHg to occlude the superficial veins. With the cuff: VRT normalizes (> 18 seconds) = superficial venous reflux VRT stays < 18 seconds = deep vein reflux	Moderately fast, easy test to identify venous reflux	Severity of VRT abnormality does not correlate with severity of deep vein disease Patient must be able to stand for ideal testing (the calf veins may be emptied with repeated inflations of a BP cuff placed around the calf, but this may not be as accurate)

Venous Ulcer Treatment Algorithm



Diabetic ulcers are associated with a high level of morbidity and mortality. Contributing factors include poor glycemic control, absence of appropriate wound care and a failure to use the correct off-loading device.

Pathophysiology

The major factors contributing to ulcer formation are neuropathy, acute or repetitive trauma, and vascular disease.

Neuropathy may affect motor, sensory and autonomic peripheral nerves of the lower extremity, presenting as distal or "stocking glove" paresthesia. Increased and continued loss of feeling in the foot results in absence of sensitivity to pain, temperature and pressure. When the neuropathy is combined with trauma, the patient may be unaware of the degree of tissue damage and subsequent inflammation and infection until the ulcer has progressed to a critical stage.

Plantar ulcers may also result from prolonged pressure, which are manifested in callus formation. Fat pad atrophy, musculoskeletal abnormalities and abnormal gait are additional factors contributing to ulcer development. More common areas of occurrence include the submetatarsal areas and distal digits.

Vascular insufficiency may significantly promote ulcer formation. Palpation of the dorsales pedis and posterior tibiales arteries may give an indication of blood flow but

are not as reliable as the use of a Doppler or other non-invasive means of testing. The ideal clinic treating of a diabetic patient will require access to a vascular laboratory for patient referral.

General Ulcer Characteristics

- Frequently circular with punched out appearance
- Periwound hyperkeratosis
- Anhydrosis of surrounding tissue
- Low to moderate drainage unless infected
- Associated with area of pressure or trauma
- Characteristics of diabetic ulcers associated with vascular disease

Vascular disease in the diabetic patient may be associated with younger age and rapid progression. Small multisegmental vessels may be involved. A patient with palpable pulses of the major vessels of the foot may still present with distal ischemia of the digits. Characteristics include:

- Shiny tight skin
- Digital discoloration
- Dependent rubor
- Loss of hair growth
- Delayed superficial venous plexus filling time
- Subcutaneous fat atrophy

Evaluation

Patient evaluation includes:

Diabetes status/glycemic control

- Diet and nutritional status
- Vascular status
- Dermatological status
- Neurological status
- Musculoskeletal presentation
- Gait analyses
- Examination of footwear

Ulcer evaluation

- Size (including depth)
- Anatomical location
- Ulcer staging or grading *(Refer to Wagner & UT Diabetic Foot Ulcer and Wound Classification Systems. P: 24 & 25 Chapter 2 Assesment and Documentation)*
- General appearance of tissue
- Amount and type of exudate
- Periwound appearance
- Presence of sinus tracts
- Exposure of tendon, bone or other deep structures

Treatment Considerations

Preulceration

- Debride callus
- Use accommodative devices or special shoes or off-loading devices to remove pressure and or protect affected site
- Instruct patients on
  - Daily inspection of feet
  - Foot hygiene
  - Selection of appropriate footwear
  - Discontinuing self-debridement
  - Discontinuing over the counter medications
  - Overall medical care

Partial-Thickness and Full Thickness Ulcers

Excluding exposure of tendon, capsule, muscle or bone

- Relieve pressure by appropriate off-loading device
- Debride callus and non-viable tissue
- Reduce risk of infection
- Consider total contact cast or off-loading walker for best pressure reduction or relief
- Choose appropriate dressing
- Instruct patient as with pre-ulceration in addition to education on wound care and dressing changes

Considerations for Product Selection

Product

Products including dressings, devices and matrices should be used according to the manufacturer's indications and directions.

NOTE 1: Totally occlusive dressings and products that hold high amounts of exudate on the wound surface, particularly over weight bearing surfaces, should be avoided on diabetic patients. New occlusive technologies may allow a dressing to wick exudate away from the wound surface and surrounding tissue while retaining it in the dressing even under pressure. Read package inserts carefully and use with extreme caution. Excessive moisture may promote maceration and decreased tissue tensile strength which may result in increased wound size when patient ambulate. Continue pressure and/or shear will produce greater tissue damage in the presence of maceration and decreased tissue tensile strength. Decreased cellular immune response may affect ability to reduce bacterial colonization. Bacterial proliferation may increase in the presence of excess moisture.

NOTE 2: Topical antimicrobial dressings should always be considered in diabetic patients with an increased response to infection. It is important for the clinician to understand the specific antimicrobial properties of any dressing selected as all antimicrobial dressings, particularly those with silver, are not the same.

Full-Thickness

Ulcers with exposure of tendon, capsule, muscle, or bone. Avoid adhesive dressings.

- Relieve pressure through use of off-loading devices. Patient may need to have activities restricted.
- Debride callus and all necrotic tissue from the wound
- Reduce risk of infection through use of antimicrobial dressings
- Rule out osteomyelitis
- Consider contact casts or special walkers (off-loading devices)
- Obtain vascular and surgical consult as needed.
- Choose appropriate dressing
- Educate patient as described for another open diabetic wound

Plantar Ulcers

Common locations include:

- Submetatarsal locations (particularly first, second and fifth sub-metatarsal heal)
- Distal digits
- Areas of boney prominence, particularly in the Charcot foot

Pressure Relief

Pressure reduction is the decrease in the level of pressure above a capillary pressure of 35 mmHg, while pressure reduction is able to bring pressure below that level relief is usually best obtained by complete non-weight bearing (bed rest, crutches, and wheelchair) or with contact casting or specialized off-loading walkers. When prescribing crutches or casts, the patient's ability to tolerate these devices as well as their living conditions and physical status must be taken into consideration.

Debridement

The majority of diabetic ulcers are surrounded by hyperkeratotic tissue. Untreated, this could impede healing. Surgical debridement should include removal of all hyperkeratotic tissue down to the level of viable tissue, as well as debridement of non-viable tissue from the wound base.

Sharp debridement is the often the most effective and rapid form of debridement. However, it should only be performed by an experienced clinician after the vascular status of the patient has been determined. Enzymatic agents and other approaches may also be used to assist

with debridement when surgical intervention is not possible. Hydrotherapy should be avoided.

Offloading the Diabetic Foot and Plantar Ulcers

Diabetic foot, neuropathic and plantar ulcers are all affected by repetitive trauma and pressure. The selection effectiveness of even the most advanced technologies and dressings will be reduced if not negated by on-going pressure and repetitive trauma. Ideally, the clinician should completely remove pressure or reduce pressure at an ulcer site to below 35 mmHg. This is may not be practical or feasible due to the patient's life style and social activities and may result in other complications. Pressure "reduction" entails decreasing the level of pressure at a wound site, to approach 35 mmHg with "pressure relief" achieved when the pressure is brought below this level.

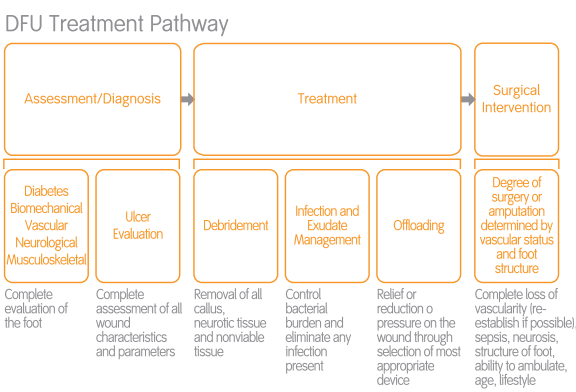
Off-loading is defined as the reduction or relief of pressure from areas of the foot at high risk for tissue breakdown or ulceration, or areas where an ulcer is already present. Offloading is a critical part of diabetic foot treatment, along with appropriate wound care and control of diabetes. The absence of off-loading could contribute to further breakdown, infection and amputation.

Methods of Offloading

Offloading techniques may be divided into three separate categories. The following table summarizes the different offloading methods.

Complete non-weighting bearing	Pressure Offloading	Other
• Bedrest • Crutches • Wheelchair	• Total contact cast • Removable cast walker	• Insoles • Felt and foam padding • Healing shoe • Extra depth or custom shoes

Choosing the best modality requires a complete evaluation of the patient's wound, life-style, financial status, mental status, and ability to tolerate the selected treatment as demonstrated in the following illustration.



When assessing the diabetic foot to determine device selection, the examination should include:

- Examination of diabetic foot ulcer
- Assessment of patient's ambulatory status and gait
- Examination of previous shoes worn
- Determination of lifestyle
- Financial Considerations
- Musculoskeletal deformities
- Vascular status

Always carefully exam the structure and mobility of the foot as musculoskeletal and rigid structure may significantly contribute to pressure and ulcer development.

Vascular assessment is always part of a complete foot examination and is critical prior to selecting off-loading devices. Please refer to the section of this Protocol Book for a review of vascular assessment of the lower extremity.

Once a complete patient assessment has been performed, the clinician may proceed to selecting the offloading device based on foot type.
Two different systems may be used to assist with selecting the best offloading device:

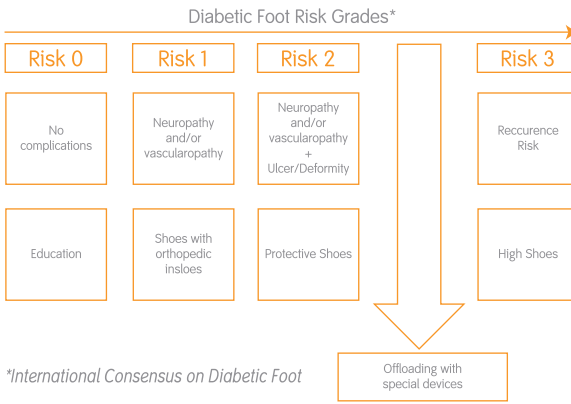
1) The International Consensus on Diabetic Foot – Diabetic Foot Risk Grades
2) The University of Texas Diabetic Foot Classification System

The recommendations are based on general presentations of diabetic feet with varying degrees of ulceration, and should only be used as a general guideline. Individual patient differences including

activities and wound presentations must be carefully considered prior to selecting any specific device. The following system is based on the International Consensus of on the Diabetic Foot.

The following recommendations for selection of the appropriate offloading device are based on the University of Texas Categorization of the Diabetic Foot.

When should Offloading be used?



**International Consensus on Diabetic Foot*

The different off-loading devices recommended are to be considered only after following the complete examination of the patient as discussed at the beginning of this chapter. The clinician needs to remember that every patient is different and will require individual considerations.

Shoe Recommendation for Diabetic Foot Categories
*based on the University of Texas DF Classiffication System

Category	Description	Recommendation for Type of Shoe
Category 0	Protective sensation intact	Well-fitting,over the counter
Category 1	Loss od Protective Sensation(LOPS)	Over the counter with molded inlay
Category 2	LOPS with deformity	Depth inlay shoe vs. custom molded Shoe
Category 3	LOPS with deformity and history of pathology	Depth inlay shoe vs. custom molded Shoe
Category 4A	Non-infected, non-ischemic wound	Offloading with wheelchair or crutches or specialized shoe
Category 4B	Charcot foot	Complete non-weight bearing
Category 5	Diabetic Foot Infection	Treat infection; then address off-loading
Category 6	Diabetic Foot Infection	Revascularization

Total Contact Cast

Total Contact Casts (TCC) are specialized plaster or synthetic casts which may vary in appearance or application depending on the training of the clinician (see photo below). The original contact cast used was made of plaster in combination with underlying padding and other materials designed to be placed in total contact with the patient's extremity, thereby allowing for redistribution on the plantar aspect of the foot.

TCCs are designed to offload through pressure redistribution while permitting the patient to continue limited ambuation. Training and skill is required to correctly apply a TCC as incorrect application can result in new wounds and further breakdown of the existing ulceration.

There are specific indications and contraindications to use of a TCC:

Indications for TCC

- Non-infected wound
- Adequate blood supply to heal (ABI>0.7)
- Wagner clasification – Grade 1 or 2
- Low exudate
- Wound can be debrided prior to applicatin of TCC

Contraindications

- Acute or uncontrolled infection
- Significant ischemia
- Greater than Wagner Stage 2
- Non-compliance
- Claustrophobia to cast devices
- Allergy to cast materials
- Wounds that cannot be debrided
- High exudate
- Severe musculoskeletal deformities

Excellent alternatives to the TCC are available today in the form of specialized Walking Boots.

Not all walking boots are the same, making it necessary for the clinician to understand the differences between various brands of manufactured products. Ideally, the following characteristics should be sought in Walking Boot:

- Includes means to prevent patient from removing device, if desired by clinician
- High level of pressure redistribution on plantar foot

- Medial and lateral support for ankle stabilization
- Ability to customize for patient
- Improves patient quality of life
- Includes insert which may be customized
- Reduces total cost of care

CLINICAL NOTE:
Remember the following Key Points
- Understand the diabetic foot and the etiology and pathophysiology of diabetic wounds
- Select Shoes after:
  - Reviewing patient history
  - Reviewing patient medical status
  - Performing a complete lower extremity examination including vascular, neurological and musculoskeletal review
  - Evaluate biomechanics and patient gait
  - Consider patient's lifestyle
- Determine what is finacially feasible for the patient

This chapter of the Protocol was designed to guide not instruct the clinician, on appropriate off-loading methods and considerations. It is recommended that the clinician read additional materials related to off-loading as well as national and international guidelines to develop a comprehensive understanding of off-loading the diabetic foot.

Infection of Dibetic Foot Ulcers

Infection of the diabetic ulcers is one of the most frequent causes of secondary complications including amputation. Early diagnosis and treatment will reduce the threat of sepsis and limb loss. Hyperglycemia should also be controlled. Early detection is important to reduce morbidity and mortality.

Prevention of infection is very important. Antimicrobial dressings may offer a means of preventing bacterial contamination from progressing to critical colonization and infection. When a severe infection occurs, which is not limited to the wound surface, antibiotics need to

be considered. Hospitalization may be required with severe infections particularly in the presence of abscess formation, cellulitis and osteomyelitis.

Local wound care, debridement and appropriate dressing selection are all part of best practice.

Prevention of the Diabetic Foot Ulcer

Ulcer development may be prevented by repetitive and aggressive patient education.

Education should include:

- Instructions on daily foot inspection
- Instructions on foot care
- Education of family members
- Appropriate footwear and off-loading devices
- Regularly scheduled visits to their health care professional

Malignant Fungating Wounds

Not all wounds can be healed. However, the wound care clinician can have a significant and positive impact in the palliative care of patients with malignant wounds secondary to local invasion or metastasis of internal cancers. These wounds can occur in up to 5% of patients with cancer and 10% of patients with metastatic disease. The most common cancers associated with cutaneous lesions are breast, melanoma, lung, head and neck, and colon. These wounds may present initially as redness, induration or painless nodules and deteriorate into draining necrotic ulcers, or fungating wounds in which the tumor mass extends above the skin surface with a fungus or cauliflower-like appearance. Central tissues affecting the quality of life of patients with malignant wounds include wound odor and drainage, pain, social isolation, and ignorance of both, patients and the health care providers regarding care of these wounds.

The goals of care for patients with malignant wounds include control of odor, management of exudate, prevention and control of bleeding, and management of pain.

Odor Control: decrease bacterial counts and necrotic tissue, which contribute to odor	• Shower, letting water run gently over wound • Use antibacterial wound cleansers (eg., PHMB-based cleansers). Skin/incontinence cleansers have mild anti-bacterials that may decrease odor. Avoid antiseptics like Dakin's or betadine, which smell and may irritate skin • Gentle debridement, using any method to remove necrotic tissue, while avoiding bleeding, which may be difficult to control • Topical metronidazole gel applied daily in thin layer across wound, covered with a non-adherent contact layer, is most efficacious at decreasing wound odor • Other topical anti-bacterials: silver, cadexomer iodine, PHMB-based gel, honey-based dressings • Kitty litter or charcoal briquettes under bed. Aromatherapy, like peppermint oil, placed under nostrils or at bedside, odor eliminating room sprays
Exudate Management	• Choose dressings based on amount of exudate as would be done for any wound (see chapter 15: dressing table) • Costly dressings will not change eventual outcome (healing is not the goal), so use of less expensive options are acceptable • Dry wounds – use non-adherent contact layers, covered with gauze or ABD pads. Use hydrogels to prevent drying and dressing adherence • High exudate – ABD pads over contact layers, menstrual pads are ideal as plastic backing protects clothing, foam dressings

Prevention/ control of bleeding	• Use of gentle hand and non-adherent contact layers • Pressure, ice packs, silver nitrate sticks for mild bleeding • Sucralfate paste (1 g sucralfate tablet in 5 ml of hydrogel) • Hemostatic agents (e.g., Gelfoam®, Surgicel®, Promogran™ • Topical vasoconstrictors (Gauze soaked with 1:1000 epinephrine, cocaine, or oxymetazoline spray). May cause more tissue necrosis • Moh's paste (caution to avoid excessive tissue damage, dermatitis, or pain) • Transcatheter embolization of arteries feeding tumor • Oral fibrinolytic inhibitors (tranexamic acid, aminocaproic acid) • Crisis medication (midazolam) and dark towels available at bedside for terminal hemorrhage
Pain management	• Systemic pain management with long and short acting narcotics • Ice packs, topical lidocaine or benzocaine • Topical opioids. Must be compounded by pharmacist. Typical mixture is morphine sulfate 10 mg/ml in 8 grams of hydrogel applied to wound surface once a day

Palliative care of the patient with a malignant wound may include surgical removal of fungating tumors and/or resection of new nodules, or chemotherapy, radiotherapy,

hyperthermia, and/or radiofrequency ablation for tumor shrinkage and pain control. Electrochemotherapy, a treatment in which the application of electric pulses to tumors facilitates penetration of topical chemotherapy, has been shown to have high efficacy at reducing or eliminating cutaneous tumors, while having minimal side effects. Although these interventions will not cure patients of their advanced cancers, they may extend life, ease pain and bleeding, and improve quality of life. Patients with malignant wounds should be referred for these treatments if compatible with the palliative goals of care.

Biological, Pharmaceutical and Medical Devices for Difficult to Heal Wounds

A variety of unique and frequently expensive modalities for difficult to treat wounds have been introduced over the past few decades. Biological skin substitutes were approved in the U.S. in the late 90's and are currently available in different configurations. During the same period, studies on growth factors multiplied. Currently there is one FDA approved growth factor in the United States, approved for difficult to heal diabetic foot ulcers, however other growth factors are available on the international market. Acellular matrices of human, porcine, bovine and equine may also be purchased for use on chronic and acute wounds. In addition to the biological and pharmaceutical materials, devices including ultrasound, hydrosurgical tools, negative pressure wound therapies, mist devices and other products have rapidly increased in number. All of these products come with a significant cost over standard approaches to wound care. The clinician must keep in mind that the majority (over 80%) of chronic wounds will respond to basic and standard approaches of good wound care. The more technologically advanced and expensive materials are designed for wounds that may be more difficult to heal or which may lead to increased morbidity and mortality if not closed in a relatively short period of time.

Biological Materials and Skin Replacements

This category comprises both living cell and acellular materials designed to stimulate cellular activity in a recalcitrant wound bed. Living cell products generally contain keratinocytes, fibroblasts or a combination of both, in a collagen based. Aerosolized and cultured cells are also available for use on clean granulating wound bases. These materials are designed for wounds with decreased or impaired cellular activity. The products have specific indications (venous, diabetic or both) based on clinical trials used for product approval. The ability of the cells to survive and contribute to wound repair is not based on the wound etiology, rather it is determined by the status of the wound bed. Therefore, it is very important that wounds are cleansed and prepared for the materials prior to application. Success of the products is based on:

- Vascular supply to the wound bed
- Wound etiology
- Ability to create a clean wound bed
- Bacterial burden levels
- Ability of cells to survive in wound bed
- Secondary dressing chosen
- Ability to keep dressings intact

The primary mode of action of living cell materials is the introduction of chemical mediators, cytokines and growth factors to the wound bed, as the products rarely act as a split thickness skin graft. Current products containing cells

may be bilayered with outer differentiated keratinocytes and dermal layer with fibroblasts and collagen, cultured cells (e.g. fibroblasts) in a polymer scaffold, individually cultured sheets of cells or aerosolized cells. The final method of action is not known to be significantly different between products.

Acellular products may be clean processed or sterile allograft materials, or sterilized bovine, porcine, aviary or equine materials. When using a cadaver derived product, it is strongly recommended to use on that is fully sterilized as clean processed materials still risk transmission of viruses and unwanted organisms.

Frequency of Application

Most living cell products require a once a week application until reepithelialization or healing has occurred. More or less frequent application may be indicated based on visible results.

Acellular products may be applied one time only following aggressive wound bed debridement or excision.

Method of Application

1. Check to ensure adequate blood supply for healing
2. Check and address and factors delaying healing
3. Aggressively debride or excise wound of all non-viable tissue/bacterial burden/biofilm
4. Apply biological material

5. Cover with secondary dressing that will not allow external penetration of bacteria
6. Ensure dressing will not be disrupted
7. Avoid use on highly exudating wounds or wounds where excess fluid cannot be removed
8. Do not leave wound covered for more than one week with living cell products
9. With acellular products, keep secondary dressing dry and intact changing secondary dressing only as needed

Growth Factors

All growth factors are cytokines but not all cytokines are growth factors. Growth factors are polypeptide molecules which may act as chemical mediators affecting cellular activities including angiogenesis, cell migration, chemotaxis, proliferation and enzyme production. The may affect any number of activities in the wound repair process including cell growth, cell metabolism, cell differentiation or other tissue repair activities. Growth factors are often named according to their origin or their target cells. The name may not necessarily reflect the function of the growth factor.

Autologous growth factors are isolated by drawing a patient's blood and processing it in a manner that allows extraction and concentration of endogenous growth factors. The exact types and levels of growth factors in the realasate are not known, thus efficacy cannot be guaranteed. The presence of high protease

activity, infection and inflammation may all contribute to rapid degradation of the growth factors rendering them ineffective. Currently, only one growth factor, becaplermin (rhPDGF-BB) is approved for sale in the United States. The current indication is for plantar diabetic neuropathic ulcers with good vascular supply. It should be used as directed by the manufacturer. Currently, it is still unclear as to the exact influence of growth factors in nonhealing chromic wounds. It is also difficult to determine which growth factors are deficient, how much to apply, when to apply it and what the exact response will be. There is a high associated cost with use of growth factors.

Frequency

Daily for the currently approved US product. Generally applied daily or every other day.

Method of Application

1. Check for adequate blood supply for healing
2. Debride wound of all non-viable tissue/bacteria/biofilm
3. Apply growth factor as indicated in instructions for use
4. Cover with secondary dressing
5. Change daily or every two days

Electrical Stimulation

Electrical stimulation has been used for many years for the treatment of unresponsive wounds, particularly pressure ulcers. Despite numerous clinical trials, the role

and benefits of electrical stimulation for chronic wounds are still not clearly defined. This differs from the literature, which is more specific, for bone healing. Current studies vary in their results and have not been consistently reproducible. Despite the scarcity of support, electrical stimulation may still be considered for wounds that do not heal. It should be applied according the manufacturer's recommendations.

Hyperbaric Oxygen Therapy

Hyperbaric Oxygen therapy does have indications for select non healing wounds as well as many non-wound related treatments. Patients are placed in monoplace or multiplace chambers for an average of 1.5 hours five days a week for days to weeks depending on the indication. Topical oxygen deliver is not the same as hyperbaric chambers where atmospheric pressure may be 2.5 atm below sea level. The value of the treatment must be weighed against the cost. Patients may also have difficulty undergoing hyperbaric therapy for social, financial and psychological reasons.

Indications include

- Refractory osteomyelitis
- Wagner Grade 3 or 4 diabetic ulcers
- Patients with high risk for graft or flap failure
- Necrotizing fasciitis
- Patients at risk for limb loss with moderate occlusion (not complete blockage
- Patients should be referred to a hyperbaric center for evaluation

Ultrasound

The use of ultrasound has been purported to assist with wound healing through the stimulation of cells in the wound bed. Supposed benefits include:

- Stimulate cell activity
- Promote angiogenesis
- Decrease edema
- Decrease tissue induration
- Promote wound closure

Well-designed studies to support use are currently not available. When this treatment modality is selected, manufacturer's recommendations should be followed

Hydrotherapy

Soaking wounds and use of hydrotherapy baths for wound margin softening and debridement are no longer recommended, particularly for diabetic foot ulcers. Soaking may promote maceration which decreases tensile strength and supports bacterial invasion into deeper tissues. Poorly cleansed devices may also introduce new pathogens into an open wound.

Hydrosurgical Devices

Hyrdrosurgical tools are designed primarily for intra-operative use, to allow for excellent precisional wound

debridement. These devices allow a surgeon to adjust the power of the tool for varying degrees of debridement. Bacteria and non-viable tissue are suctioned away from the wound, allowing for removal of biofilm, superficial bacteria and necrotic tissue. These devices may also be used surgically to assist with tissue remodeling, debriding undermined wound margins, and expediting and facilitating wound closure. Hydrosurgical tools allow significantly greater accuracy and selective tissue removal than a standard surgical blade.

Stem Cell Therapy

Stem cell therapy is an actively researched area. Studies with chronic wounds have been performed with Bone Marrow Aspirate (BMA) and mesenchymel derived stem cells. Results are promising, but large randomized clinical trials have yet to be performed. BMA and Mesenchymel stem cells are suggested to expedite closure, however greater scientific support is still be awaited for chronic wound use.

Negative Pressure Wound Therapy (NPWT)

Negative pressure wound therapy (NPWT) is also known as Topical Negative Pressure (TNP) and refers to any system using negative pressure to promote wound closure.

NPWT is a non invasive technique by which negative pressure is delivered to a wound to promote healing. It is believed that it positively impacts on healing in a variety of ways, these include:

- Local reduction in oedema
- Removal of wound exudate (and all the constituents such as MMPs and bacteria)
- Stimulation of cell proliferation
- Alteration of blood flow at the wound edges
- Stimulation of angiogenesis
- Promotion of granulation tissue
- Provision of a closed, moist wound environment
- Contraction of wound edges
- Mechanical stimulation of the wound bed

It is also suggested that NPWT reduces the complexity / size of the wound, optimises the wound bed prior to and following surgery and reduces the complexity of surgical procedures, and has faster abdominal closure rates and earlier discharge from Intensive Care rates than other forms of temporary abdominal closure. More recently it has been suggested that single use NPWT may have a role to play in reduction of keloid scarring.

NPWT may be used in a wide range of wounds both acute and chronic. These include trauma, open abdomen, acute wound dehiscence, skin grafts, pressure ulcers, leg ulcers and diabetic foot ulcers.

NPWT is contra indicated in

- Malignancy
- Previously confirmed or untreated osteomyelitis
- Non enteric or unexplored fistulae
- The presence of necrotic tissue with eschar
- Use over exposed blood vessels, nerves or organs or exposed anastomotic sites

It has been suggested that the use of NPWT may be painful for some patients and may cause trauma to the surrounding skin on removal of the dressing, however a review by Upton and Andrews (2013) identified that pain is not always a problem and there are varying levels of pain reported depending on key treatment factors such as the system and the dressing/filler used. They also suggest that dressing and filler type may impact on whether trauma occurs.

How to use NPWT

There are a range of reusable NPWT devices available including the traditional systems (tNPWT) which tend to be larger and can operate from mains or batteries, smaller portable/battery powered devices without canisters and single-use options which can operate on batteries for up to 7 days of single use. The reusable systems have

several components: the interface material which can be foam or gauze, an occlusive drape which secures the interface in situ, tubing, a pump and, typically, a collection canister. The pumps may be used on intermittent or continuous suction and there is a range of pressure settings. An additional wound contact layer may be used to protect underlying structures such as tendons, and some clinicians do use fenestrated silver dressing if the wound is at high risk of or clinically infected.

Selecting a filler

Both gauze and foam appear to be equivalent with respect to wound healing. Clinical differences have been noticed in the quality of the granulation tissue produced; foam appears to give a thicker, looser granulation and gauze a dense and less thick tissue which is slightly paler. Foam appears to be used more in larger regular sized wound with gauze being much easier to use in wounds that have irregular shape, undermining or are small although gauze can also be useful in very large irregular wounds. Select NPWT manufacturers supply gauze that is already impregnated with polyhexamthylene biguanide (PHMB) therefore antimicrobial wound contact layers are less likely to be used. Foam should be used where a more dense hypertrophic granulation is required and scarring is less likely, such as sternotomy wounds or fasciotomy wounds in compartment syndrome where the splinting effect of the foam also encourages greater contraction. Gauze is popular prior to skin grafting, when cosmetics or joint mobility is important. The use in military trauma has mainly been with gauze due to its ease of application.

On occasions the granulation tissue may grow into foam (hence use of contact layers) however this has not been reported with the use of gauze.

Determining the pressure

The first NPWT manufacturers usually recommended using intermittent pressure, i.e. pressure being applied in a cyclical way, however no clinical benefits of this approach were noted and practically it caused increased pain, noise and sleep disturbance for patients therefore the most common treatment mode currently is to use the devices on continuous suction. Devices may be disconnected to facilitate other activities such as bathing or showering for up to a maximum of 2 hours. The recommended pressure setting varies according to the filler used and the wound and individual manufacturers' guidelines should always be consulted prior to use. Lower settings are usually used with the gauze fillers than the foam but there is little evidence to support the use of any particular pressure. Lower pressures are recommended in patients with reduced vascular supply or who are experiencing pain in the wound bed. A range of 60-120 mmHg has been suggested as adequate for attaining positive results.

Single use disposable systems

In the last 2 years very small single-use NPWT systems have become available. They do not require a canister to collect the exudate as it is drawn into a superabsorbent dressing and dispersed as vapour via the dressing's outer vapour permeable film layer. These devices usually last for

up to 7 days and are then replaced. They are starting to be used prophylactically to prevent wound breakdown in high risk surgeries such as:

- Cardiothoracic surgery
- Orthopaedic surgery
- Dehisced incision sites
- Lower extremity bypass
- Abdominal surgery

And with high risk patients including those with:

- Poor vascular status
- Hypertension
- Infection
- Potential post-operative swelling and oozing

Or patients who are

- Immunocompromised
- Smokers
- Diabetics
- Obese

Specialist Systems

As knowledge and expertise in the use of NPWT grows manufacturers are increasingly producing specialist versions of their systems for example for use intra abdominally or to allow instillation of fluids to allow delivery of topical treatment fluids across the wound surface. As their confidence with NPWT systems grow, clinicians continue to push the boundaries of practice

applying NPWT over large vessels and exposed organs such as the heart. And as more manufacturers enter the NPWT market, systems become increasingly complex and specialised with, for example, data capture and analysis systems.

Conclusion

Negative pressure wound therapy is a treatment option which when used appropriately demonstrates not only improved patient outcomes but also cost savings. Whilst Cochrane reviews still suggest that there is limited RCT evidence, hundreds of thousands of clinicians attest to seeing real clinical differences in incredibly complex patients. NPWT is a useful therapy when used sensibly and started and stopped at appropriate times for the phase of wound healing. Its use gives significant benefits not just in terms of healing but also in patient focussed factors including improving quality of life by managing exudate leakage and odour, reducing wound to manageable size, reducing the length of inpatient stay and often preventing the need for surgery.

Skin Tears

Treatment Objectives

The primary purpose is to treat superficial skin tears and prevent further damage of the skin:

- Protection
- Reepithelialization

Product

- Polyurethane films
- Petrolatum impregnated gauzes
- Non-adherent foams

Frequency of Use

May be left on from 3 to 7 days. Leave on as long possible to avoid further skin damage.

Application

- Gently cleanse affected area
- Debride any loose non-viable tissue. If tissue has been avulsed downwards and blood flow is compromised to skin, remove loose tissue.
- Select a film, foam or petrolatum dressing that extends 2 cm beyond the wound margin

- Use a gauze wrap or a hypoallergenic non aggressive tape to hold to skin
- Avoid too much tension or pressure on the skin
- Protect surrounding skin as needed with a skin sealant
- Products may be left on for up to 7 days. If using petrolatum dressings, change more frequently to avoid drying and adherence to skin
- If a dressing is stuck to the skin, moisten with a surfactant cleanser, sterile or saline until it is loose enough to remove without further skin damage

Radiation Wounds

This class of wounds is particularly difficult to treat as cells in the area may have been permanently damaged by radiation. Treatment objectives include

- Promoting reepithelialization
- Odor control
- Drainage control
- Pain control
- Decreasing risk of infection

Promoting Reepithelialization

Debridement of all non-viable tissue is very important. It may be difficult to extend the wound to bleeding margins, however this should be attempted only if there is no risk of extensively compromising extensive tissue or

underlying structures and organs. Methods to assist with granulation and reepithelialization include:

- Hydrogels
- Hyperbaric oxygen (consider expense and ability of patient to attend multiple sessions)
- Skin substitutes containing living cells
- Growth factors (observe contra-indications for malignancies-use only as indicated)
- Special ointment
- Acellular matrices

Malodorous Wounds

Certain radiation wounds may be malodorous due to on-gong disease. Various options to control odor are available.

- Dressings soaked in 1% metronidazole solution and changed 1 to 2 x per day
- Topical 0.75% metronidazole gel daily per package indications
- Activated charcoal dressings
- Odor absorbing foam dressings

Heavily Draining Wounds

- Slow absorbing foam dressings with high exudate retention and high moisture vapor transmission
- High absorbent pads changed 1-2 times daily.
- Consider negative pressure wound therapy

Pain Control

- Avoid frequent dressing changes
- Avoid adhesives directly to skin; use mesh nets when possible. Avoid tape on irradiated skin
- Use hydrogels on wounds with lower levels of drainage

Dehisced Surgical Wounds

Product selection for dehisced surgical wounds will vary depending on the size, location and bacterial burden of the wound.

Treatment Objectives Include

- Promoting granulation and reepithelialization
- Reapproximating wound margins when possible
- Reducing bacterial burden
- Preventing increase in wound size
- Preventing wound bed dessication

PRODUCTS

- Amorphous hydrogels
- Cadexomer iodine gel
- Alginate, collagen, cellulose and other fibrous dressings

- Negative pressure wound therapy
- Enzymes

Amorphous Gels

Frequency of Use

- Daily with hydrogels
- Every 1-2 days depending on exudate, with cadexomer iodine gels

Application

- Cleanse wound
- Remove any non-viable tissue
- Apply a thin layer into wound bed. If there is a deep cavity, a hydrogel may be applied with lightly packed hydrogel impregnated gauze
- Avoid cadexomer iodine in deep cavities, tunnels or where underlying structures cannot be visualize
- Cover with an non-adherent dressing and secure with hypoallergenic tape. Avoid frequent tape removal when tape is used

Calcium Alginates, Collagens, Collagen Alginates, Celluose, Hydrofiber and Fibrous Materials

Frequency of Use

Apply every 1-3 days depending on level of exudate. It is not recommended to go more than three days.

Application

- Cleanse wound with appropriate cleanser
- Remove non-viable tissue
- Apply skin sealant to surround skin as needed
- Cut dressing to size of the wound and place in wound bed
- Cover with an absorbent, non-adherent dressing
- If using tape, use hypoallergenic tape

Wound Dehiscence

Wound dehiscence is a complication of surgery where the wound reopens along the line of the incision. It can range in severity from a superficial separation of a small part of the wound to full thickness separation along the whole incision.

Abdominal wound dehiscence or 'burst abdomen' is a severe postoperative complication, with mortality rates reported as high as 45%. Its incidence is usually reported as from 0.2-3.5% although some studies report rates as high as 10%. Abdominal wound dehiscence resulting in evisceration is a surgical emergency, demanding immediate treatment. Alongside the high mortality associated with this complication, the significant morbidity highlighted by the resulting prolonged hospital stay, high incidence of incisional hernia and need for further surgical operations demonstrate the potential severity of this complication. During long term follow up of a cohort of patients who had undergone abdominal surgery those patients who have had an abdominal wound dehiscence have been shown to have lower scores for body image and QoL than age and sex matched controls from the same cohort.

The aetiology of wound dehiscence is multi-factorial. The consensus would seem to be that emergency surgery, age, smoking, surgical site infection, suture material

failure, poor surgical technique, obesity, anaemia, malnutrition, malignancy, corticosteroid use and previous chemotherapy or radiotherapy are all risk factors.

Despite advances in peri-operative care and suture materials the incidence of abdominal wound dehiscence and the associated mortality have remained largely unchanged over recent decades. It has been suggested that some of this may be due to the increased benefits from technological advances being outweighed by the increased risk factors within an ageing population [1]. If this hypothesis holds true then those patients with abdominal dehiscence are more likely to be managed conservatively as the risks for further surgery to manage their wound problems may well outweigh the perceived benefits. This is often a judgement made by the treating surgeon based on their own experience and perceptions of the problems associated with an acute abdominal wound.

Wound dehiscence is a surgical emergency and the opinion of the treating surgeon should be sort. The patient should be appropriately resuscitated and underlying risk factors should be controlled as far as possible, i.e. antibiotics should be given to treat or prevent surgical site infection (if possible tissue or pus samples should be sent to microbiology prior to starting antibiotics), tight glycaemic control established in the diabetic patient. Initially the wound and underlying contents should be protected whilst a decision is made about appropriate management. Essentially the options are for conservative management in which case the resultant wound will be allowed to heal via secondary intention, or for operative

management in which case the patient will be taken back to the operating room to have the wound debrided and a repeat primary closure performed. The operative approach can sometimes be delayed to allow the patient to be appropriately resuscitated and stabilised often in a critical care setting.

The aims of wound management in these patients should be initially to protect the underlying structures, prevent further infection and manage exudate from the wound. In the emergency setting this can be as simple as using damp gauze to pack the wound and an occlusive dressing. Longer term solutions include the use of wound management systems. If the wound is left to heal by secondary intention as well as protecting underlying structures, controlling any infection and managing exudate the aim of wound management should include encouragement of granulation tissue formation. Negative Pressure Wound Therapy is one way to achieve these goals. Caution should be exercised if considering the use of NPWT if the patient is at risk of or a fistula is suspected.

Fistula

A fistula can be defined as an abnormal connection between two structures lined with endothelium or epithelium. For example an enterocutaneous fistula is an abnormal connection between the lumen of the bowel and the surface of the skin and a colo-vesical fistula is a connection between the lumen of the colon and the bladder. Management of fistulae between the GI tract and the skin often involves wound care clinicians and

this chapter therefore focuses on the management of enterocutaneous fistulae, although many of the principles can be applied to the management of other types of fistula.

The goals of therapy for patients with enterocutaneous fistulae are to correct any metabolic or nutritional deficits, control infection and re-establish the continuity of the gastrointestinal tract. The principles of enterocutaneous fistula management can be summarised by the acronym SNAP:

- Control local or systemic sepsis and skin care
- Ensure adequate nutritional support for the patient
- Define the anatomy of the fistula
- Procedure to correct fistula

Some fistulas will close with conservative management by controlling sepsis and providing appropriate nutritional support to promote healing and restrict the amount of fluid passing through the fistula. However a surgeon with the appropriate skills should be involved in the patient's management in case operative intervention is required. The role of wound management in these patients is to aid in the controlling of local sepsis, protecting surrounding skin and managing the fistula output. Often the simplest way to do this is to use an ostomy bag. Due to the high risk of infection in these cases any procedure to repair the fistula often involves the laying open of fistula track to heal by secondary intention. In these cases the added aim of wound management is to promote granulation tissue formation.

A mucous fistula is a fistula created deliberately during an operation to control the distal remnants of the bowel after a bowel resection when it has not been possible or would have been inappropriate to form an anastomosis between the two ends of the bowel during the initial surgery (often emergency surgery). The two cut ends of the bowel are brought to the surface of the skin with a stoma being formed from the proximal end and mucous fistula formed from the distal end. It has the advantages of allowing any mucus to drain from this distal portion of bowel as well as making it easy to locate at a subsequent operation to reverse the stoma. Surgeons will often site a mucus fistula at one end of the surgical incision. When managing a mucus fistula healing is not an appropriate endpoint to aim for and clinicians should concentrate on managing any discharge and protecting the surrounding skin.

CLASSIFICATION/ DESCRIPTION	INDICATIONS	CONTRAINDICATIONS	ADVANTAGES & DISADVANTAGES	HELPFUL HINTS
Transparent Polyurethane Films - Transparent - Polyurethane film - Gas permeable - Moisture vapor permeable - Impermeable to bacteria and liquids - Adhesive	- Dry to minimally exudating wounds - Partial-thickness - Granular or necrotic ideal for softening eschar - Skin tears - May use over absorptive wound fillers or hydrogels on full-thickness wounds	- Infected wounds - Wounds with heavy exudate - Fragile surrounding skin	A: Protection - Autolysis (esp. eschar) - Allows visual assessment - Waterproof - Flexible - Pain reduction - Moist environment - Up to 7 day wear time D: Not absorptive - Excess drainage may cause maceration of surrounding skin - May strip fragile skin upon removal - May be difficult to apply	- Use a large enough dressing to cover at least one inch of surrounding skin - Application of skin sealant to surrounding skin improves seal - Change dressing when exudate leaks onto intact skin around the wound to avoid maceration

WOUND DRESSINGS

CLASSIFICATION/ DESCRIPTION	INDICATIONS	CONTRAINDICATIONS	ADVANTAGES & DISADVANTAGES	HELPFUL HINTS
<u>Hydrocolloids</u> - Wafer dressing that interacts with wound exudate to form a moist gel on wound bed - Impermeable to oxygen (occlusive) - Impermeable to bacteria - Adhesive	- Wounds with low to moderate exudate - Partial or full-thickness - Granular or necrotic - Pressure ulcers - Venous ulcers - May be used over absorptive wound fillers, alginates, or hydrogels depending on amount of drainage	- Infected wounds - Third degree burns - Diabetic ulcers - Arterial ulcers - Wounds with heavy exudate - Fragile surrounding skin	A: Protection - Autolysis - Waterproof - Flexible - Pain reduction - Moist environment - 3 to 7 day wear time - Insulates wound D: Odor - May strip fragile skin upon removal - Excess drainage can cause maceration of surrounding skin - Potential for sensitivity to adhesive	- Consider patch test to check for allergy to adhesive when using over venous ulcers - Cover at least one inch of surrounding skin for improved adhesion - Change the dressing before it leaks - for e.g., if it leaks on the 5th day, change it every 4 days - Educate families in advance of the odor and drainage associated with this product

WOUND DRESSINGS

CLASSIFICATION/ DESCRIPTION	INDICATIONS	CONTRAINDICATIONS	ADVANTAGES & DISADVANTAGES	HELPFUL HINTS
Foams - Polyurethane foam - Varying degrees of thickness and gas permeability - Adhesive and nonadhesive forms	- Wounds wit moderate to high exudate - Partial or full-thickness - Granular or necrotic - Pressure ulcers - Venous ulcers - Diabetic ulcers - Arterial ulcers - Infected wounds if changed daily - Can be used over hydrogels, absorptive wound fillers, or alginates	- Stage 1 wounds - Dry wounds - Fragile surrounding skin (adhesive foams)	A: Protection - Autolysis - Conformable - Moist environment - Insulates wound - May decrease excess granulation tissue - 4 to 7 day wear time D: Some foams require tape or another securing method - Adhesive foams may strip skin upon removal - Cavity foams may damage tissue if over packed	- Tape nonadhesive foams across dressing rather than picture framing with tape; this keeps the foam in contact with the wound - Cover at least one inch of surrounding skin - Most foams should be changed when strike through of drainage is within one inch of the edge – read package instructions

WOUND DRESSINGS

CLASSIFICATION/ DESCRIPTION	INDICATIONS	CONTRAINDICATIONS	ADVANTAGES & DISADVANTAGES	HELPFUL HINTS
Alginates - Naturally occurring polymer of seaweed - Gel formed when fibers interact with wound fluid - Pad or rope form - Absorbent	- Wounds with moderate to heavy exudate - Partial or full-thickness - Granular or necrotic - Pressure ulcers - Venous ulcers - Diabetic ulcers - Arterial ulcers - Used as a filler with other dressings - Infected wounds if changed daily	- Dry or low exudating wounds - Not recommended for third degree burns	A: Autolysis - Conformable - Moist environment - Nonadherent - Hemostatic - Pain reduction - Decreased frequenc of dressing changes - May stay in place for up to 7 days D: Requires secondary dressing - May dry out and adhere to wound, requiring saline soak to remove	- For very high draining wounds, cover with gauze or ABD pad and change when drainage strikes through to outside - May cover with foam, hydrocolloid, or film, depending on amount of exudate

WOUND DRESSINGS

CLASSIFICATION/ DESCRIPTION	INDICATIONS	CONTRAINDICATIONS	ADVANTAGES & DISADVANTAGES	HELPFUL HINTS
Absorptive wound Fillers - Sheets, ropes, pastes, granules, or powders that absorb exudate - Most are composed of starch copolymers	- Moderate to high exudate - Partial or full-thickness - Granular or necrotic - Pressure ulcers - Venous Ulcers - Diabetic ulcers - Arterial ulcers - Used as a filler with other dressings	- Dry wounds - Deep tunneling wounds or deep undermining	A: Autolysis - Conforming - Moist environment - Absorbs exudate - Pain reduction - No reinjury at removal - Up to 7 day wear time D: Requires secondary dressing	- Wounds should only be filled 1/3 to 1/2 full read product insert - Absorption capacity varies among fillers - read product insert

WOUND DRESSINGS

CLASSIFICATION/ DESCRIPTION	INDICATIONS	CONTRAINDICATIONS	ADVANTAGES & DISADVANTAGES	HELPFUL HINTS
Collagen-based products - Sheets, powders, particles, and ropes that absorb exudate, or gels that provide wound hydration - Products differ in collagen source (e.g. bovine vs. avian and molecular structure - Some products are 100% collagen, and others are combined with other products such as alginates or hydrogels - Purported actions include: -absorbence -hemostasis -chemotaxis -provision of matrix in wound for new cell ingrowth	- Granular or necrotic wounds - Partial or full-thickness - Pressure ulcers - Venous ulcers - Diabetic ulcers - Arterial ulcers - Utilize powders, particles, and pads for wounds with moderate to heavy exudate - Utilize gels for dry wounds	- Do not use absorptive form on dry wounds - Sensitivity to collagen source (bovine, porcine, or avian)	A: Autolysis - Conforming - Moist environment - High absorbency with all products except gels - Can be used on infected wounds if changed qd - Up to 7 day wear time depending on the amount of drainage D: Requires secondary dressing - Powders and particles may be difficult to apply	- An increase in drainage may be seen in the first few days of treatment - Wounds may appear larger in the first few days of treatment due to edema reduction - Some powders/particles may be mixed with saline to form a paste - Some products may expand so do not pack in tight areas - **Products differ between manufacturers; read product insert and talk to manufacturer prior to use

WOUND DRESSINGS

CLASSIFICATION/ DESCRIPTION	INDICATIONS	CONTRAINDICATIONS	ADVANTAGES & DISADVANTAGES	HELPFUL HINTS
<u>Hydrogels</u> - Sheets or amorphous gels that have 20% 90% water - Some have starch copolymers that absorb small amounts of exudate - Some products are dehydrated gels that offer more absorption - Nonadhesive - Gas permeable	- Dry to minimally exudating wounds - Partial-thickness: sheet gel - Full-thickness: amorphous gel - Granular or necrotic - Pressure ulcers - Diabetic ulcers - Arterial ulcers (do not moisten an arterial ulcer if no healing potential- leave dry) - Amorphous gels may be used on infected wound if changed qd	- Wounds with heavy exudate - Stage 1 wounds - Sheet hydrogels are not recommended on infected wounds	A: Autolysis - Conforms to wound bed - Moist environment - Nonadhesive - Pain reduction - No trauma upon removal D: Potential to macerate surrounding skin - May require secondary dressing - Some products may dehydrate in wound	- Saturate gauze pad with amorphous gel to pack into wounds with depth - Change dressing based on amount of drainage- if wound is drying out after one day, change qd; if wound is staying moist longer, change less often (if wound not infected) - Sheet hydrogels work well on skin tears - change only 1-2 times a week

WOUND DRESSINGS

CLASSIFICATION/ DESCRIPTION	INDICATIONS	CONTRAINDICATIONS	ADVANTAGES & DISADVANTAGES	HELPFUL HINTS
Antimicrobial Dressings Sheets, pastes, foams, films, or gauze dressings with nontoxic antimicrobials that maintain a moist environment (gauze product may dry out)	- Indicated to decrease colonization of microbes and reduce the risk of infection in partial- and full thickness wounds - Absorptive capacity varies among products	- Sensitivity to ingredients	A: Provides nontoxic alternative to antiseptics in patients at risk for infection - Broad-spectrum coverage - Reduces wound odor - Film dressings provide bacterial barrier D: Expensive - Some products require secondary dressing	Match dressing to exudate level

WOUND DRESSINGS

CLASSIFICATION/ DESCRIPTION	INDICATIONS	CONTRAINDICATIONS	ADVANTAGES & DISADVANTAGES	HELPFUL HINTS
Gauze - Linen fiber dressing - Some are woven, some are nonwoven	- Wounds with minimal to heavy exudate - Partial or full-thickness - Granular or necrotic - Pressure ulcers - Venous ulcers - Diabetic ulcers - Arterial ulcers - May be used on infected wounds - Use over topical antibiotics, growth factors, or enzymes	None	A: Universally available - Easy for caregiver to use - Ribbon gauze packs deep tunnels - Facilitates mechanical debridement D: Nonselective debridement - will har healthy tissue - Readily dries out wound - Must be kept continually moist with saline to provide moist wound healing - Usually requires multiple dressing changes per day - Cotton fibers left in wound may cause prolonged inflammation and may interfere with wound healing	- Avoid use of wet-to-dry dressings if possible because of pain and tissue damage upon removal - For continuously moist dressing, remove secondary dressing and reapply saline to packing every 4 - 6 hours - Use ribbon gauze for packing deep sinus tracts - Pack wounds lightly to prevent pressure on tissue

References

Chapter 2 | Assessment and Documentation

Bates B. *Guide to physical examination and history taking*. 11th ed. Philadelphia, Pa: Lippincott Williams & Wilkin;2012

Bergstrom KJ. Assessment and management of fungating wounds. *J WOCN* 2011;38:3137

da Costa Santos CM, de Mattos Pimenta CA, Nobre MR. A systematic review of topical treatments to control the odor of malignant fungating wounds. *J Pain Symptom Manage* 2010;39:1065-1076

Eklöf B, Rutherford RB, Bergan JJ, et al. Revision of the CEAP classification for chronic venous disorders: consensus statement. *J Vasc Surg* 2004;40:124801252

Hirsch AT, Haskal ZJ, Hertzer NR, Bakal CW, et al. ACC/AHA 2005 Practice

Guidelines for the management of patients with peripheral arterial disease (lower extremity, renal, mesenteric, and abdominal aortic): a collaborative report

Circulation 2006;113(11):e463-654

Seaman S. Management of malignant fungating wounds

in advanced cancer. *Semin Oncol Nurs* 2006;22:185–193

Lymphoedema Framework. Best Practice for the Management of Lymphoedema. International consensus. Lon: MEP Ltd, 2006.

American Cancer Society: Lawenda, B., Mondry, T. & Johnstone, P. (2009). Lymphedema: A primer on the indentifications and management of a chronic condition in oncologic treatment.

Zuther, J.E. & Norton, S. (2013). Lymphedema anagement: The Comprehensive Guide for Practitioners, 3rd edition. Thieme, New York

Chapter 3 | Infection

The use of topical antiseptic/antimicrobial agents in wound management. 2nd edition. Wounds UK, London, 2011

Gottrup, F., Apelqvist, J., Bjansholt, T. et al. EWMA Document: Antimicrobials and Non-healing Wounds—Evidence, Controversies and Suggestions. J Wound Care. 2013; 22 (5 Suppl.): S1–S92

International consensus. Appropriate use of silver dressings in wounds. An expert working group consensus. London: Wounds International, 2012.Available to download from: www.woundsinternational.com

Leaper DJ, Schultz G, Carville K, Fletcher J, Swanson T, Drake R (20012) . Extending the TIME concept: what have we learned in the past 10 years? International Wound Journal; 9 (Suppl. 2):1–19

Phillips PL, Wolcott RD, Fletcher J, Schultz GS(2010) Biofilms Made Easy Wounds International 1 (3)

Schultz G and Dowd R (2013) Wound infection and diagnostics in practice: What is emerging? Wounds International 4(1) 4 - 6

Vowden P, Vowden K and Carville K (2011) Antimicrobial dressings Made Easy Wounds International 2 (1)

World Union of Wound Healing Societies (WUWHS). Principles of best practice

Wound infection in clinical practice. An international consensus. London: MEP Ltd, 2008. Available from www.mepltd.co.uk

Chapter 6 | The Kennedy Terminal Ulcer

Charcot, JM, Lecture III, Disorders of Nutrition Consecutive on Lesions Of The Spinal Cord and Brain, 1877, p.76

Ford, D. Pressure Ulcer Named after Byron nurse who discovered it, People Northwest, Fort Wayne News Sentinental, Oct. 8, 1992

Kennedy, K., RN, CS, FNP. Gaymar Pictorial Guide To Pressure Ulcer Assessment, Gaymar Industries, Inc. 1997

Kennedy, K.L., RN, CS, FNP., The Prevalence of Pressure Ulcers In An Intermediate Care Facility, Decubitus, Vol.2, No. 2, May 1989, pp.44-45

Kozier, B., RN, MN, Erb, G, RN, BSN, Olivieri, RN, PHD, Fundamentals of Nursing, fourth edition, 1991, Addison –Wesley

Krasner, D.L., PhD., RN, CWOCN, CWS, FAAN, Rodeheaver, PhD., Sibbold, R.G., BSc, MD, FRCPC, MACP, DABD, Chronic Wound Care: A Clinical Source Book for Healthcare Professionals, Third Edition, 2001, Health Management Publications

Levin, JM, JAGS, 53: Lectures on Diseases of the Nervous System, 1877, 1248-1251

CMS Long Term Care Hospital Quality Reporting Program Manual: Chapter 3: Section M, p. M3

Skin Changes At Life's End (SCALE) Consensus Statement, October 1, 2009

Chapter 8 | Venous Ulcers

Hurley, J.P. "Chronic Venous Insufficiency: Venous Ulcers and Other Consequences", Chronic Wound Care, 2nd Edition, Edited by D. Krasner, Health Management Publications, King of Prussia, PA 1997

Chapter 10 | Malignant and Fungating Wounds

Bates B. Guide to physical examination and history taking. 11th ed. Philadelphia, Pa:

Lippincott Williams & Wilkin;2012

Bergstrom KJ. Assessment and management of fungating wounds. J WOCN 2011;38:3137

da Costa Santos CM, de Mattos Pimenta CA, Nobre MR. A systematic review of topical treatments to control the odor of malignant fungating wounds. J Pain Symptom Manage 2010;39:1065-1076

Eklöf B, Rutherford RB, Bergan JJ, et al. Revision of the CEAP classification for chronic venous disorders: consensus statement. J Vasc Surg 2004;40:124801252

Hirsch AT, Haskal ZJ, Hertzer NR, Bakal CW, et al. ACC/AHA 2005 Practice

Guidelines for the management of patients with peripheral arterial disease (lower extremity, renal, mesenteric, and abdominal aortic): a collaborative report

Circulation 2006;113(11):e463-654

Seaman S. Management of malignant fungating wounds in advanced cancer. Semin Oncol Nurs 2006;22:185–193

Chapter 12 | Negative Pressure Wound Therapy (NPWT)

Davis KE, Lafontaine J, Bills J, Noble D, Wight-Carter M, Oni G, Rohrich RJ, Lavery LA.(2013) The comparison of two negative-pressure wound therapy systems in a porcine model of wound healing. Wound Repair Regen. Aug 8. doi: 10.1111/wrr.12079. [Epub ahead of print]

Dowsett C, Lynn D, Henderson V and Searle R (2012) The economic benefits of negative pressure wound therapy in community based wound care in the NHS *International Wound Journal* Oct;9(5):544-52. doi: 10.1111/j.1742-481X.2011.00913.x. Epub 2012 Feb 9

Fraccalvieri. M, Sarno. A, Gasperini. S, Zingarelli. E, Fava R, Salmone M and Bruschi S (2012) Can single use Negative Pressure Wound Therapy be an alternative method to manage keloid scarring? A preliminary report of a clinical and ultrasound / colour – power – doppler study International Wound Journal 10 (3) 340 – 344

Kaplan M, Daly D, Stemkowski SEarly intervention of negative pressure wound therapy using Vacuum-Assisted Closure in trauma patients: impact on hospital length of stay and cost. Adv Skin Wound Care. 2009 Mar;22(3):128-32. doi: 10.1097/01.ASW.0000305451.71811.d5

Langer V, Bhandari PS, Rajagopalan S, Mukherjee MK.(2013) Negative pressure wound therapy as an adjunct in healing of chronic wounds. International Wound Journal. 2013 Jul 16. doi: 10.1111/iwj.12132. [Epub ahead of print]

Leaper DJ (2009) Editorial: Evidence based wound care in the UK International Wound Journal 6 (2) 89 - 91

Lindstedt S, Hansson J and Hlebowicz J (2012) the effect of negative wound pressure therapy on haemodynamics in a laprostomy wound model International Wound Journal 10 (3) 285 - 294

Malmasjo M and Borgquist O (2010) NPWT settings and dressing choices Made Easy Wounds International 1 (3)

Upton D, Andrews A.(2013) Pain and trauma in negative pressure wound therapy: a review. International Wound Journal. Mar 12. doi: 10.1111/iwj.12059. [Epub ahead of print]

World Union of Wound Healing Societies (2008) principles of best practice: vacuum assisted closure: recommendations for use. A consensus document. London. MEP Ltd

Chapter 14 | Wound Dehisence

Van Ramshorst, G.H., et al., Abdominal wound dehiscence in adults: development and validation of a risk model. World Journal of Surgery, 2010. 34(1): p. 20-7

Webster, C., et al., Prognostic models of abdominal wound dehiscence after laparotomy. The Journal of surgical research, 2003. 109(2): p. 130-7

Heller, L., S.L. Levin, and C.E. Butler, Management of abdominal wound dehiscence using vacuum assisted closure in patients with compromised healing. American journal of surgery, 2006. 191(2): p. 165-72

Carlson, M.A., Acute wound failure. Surgical Clinics of North America, 1997. 77(3): p. 607-636

Van Ramshorst, G.H., et al., Long-Term Outcome Study in Patients with Abdominal Wound Dehiscence: a Comparative Study on Quality of Life, Body Image, and Incisional Hernia. Journal of Gastrointestinal Surgery, 2013: p. 1-8

Spiliotis, J., et al., Wound dehiscence: is still a problem in the 21th century: a retrospective study. World journal of emergency surgery : WJES, 2009. 4: p. 12

Kaushal, M. and G.L. Carlson, Management of enterocutaneous fistulas. Clin Colon Rectal Surg, 2004. 17(2): p. 79-88

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