Leg Ulcer Assessment & Management
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(Please note, this is only a brief overview from the workshop and not every area of lower limb assessment or wound management for lower limbs is covered.)

Managing lower limb wounds is not always easy with many presenting complex challenges. It is vital for nurses to not only have an understanding of the anatomy and physiology of the body but the physiology of wound healing, factors affecting wound healing, good assessment and documentation skills. Together, these will enable not only the nurse, but the interdisciplinary team to enhance the outcomes of the wounds they manage.

To have a diagnosis through assessment and a goal for the management of a wound is vital. This management needs to planned in conjunction with the person with the wound to ensure compliancy and positive outcomes.

For the purpose of this workshop we have adapted Harding et.al (2007) model, using a systematic approach to clinically assess people with wounds; that lead to an identifiable plan for management and evaluation. The HEIDIE model includes

**History**
**Examination**
**Investigations**
**Diagnosis**
**Implementation**
**Evaluation**
So why look at the history? The history will give clues as to the aetiology of the wound as well as factors that may be of detriment to the healing process. It is important to document these factors and use them when planning care.

- **Medical**
  - Past History
  - Previous Ulceration etc.
  - Past Surgeries
  - Stoma
  - Previous DVT or PE

- **Current disease processes**
  - Cancer (radiotherapy)
  - Rheumatoid arthritis
  - Diabetes (Type I / Type II - medication or diet controlled)
  - Blood disorders
  - Renal Failure/ Transplant
  - Hypertension
  - Skin disorders (connective tissue)
  - Auto-immune disorders
  - Inflammatory bowel disease
  - Liver failure

- **Medication**
  - Current
  - Past
  - Steroids
  - Anti-inflammatory
  - Cytotoxic agents
  - Anti-rejection medications
  - Over the counter medications

- **Age**
  - Neonatal
  - Elderly

- **Pain**
  - Impacts on quality of life
  - Presence /heightened sensitivity with chronic wounds/ anticipatory pain
  - Description/ severity
  - Absence / neuropathy (DANGER)

- **Smoker**
  - Past
  - Present
  - Impairs tissue restoration / collagen
  - Nicotine has a vaso-constrictive effect
  - Increases risk of surgical wound infection
- **Body Mass Index**
  - Within range
  - Below range
  - Above range
  - Obesity

- **Dietary Intake**
  - Poor nutrition
  - Supplements
  - Water intake
  - Vegetarian

- **Mobility**
  - Independent
  - Impaired / altered gait (will alter pressure on feet)
  - Immobile
  - Aids – are the correct/ fit well

- **Neuropathy**
  - Sensory - loss of pain, pressure, temp awareness
  - Motor - atrophy & muscle weakness - deformities
  - Autonomic - excessive skin dryness, cracks

- **Claudication**
  - Distance can walk before pain onset
  - How long to rest before resuming walking
  - Description of pain – cramping – where?
  - Having to sit to relieve the pain may indicate back issues – spinal canal stenosis

- **Continence / Incontinence**

- **Hygiene**
  - Independent
  - Requires help/ services

- **Sleep patterns**
  - Waking with rest pain – hang leg over the edge of the bed to relieve pain
  - Breathing difficulties – sleeping in a chair

- **Social situation and occupation**
  - Stands/ sits for long periods of time

- **Family history**
  - History of varicose veins
  - History of lymphoedema

- **How wound occurred**
  - Trauma
  - Spontaneously

- **How long the wound has been there**

- **Condition – improving /deteriorating**

- **Factors that aggravate or alleviate the symptoms - examples are**
  - Leg in dependent position will help someone with arterial disease
  - Those with venous disease will find it more comfortable to have leg elevated
Examination

So why examine? It is important to get an overall picture of what may have caused the wound as well as other factors that may inhibit wound healing. Often it is the not so obvious factors that may cause a problem; therefore a quick examination is beneficial with the persons consent.

Impaired circulation or underlying vascular disease is often contributing factors to leg or foot ulcers. It is therefore important to examine both legs and feet, noting the differences between the two.

- Buerger’s test
  - A non invasive test to identify arterial insufficiency in a limb
  - Lift and support persons leg 30o to 45o for 2 minutes while sitting or laying (monitor colour)
  - Then, place the limb in dependent position (on floor or over side of bed)
  - Rapid pallor upon raising leg demonstrates poor arterial supply – the leg should remain a healthy colour
  - In dependent position the leg without arterial insufficiency will continue normal healthy colour
  - If significant arterial disease present the foot will turn to a bright red colour (reactive hyperaemia) as a result of blood pooling in arterioles
• Pulses
  o Femoral
  o Popliteal
  o Dorsalis Pedis (12% population do not have one anatomically)
  o Posterior Tibial

Posterior Tibial Artery

Dorsalis Pedis Artery

• Skin (include the skin to the whole body)
  o Texture
  o Colour
  o Pigmentation/haemosiderin staining
  o Bruising
  o Transparency
  o Oedema
  o Eczema/dermatitis
  o Welts
  o Chaffing

• Signs of malnutrition

• Impaired circulation
  • capillary refill
  • hair loss on affected extremity
  • thin, smooth, shiny skin
  • thick, brittle nails
  • tapering of fingers or toes
  • skin breakdown, possibly traumatic, ulceration, gangrene
Foot Deformity Score (1 point for each)
- Small muscle wasting
- Charcot foot deformity
- Bony prominence
- Prominent metatarsal heads
- Hammer or claw toes
- Limited joint mobility

- Ulceration / wound
  - Location
  - Dimensions
  - Depth
  - Surrounding skin
  - Other involvements – bone/tendon

Usual locations of ulcers in the diabetic foot. Ulceration is particularly likely to occur over the dorsal portion of the toes and on the plantar aspect of the metatarsal heads and the heel.

Using the TIME acronym can also be helpful at this point to aid in assessment of:

T  Tissue
I  Inflammation / Infection
M  Moisture balance
E  Edge of the wound advancement or not / Surrounding skin

- Tissue
  - Necrosis – wet/dry
  - Slough – wet/dry
  - Infected
  - Granulation
  - Hypergranulation
  - Epithelialisation
• Inflammation / Infection
  o When the bacteria colonisation in and around the wound site rises to a critical level it leads to tissue destruction and invasion accompanied by local or systemic symptoms. Wound infection prolongs the inflammatory stage
  o Most chronic wounds are colonised with high levels of bacteria, it is only when the host is compromised that a problem arises.
  o Infection leads to
    ▪ Wound breakdown / delayed healing
    ▪ Increased levels of exudate / seopurulent / haemopurulent
    ▪ Pus / abscess
    ▪ Increased / unexpected pain / tenderness (diabetics may not feel this)
    ▪ Oedema / Swelling Heat/ Increase in local skin temperature
    ▪ Erythema (may not be an indication in diabetics)/ cellulitis
    ▪ Discolouration of wound bed / tissue
    ▪ Malodour
    ▪ Elevated blood glucose levels in diabetic patients

• Moisture
  o Moist wound healing the goal
  o Important to get a balance
  o Excessive moisture is detrimental to wound healing an causes maceration and further damage to the peri-wound
  o Dry wounds also do not heel well

• Edge of the wound advancing or not
  o Documentation vital – history, tracings, photo’s (consent)
  o Examine the wound edges – edges that are rolled inward in a chronic wound indicate that the body thinks that the wound has healed – will require debridement to make it an acute wound again
  o Look at the peri wound skin

![Image of ulcer edge types](image)

**Figure 1.15** The varieties of ulcer edge.
Investigations

Further investigations may or may not be required in aiding in obtaining a diagnosis

- Blood Test
  - Complete blood count
  - Chemistries

- Wound Swab
  - Clean the wound first to remove any surface contamination
  - Moisten with normal saline prior to swabbing
  - Use the Levine technique – rotate swab over 1cm² area with enough pressure to express wound fluid from within the tissue – gives a more accurate account of bioburden rather than surface contamination
  - Put as much information as possible on the request form
  
  http://www.woundsinternational.com/practice-development/ten-top-tips-for-taking-a-wound-swab/page-4

- Biopsy

- Tuning fork - vibration

- Monofilament

- Neuropathy Disability Score
  - Pinprick sensation-sharp/blunt
  - Vibration perception
  - Temperature perception
  - Ankle reflexes


Nylon monofilament test. There is a risk of ulcer formation if the patient is unable to feel the monofilament when it is pressed against the foot with just enough pressure to bend the filament. The patient is asked to say "yes" each time he or she feels the filament. Failure to feel the filament at four of 10 sites is 97 percent sensitive and 83 percent specific for identifying loss of protective sensation.

  http://www.aafp.org/afp/980315ap/armstron.html
**Ankle Brachial Pressure Index (ABPI)**

It is important that the results of an ABPI test be interpreted with the full understanding of existing underlying co-morbidities, which may influence not only the disease process but which may potentially introduce errors in the measurement process itself. It should also be understood that ABPI assessment is an investigative tool for the arterial circulation of the lower limbs and does not, in its self, shed any light as to the over all status of the venous system.

The ankle/brachial pressure index (ABPI) is the ratio of pedal artery pressure divided by the brachial pressure and is a very useful non-invasive test for assessing the arterial circulation in the lower limbs. Under normal conditions and with the patient supine, systolic blood pressure in the legs is equal to or slightly greater than the systolic pressure in the upper limbs.

In the presence of an arterial stenosis, a reduction in pressure occurs distal to the lesion. The ankle brachial pressure index, which is calculated from the ratio of ankle to brachial systolic pressure, is a sensitive marker of arterial insufficiency.

Both brachial pressures are measured and the highest is use as the common denominator in the ABPI equation. The dorsalis pedis and posterior tibial artery pressure in both feet are measured and the respective ABPI’s calculated.

For diagnostic purposes, the highest ABPI of each limb may be used as an indicator of overall perfusion of that limb. ABPI’s of $\geq 0.96$ and $<1.3$ are in the normal range where the probability of significant arterial disease is low. Patients with ABPI less than 0.96 may exhibit symptoms of arterial occlusive disease such as intermittent claudication with exercise and these symptoms will get worse as the ABPI fall further.

Patients with claudication tend to have ankle brachial pressure indexes in the range 0.5 - 0.96, where as those with critical ischaemia usually have an index of $<0.5$. The ABPI also has prognostic significance because of the association with arterial disease elsewhere especially coronary heart disease (Arnand & Arnand 2005).

Along with the ankle/brachial pressure index, a thorough assessment is vital. This includes noting the presence or absence of

- Intermittent claudication- talk to the patient about the distance they are able to walk before experiencing cramps and ceasing walking
- Lower extremity pulses
- Skin temperature
- Skin changes
- Ulceration
**Procedure – Ankle Brachial Pressure Index**

1. *Explain the procedure to the patient and obtain consent for the procedure*
   
   It is important that the patient is comfortable with the concept of the procedure so that they feel relaxed and prepared.

2. *Prepare bed and work area and wash hands – adhere to OH&S principles*

3. *Prepare patient - lie patient supine and rest*
   
   Prior to the Doppler assessment it is important that the patient rest for 15-20 minutes to reduce the effects of exercise on the blood pressure (*Hislop, 1996*).

   At the time of the assessment, lay the patient in the supine position with the head elevated at approximately 20-30 degrees to reduce postural changes in blood pressure (*Stubbings, 1996*). Place the arms and legs at the same level as the heart to reduce errors in pressure measurement due to gravity.

   Footwear, socks, stockings or any bandaging should be removed.

4. *If the patient is unable to lay flat*
   
   If the patient is unable to lie flat (such as with heart failure, COPD); it may be possible to raise the legs and lower the arms so that the feet and wrists are at the same level and measure the radial/ulnar pressure in place of the brachial pressures.

   Avoid calculating ABPI values when measurements are made with the patient sitting or standing as variations in pressure due to gravity will negate the value of the test as pressure comparisons will be invalid.

5. *Choose the probe*
   
   Generally an 8mmHz is used to detect most peripheral pulses. In the case of increased oedema, a 4mm Hz may be more helpful.

6. *Apply blood pressure cuff*
   
   This should be applied on the upper arm when taking a systolic brachial or radial reading or the distal leg (gaiter region) when taking a systolic pressures of the dorsalis pedis pulse or a posterior tibial arteries.

   The cuff should be long enough to ensure that 80% of the circumferences of the upper arm or ankle can be covered by the bladder of the cuff, and that the width of the cuff is at least 40% of the limb circumference. The systolic pressure will be over-estimated if the bladder of the cuff is too short or too narrow (*Anderson 2007*).
7. **Apply ultrasound gel to skin**

Ultrasound gel is applied to the patient’s skin to allow for efficient transmission of the emitted and reflected ultrasound beams. Ultrasonic gel should be used to fill in the gap between the probe and skin for the ultrasonic sound transmission. Ensure that the correct type of gel is used to ensure an effective transmission and prevent probe erosion.

8. **Place probe in correct position**

Place the probe on the measurement area and move it slowly to locate the point where the Doppler sounds are at the maximum. The probe should be placed at an angle of approximately 45° to 60° to the vessel without pressure. Please note the best sound is the best angle.

9. **Inflate arm cuff and record systolic pressures of bilateral arms**

A blood pressure cuff is placed on the arm and a brachial/radial systolic reading is measured. Ensure that a pulse is audible. The cuff is then inflated to 20-30 mmHg higher than the last beat heard to ensure complete compression (Huntleigh Diagnostic, 1996) and deflated slowly. A reading is obtained when the first arterial sound returns (only a systolic pressure is required). Repeat the process for the other arm.

It is important to take a reading from both arms with the highest reading documented and used for the ABI calculation. Brachial systolic pressure can vary between limbs; however a difference of greater than 15mm Hg suggests underlying arterial arch or upper limb arterial disease. **Notify Medical Officer.**
10. **Inflate leg cuff and record systolic pressures**

The cuff is then placed above the malleoli in the gaiter region. If there is an ulcer present, clear kitchen grade flim should be placed around the ulcer to prevent cross infection from the cuff (Anderson 2007).

Pulses may be palpated prior to placing probe. A reading is obtained in the same way that the brachial/radial reading is obtained. The dorsalis pedis and posterior tibial artery pressures are measured from both legs and recorded.

The higher of the readings for either the posterior tibial or dorsalis pedis are used to calculate the ABI with the highest brachial/radial pressure obtained.

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It is important to avoid repeatedly inflating the cuff for long periods of time as this will lead to a decline in pressure and false readings. It is recommended that there is a 1 minute interval between inflations to reduce the risk of reactive hyperaemia.

In patients with diabetes and heavily calcified vessels the arteries are often incompressible. This results in artificially elevated results and underestimation of the severity of disease (Sacks et.al 2003).

If you find that you pump the cuff to high levels such as over 220mmHg and there is no compression of the vessel, this must be documented; and is considered an incompressible vessel. It is important to then move on to toe pressures in order to reflect perfusion (Sacks et.al. 2003).

Many patients are unable to tolerate high compression of the cuff, especially those with painful ulceration. This must also be documented in order to interpret the results accurately.
11. **Calculate ABI**

The ABI is calculated by dividing the highest documented systolic foot pressure on each leg by the highest systolic arm pressure as follows:

\[
\text{Ankle Brachial Pressure Index (ABPI)} = \frac{\text{Highest Foot Pressure}}{\text{Highest Arm Pressure}}
\]

12. **Clean equipment with an Alcohol Wipe or Tuffy Wipe™**

13. **Ensure appropriate documentation**

All results are documented appropriately.

When documenting it is important to gather as much information from the patient as possible such as:

- Claudication distance
- Disease processes such as diabetes, rheumatoid arthritis
- Medications
- Oedema
- Ulceration
- Smoking
- Any lower limb procedures (stents, bypass)
- Rest pain

<table>
<thead>
<tr>
<th>Normal</th>
<th>Reduced</th>
<th>Ischaemia</th>
<th>Incompressible</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9 – 1.2</td>
<td>0.5 – 0.9</td>
<td>&lt; 0.5</td>
<td>&gt; 1.3</td>
</tr>
</tbody>
</table>

**Important to Note**: Calcification of the arterial wall prevents accurate pressure measurements.

- ABI may be artificially elevated in people with – Diabetes, Chronic Renal Failure (CRF) and Rheumatoid Arthritis.
**False Readings**

False readings may result from the following circumstances:

- **Excessive Oedema**: vessels are difficult to compress when there is excessive oedema present in the surrounding tissue, leading to falsely elevated readings.

- **Co-morbid conditions**: patients with rheumatoid arthritis, severe atherosclerosis, renal disease, diabetes.

- **Calcification**: often seen in diabetics, renal dialysis, renal transplant and patients on extended corticosteroids. The distal arteries may be calcified and uncompressible giving a false high reading.

- **Incorrect cuff size**: an appropriate sized cuff should be used, one that is 20% larger than the limb. A higher than true reading will be obtained if the cuff is too small.

- **Cuff inflation and deflation**: ensure cuff is inflated to 20-30 mmHg beyond the last arterial signal to ensure complete compression is obtained. Deflate the cuff at 2-4mmHg/sec. Rapid deflation can cause the highest pressure to be missed and a reading error recorded.

- **Incorrect pressure of probe**: increased pressure at the probe site will distort, reduce or obliterate the flow resulting in false readings and distorted results.

- **Temperature**: The ambient temperature of the test environment will effect the autoregulation of the skin circulation. Warm environments cause vasodilation and may result in a fall of distal pressure whereas cool environments leading to vasoconstriction and may lead to possible distal pressure elevation.

- **Brachial/radial pressure**: both brachial/radial pressures should be obtained. Be aware of large differences between both arms. A difference of >10 mmHg may indicate arterial occlusive disease and 20 mmHg may indicate proximal arterial occlusion on the side of lower pressure.

* (Iannos, 1998; Cantwell-Gab, 1996)
# Actions to Ensure Correct ABI Readings are Obtained

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Action</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resting</td>
<td>Ensure patient is relaxed and comfortable</td>
<td>Reduces effect of previous exercise on BP</td>
</tr>
<tr>
<td></td>
<td>Explain procedure to patient and gain consent</td>
<td>Reduces possible effects of stress on BP</td>
</tr>
<tr>
<td>Position</td>
<td>Lay the patient flat for approx 15-20 mins with legs at same level as heart</td>
<td>Lying flat reduces postural changes in BP (Stubbings 1996)</td>
</tr>
<tr>
<td></td>
<td>If unable to lay flat try placing wrist and leg at same level</td>
<td></td>
</tr>
<tr>
<td>Arms</td>
<td>Place appropriate sized cuff around upper arm</td>
<td>Inappropriate cuff size will give false results</td>
</tr>
<tr>
<td></td>
<td>Locate brachial/radial pulse by palpating and apply U/S gel</td>
<td>U/S gel must be used – air is a poor conductor of U/S. KY gel is poor conductor and may damage probe</td>
</tr>
<tr>
<td></td>
<td>Hold gently over pulse and 45 degree angle - locate best signal</td>
<td>Too much pressure from probe will distort or obliterate signal – to ensure optimal signal is maintained throughout cuff inflation – probe angle other than at 45 degree will result in poor quality signal</td>
</tr>
<tr>
<td></td>
<td>Inflate cuff until signal disappears – then deflate cuff slowly</td>
<td>Slowly deflating the cuff ensures accurate measurement</td>
</tr>
<tr>
<td></td>
<td>Record measurement when signal first returns (systolic only) Repeat procedure for other arm</td>
<td>A significant difference in the systolic pressure of each arm is suggestive of occlusive disease</td>
</tr>
<tr>
<td></td>
<td>Use highest systolic reading</td>
<td>Highest recorded pressure is taken as the numerator in ABI</td>
</tr>
<tr>
<td>Legs</td>
<td>Place appropriate size cuff around ankle and if ulcer present – protect with either kitchen grade film (glad wrap) or thin dressing</td>
<td>Saves ulcer and cuff from contamination</td>
</tr>
<tr>
<td></td>
<td>Locate dorsalis pedis using palpation or Doppler and U/S gel. Continue as per arm pressure.</td>
<td>Warn patient they may feel discomfort</td>
</tr>
<tr>
<td></td>
<td>Record first signal when returns and repeat for posterior tibial. Repeat procedure on other leg</td>
<td>Dorsalis pedis is congenitally absent in approx 10% of population</td>
</tr>
<tr>
<td></td>
<td>The highest ankle pressure of each leg is used to calculate the ABI</td>
<td>The pressure recorded is that required to occlude the artery at the level of the cuff and not the site of the probe</td>
</tr>
</tbody>
</table>

*(Hislop, 1997)*
**TOE PRESSURES**

Toe pressures are an important diagnostic tool in people with atherosclerotic or calcified vessels who have abnormally high values or who may have incompressible vessels.

Calcification of the artery wall is common in patients with diabetes, rheumatoid arthritis, renal transplant, renal dialysis and in patients that have had extended use of corticosteroids. The incidence of calcification of the digital arteries is less than that of the tibial arteries. By using a photoplethysmograph (PPG) set to detect arterial blood flow in the skin and combined with a digit pressure cuff, digital arterial pressures can be measured in a similar way to that of the pedal arteries.

The waveform morphology recorded from the digital arteries is influenced in the same way as that of the Doppler waveforms in the pedal arteries and hence are indicative of the perfusion status of the lower limb. An arterial PPG is also used to predict the likelihood of healing when ulceration is present in patients with calcified vessels. (Bonham, 2003).

The PPG works via the detection of changes to skin blood volumes during the cardiac cycle. This is done by two diodes located on the PPG probe, one of which emits light (infrared) that penetrates a small distance into the skin and the other diode receives the light reflected from the red blood cell within the small vessels in the skin.

The amount of light that gets back to the receiving diode is proportional to the volume of blood in the vessels directly below the PPG probe. By setting the PPG instrument to detect rapid changes in blood volume as would happened from beat to beat of the heart, we can record a waveform corresponding to this and use this wave form to measure pressure after digital artery compression in the same way as we do for pedal assessment of pressure.
Procedure – Toe Pressure

*Explain the procedure to the patient and obtain consent for the procedure.*

It is important that the patient is comfortable with the concept of the procedure so that they feel relaxed and prepared

1. **Prepare bed and work area and wash hands – adhere to OH&S principles.**
   
   Ensure the room temperature is comfortable and the skin surface of the lower limb is warm. Cold constricts superficial blood vessels and jeopardize the accuracy of the results

2. **Prepare patient - lay patient supine and rest**

   It saves time to follow the ABI with bilateral toe pressures. Ensure the patient is in the supine position with the head elevated at approximately 20-30 degrees to reduce postural changes in blood pressure *(Stubbings, 1996).*

   Footwear, socks, stockings or any bandaging should be removed

3. **Apply cuff around toe**

   A 2.5cm width cuff attached to a sphygmometer is carefully applied to the great toe if possible. If too painful, ulcerated or has previously been amputated, the next largest toe is used.

4. **Use PPG Probe**

   The Hadeco Smartdop 45 comes with a probe specifically designed to take toe pressures. This probe has a small round oximeter attached. Ensure the probe for ABI is removed carefully and the PPG probe is attached gently and correctly into position so as not to bend the pins. Ensure the circle on the probe pins is at the top.
5. **Apply double sided tape**
   
   With the cuff in place, double sided tape is used to secure the PPG probe to the toe. Probe must be secure and touching all skin surfaces to ensure a complete seal and light does not interfere with the signal.

6. **Turn PPG on and run wave form**
   
   Turn on the PPG and run until a wave form is evident on the screen. If perfusion is poor, the waveform will be damped and if the circulation to the lower limb / toe is severely restricted, there may be insufficient amplitude in the PPG waveform to accurately measure toe pressures. If this is the case it must be documented as such in the documentation data sheet.

7. **Inflate Cuff**
   
   Once a uniformed wave is present on the screen, inflate the cuff to 300mmHg. You will then note on the screen a flat line; indicating that perfusion to the toe has been interrupted.

8. **Deflate Cuff**
   
   Slowly deflate the cuff with a steady uninterrupted motion – this will allow you to watch the screen to identify when the systolic pressure comes in at the beginning of a uniformed waveform.

9. **Document**
   
   Document the systolic pressure reading with a description of the wave or a segmental print – you may freeze and print by pushing the button on the side of the probe – a 5 second freeze frame will print.

   This is an absolute toe pressures - a systolic reading.

Some studies and literature break this down further to gain a Toe Pressure Brachial Index. The highest arm reading is used to make the calculation.

   \[
   \text{Toe Pressure Brachial Index (TPBI)} = \frac{\text{Systolic Toe Pressure}}{\text{Highest Arm Pressure}}
   \]

10. **Clean equipment with an Alcohol Wipe or Tuffy Wipe™**
**Absolute Toe Pressure Results**

<table>
<thead>
<tr>
<th></th>
<th>Non Diabetic</th>
<th>Diabetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unlikely to heal</td>
<td>&lt;30mmHg</td>
<td>&lt;40mmHg</td>
</tr>
<tr>
<td>Moderate likelihood of healing</td>
<td>40-60mmHg</td>
<td>40-60mmHg</td>
</tr>
<tr>
<td>Should heal</td>
<td>&gt;60mmHg</td>
<td>&gt;60mmHg</td>
</tr>
</tbody>
</table>

![Normal waveform](image1.png)

![Abnormal irregular waveform](image2.png)
### Actions to Ensure Correct Toe Pressure Readings are Obtained

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<tr>
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<th>Rationale</th>
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</thead>
<tbody>
<tr>
<td><strong>Resting</strong></td>
<td>Ensure patient is relaxed, comfortable and warm</td>
<td>Reduces effect of previous exercise</td>
</tr>
<tr>
<td></td>
<td>Explain procedure to patient and gain consent</td>
<td>Correct body temperature reduces risk of invalid results of cold toes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduces possible effects of stress on patient</td>
</tr>
<tr>
<td><strong>Position</strong></td>
<td>Use same position as ABI</td>
<td>This ensures patient is rested and is easier for patient and nurse</td>
</tr>
<tr>
<td></td>
<td>Continue toe pressures following ABI</td>
<td></td>
</tr>
<tr>
<td><strong>Toes</strong></td>
<td>Place appropriate size cuff (2.5cm) around great toe if possible - if ulcer or amputation of toe present it may not be possible</td>
<td>Warn patient they may feel discomfort when the cuff is inflated</td>
</tr>
<tr>
<td></td>
<td>May try next digit if ulceration, size and/or clawing permits</td>
<td>Amputation, pain or biomechanical changes may not permit access to toes</td>
</tr>
<tr>
<td></td>
<td>Use double sided tape to attach oximetry to toe – lights to toes – ensure tight seal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Run wave form until an even wave form is present</td>
<td>This enables the equipment to pick up the red blood cell action in the capillaries</td>
</tr>
<tr>
<td></td>
<td>Press orange button on sphygmometer and then pump ball with one hand action</td>
<td>This gives the base line wave form</td>
</tr>
<tr>
<td></td>
<td>Look at the wave form on the doppler machine – will give a straight line</td>
<td>This allows for full inflation of the toe cuff to 300mmHg – If does not inflate properly, may indicate a leak or hole in the cuff</td>
</tr>
<tr>
<td></td>
<td>With a sweeping, controlled motion deflate the cuff until the base line wave form returns</td>
<td>This indicates that the blood supply to the toe has been altered</td>
</tr>
<tr>
<td></td>
<td>Record first signal when returns</td>
<td>This ensures accuracy with little error – letting the cuff down in start stop motions will give errors in readings</td>
</tr>
</tbody>
</table>
Other Investigations of Vascular Tree

<table>
<thead>
<tr>
<th>Modality</th>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duplex U/S</td>
<td>✓ Non-invasive</td>
<td>✗ Difficulties with calcium and adipose tissue</td>
</tr>
<tr>
<td>Venous</td>
<td>✓ Inexpensive</td>
<td>✗ Operator dependent</td>
</tr>
<tr>
<td>Arterial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MRA</td>
<td>✓ Non-invasive</td>
<td>✗ Contraindications</td>
</tr>
<tr>
<td></td>
<td>✓ Non-toxic</td>
<td>✗ May “overcall” stenosis</td>
</tr>
<tr>
<td></td>
<td>✓ Moderate cost</td>
<td></td>
</tr>
<tr>
<td>CTA</td>
<td>✓ Non-invasive</td>
<td>✗ Contrast load</td>
</tr>
<tr>
<td></td>
<td>✓ Fast</td>
<td>✗ Difficulties with calcified vessels</td>
</tr>
<tr>
<td></td>
<td>✓ Moderate cost</td>
<td></td>
</tr>
<tr>
<td>DSA</td>
<td>✓ Excellent definition</td>
<td>✗ Invasive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>✗ Contrast load</td>
</tr>
<tr>
<td></td>
<td></td>
<td>✗ expensive</td>
</tr>
</tbody>
</table>

- Angiography
  - Local anaesthetic
  - Catheter inserted in groin under X-ray guidance
  - Dye injected to reveal disease, narrowing of arteries and stenosis

  - Complications
    - Bleeding from the puncture site
    - Haematoma of groin
    - Migration of closure devise
    - False aneurysm
Getting the correct diagnosis is vital. This will ensure that the correct treatment is put into place. Below are only a few examples

- **Leg / Foot Ulcers**

<table>
<thead>
<tr>
<th>Type</th>
<th>VENOUS</th>
<th>ARTERIAL</th>
<th>NEUROPATHIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Gaiter region, lower calf</td>
<td>Pressure areas, toes, 1st – 5th MTP joints, heel, malleoli</td>
<td>Pressure areas of the foot including plantar</td>
</tr>
<tr>
<td>Swelling</td>
<td>Yes</td>
<td>Not usually</td>
<td>Not usually</td>
</tr>
<tr>
<td>Pain</td>
<td>Less common than arterial</td>
<td>Yes – except if also neuropathic</td>
<td>No</td>
</tr>
<tr>
<td>History</td>
<td>Often recurrent DVT/varicose veins likely</td>
<td>May have claudication or rest pain</td>
<td>Diabetes alcohol, spinal pathology</td>
</tr>
<tr>
<td>Associated features</td>
<td>Venous skin change, lipodermatosclerosis</td>
<td>+/- gangrene</td>
<td></td>
</tr>
<tr>
<td>Skin around ulcer</td>
<td>Stasis dermatitis, pigmentation</td>
<td>Atrophic, may be inflamed</td>
<td>Callous</td>
</tr>
<tr>
<td>Presence of pulses</td>
<td>Yes but may be difficult to feel - oedema</td>
<td>No/ reduced</td>
<td>Yes/ reduced</td>
</tr>
<tr>
<td>Investigations</td>
<td>? nil, ? venous duplex, ABPI – exclude arterial</td>
<td>Ankle Brachial Pressure Index (usually &lt;0.6), Toe Pressures if diabetic</td>
<td>Exclude arterial ABPI, Toe Pressures TCO2</td>
</tr>
<tr>
<td>Management</td>
<td>Compression, ? fix isolated superficial vein incompetence</td>
<td>Revascularise if possible or necessary</td>
<td>Pressure relief / podiatry / orthotics</td>
</tr>
<tr>
<td>Comments</td>
<td>• Vasculitic ulcers - exclude above causes, may need biopsy</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Malignant ulcers - biopsy suspicious ulcers or if not responding as expected</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Combination of above aetiologies common</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Intervention

Individually tailor management with the person with a wound. Ensure that they are happy with the plan and that they are actually physically and psychologically able to cope with the treatment. This will ensure compliancy and good outcomes.

1. Arterial

**Peripheral Arterial Disease**

<table>
<thead>
<tr>
<th>Asymptomatic</th>
<th>Symptomatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermittent claudication</td>
<td>Critical limb ischaemia</td>
</tr>
</tbody>
</table>
  * Pain, ache, cramp, fatigue on exertion
  * Symptoms relieved by rest

**Pathological progression to atherothrombosis**

- Normal
- Fatty streak
- Atherosclerotic plaque
- Unstable plaque
- Clot formation

- Clinically silent
- PAD
- TIA, Angina
- PAD
- Ischaemic stroke, myocardial infarction


- Requires interdisciplinary approach
- Pain control
- ? Revascularise
- Keep dry and non infected until revascularised – NEVER DEBRIDE WHEN VASCULAR SUPPLY IS COMPROMISED
- Offload pressure
- Medication management – antiplatelets, statins (smooth vessel wall), antihypertensives, diabetic control
- Risk factor management
  - Hypertension \( \leq 140/85 \) mm Hg (no diabetes)
    - \( < 130/80 \) mm Hg (diabetes)
  - Hyperlipidemia
    - Total cholesterol \( < 4.0 \) mmol/L
    - LDL cholesterol \( < 2.5 \) mmol/L
    - \( 2.0 \) mmol/L in “high risk”
  - Smoking cessation
  - Diabetes \( < 7.0\% \)
  - Weight reduction
  - Other-comorbidities – heart disease, renal disease
- Claudicants – increase exercise tolerance
- Rest pain with or without rest pain may require rapid intervention
**Intervention – treatment options**

- Stop smoking
- Regular exercise - walking program
- Control high blood pressure
- Antiplatelet Agents
- Control high cholesterol (statins)
- Control diabetes with regular HbA1c checks
- Balanced diet
- Healthy weight
- Foot care/leg care
- Offload pressure
- Treat infection with correct antibiotics
- Leave dry gangrene intact

*Never debride until revascularised*

**Intervention – lower limb occlusive disease**

- Angioplasty +/- stent
- Femoral Popliteal Bypass
- Femoral Tibial Bypass
- Percutaneous Transluminal Angioplasty
- Profundaplasty
- Lumbar Sympathectomy
- Amputation
2. Venous Ulcer

**Diagnosis – 2. Venous Ulcer**

- Chronic venous hypertension
- Chronic oedema
- Increased capillary permeability
- Heamosiderin deposition
- Lipodermatosclerosis
- Tissue Ischaemia

**Diagnosis – Venous Ulcer**

- Varicose Veins
- Venous eczema
  - Skin irritation
  - Redness, scaling, pruritus
- Ankle flare
  - Red threads around the ankle
  - Dilatation of malleolar venules

---

**Diagnosis – Venous Ulcer**

- Haemosiderin staining
  - Gaiter region
  - Haem-deposits in tissue after red blood cell break down
  - Red / brown discoloration
- Varicosities
- Lipodermatosclerosis (hard, woody)
- Atrophe blanche
- Leg shape (upside down champagne bottle OR straight up thin no calf muscle)

---

**Interventions – Compression Therapy & Exercise**

- Gold standard treatment & prevention venous ulcers
- Control of leg oedema
- Applies pressure to skin and underlying tissue
- Ankle Flexion-Extension exercises & ambulation
- Increases venous flow & calf pump function

---

Standard 4 Best Practice In Wound Care (2002) AWMA Standards for Wound Management
• Requires compression to aid calf muscle pump – by applying pressure to the tissue, fluid will be forced back into the venous system, decreasing oedema and allowing the ulcer to heal – Gold Standard
• Ensure foot and ankle pulses present prior to application
• Use caution in patients with Oedema caused by severe uncontrolled heart failure - the sudden return of fluid to the heart with compression therapy will exacerbate the patient's condition
**Inelastic system**
- Inelastic (short stretch) bandage less than 50% stretch ability
- Single layer; multi layer
  - Requires the patient to be mobile to provide compression
  - Utilises calf muscle pump action to aid venous return
  - The resting pressure is low
    - Mobile patient
    - Leg ulcers
    - Oedema management
    - Lymphoedema
    - Venous insufficiency
    - Able to be tolerated by those with MILD arterial insufficiency

**Elastic System**
- Elastic (long stretch) bandage with more than 50% stretchability
- Provides high resting compression
- Apply reduced pressures when mobilising
- Support of ligaments and joints
- Reduced mobility
  - Venous insufficiency
  - Leg ulcers
  - Oedema
Multilayered Compression System

- A system of bandages whereby the pressure exerted is gradually built up using an accumulation of layers which combined give 40mmHg at the ankle, graduating to 17mmHg at the knee
  - Venous Leg ulcers
  - Oedema management
  - Lymphoedema
  - Venous insufficiency
  - ABI > 0.8

- Modified layered compression MAY be able to be tolerated by those with MILD arterial insufficiency (ABI 0.6-0.8)
  - For 17mmHg use the 3rd layer with 1 and 2
  - For 23 mmHg use the 4th layer with 1 and 2
- (together the 1, 2, 3, 4 make up the 40mmHg)

Cohesive inelastic system

- Application video can be found at:
  - http://www.youtube.com/watch?v=FqKjBE6_0AU
  - This system comes in 40mmHG as well as a modified lite version

Graduated compression stockings

- Knitted stocking that provides graduated compression for oedema management, moderate to severe venous insufficiency and lymphoedema of the lower limb/s
- Increase the pressure in the tissues beneath the skin reducing excess leakage of fluid from the capillaries and increasing absorption of tissue fluid by the capillaries and lymphatic vessels leading to oedema reduction
- Help to control the diameter of superficial veins beneath the stocking by not allowing to over expand with blood, preventing “pooling” and aiding venous return to the heart
- Doners and applicators are available to aid in application – can be difficult to get on – need to assess patient carefully

<table>
<thead>
<tr>
<th>Liner</th>
<th>Class I ------</th>
<th>Class II ------</th>
<th>Class III -------</th>
</tr>
</thead>
<tbody>
<tr>
<td>10mmHg</td>
<td>15-20mmHg</td>
<td>20-30mmHg</td>
<td>30-40mmHg</td>
</tr>
<tr>
<td>Tired legs</td>
<td>Tired legs, heavy feeling</td>
<td>Deep venous insufficiency</td>
<td>Severe varicosia</td>
</tr>
<tr>
<td>Minor ankle, leg, foot swelling</td>
<td>Minor ankle, leg, foot swelling</td>
<td>Moderate to severe varicosis</td>
<td>Severe oedema and lymphoedema</td>
</tr>
<tr>
<td>Easy to apply</td>
<td></td>
<td></td>
<td>Chronic venous insufficiency</td>
</tr>
<tr>
<td>Can be worn in conjunction with other stockings to increase pressure and aid in ease of application on other Classes</td>
<td></td>
<td>Moderate oedema Prevention of recurrent venous ulcers</td>
<td>Prevention and management of venous ulceration</td>
</tr>
</tbody>
</table>
• Contraindications
  o Ischemia, arterial ulcers
  o Uncontrolled congestive heart failure
  o Untreated septic phlebitis of the leg
    • Used with caution in people with
    • Skin infections
    • Weeping dermatological problems
    • Incompatibility to fabric of garment
    • Impaired sensitivity of the limb
    • Immobility (confinement to bed)
    • Arterial ulcer

• Prior to application
  o **Client assessment**
    ▪ Heart failure
    ▪ Other co-morbidities
    ▪ Pain
    ▪ Mobility
    ▪ Ability to tolerate – don/doff
  o **Limb assessment**
    ▪ Arterial supply
    ▪ Foot deformities
    ▪ Skin
    ▪ Shape of limb
    ▪ Measure ankle circumference
    ▪ Correct system/ combination of bandages
  o **Address hygiene**
    ▪ Use pH appropriate cleanser
    ▪ Debride devitalised tissue / scale – harbor bacteria – friction & shear - ulceration
  o **Wound contact material**
    ▪ Skin care – emollient/ moisturiser
    ▪ Avoid products that induce allergy or irritation
    ▪ Consider cotton liner under compression
    ▪ Choose products that address odour, infection, exudate, pain
  o **Psychological preparation**
    ▪ Commitment to treatment
    ▪ Risk factor minimisation
    ▪ Lifestyle changes

  o Debridement is the process of removing non-living, devitalized, necrotic, sloughy tissue and debriri from a wound which aids in preparing the wound bed and promoting the healing process
    ▶ Autolytic Debridement
    ▶ Mechanical Debridement
    ▶ Enzymatic Debridement
    ▶ Sharp Debridement
    ▶ Maggot Therapy

*Never debride where vascular system is compromised*
3. Mixed Venous/Arterial

- Difficult to diagnose – requires more extensive investigations
- How significant is the arterial disease - ? Revascularisation
- HEIDIE - Do NO Harm - Requires a Multi –D approach
- Modified compression may be acceptable
- Local wound care - Good skin care
- Offload pressure /Footwear/podiatry
- Control co-morbidities & risk factors

Inter-Society Consensus for the Management of Peripheral Artery Disease (TASC II) (2007)
Standard 1 Collaborative Practice and Interdisciplinary Care (2002) AWMA Standards for Wound Management
Standard 4 Best Practice In Wound Care (2002) AWMA Standards for Wound Management
Diagnosis - 4. Lymphatic

- Abnormal collection of lymph - groin dissection, cancer
- Bacterial infection & venous HT/ congestion/ valvular insufficiency – transport system does not work
- Failing lymphatics – overload of fluid with protein – degradation & chronic inflammation; lymph stasis;
  HIGH PROTEIN OEDEMA
- Oedema is water – protein & water are the difference – Heart failure; Chronic venous insufficiency; ascites; pregnancy, inactivity

Interventions/ Evaluation

- Skin care
- Local wound care
- Debride
- Skin care
- Local wound care
- Treat infection
- Exercise and movement
- Massage
- Compression bandages/ hosiery
- Lifestyle Management
- Education
- Support
Diagnosis & Intervention
5. Trauma

- Commences with trauma – skin tear, gash, knock, pressure
- May have infection present
- May be non healing

Treat underlying pathophysiology
- Treat infection
- Local wound bed preparation and care
- Surgical debridement
- Skin care
- Offload/redistribute pressure
- Education/support
- Risk factor minimisation - lifestyle

Standard 1 Collaborative Practice and Interdisciplinary Care (2002) AWMA Standards for Wound Management
Standard 4 Best Practice in Wound Care (2002) AWMA Standards for Wound Management

Diagnosis & Intervention
6. Vasculitis

- General term – Inflammation of blood vessel walls
- Immune pathologies – Rheumatoid arthritis, Lupus
- Extremely painful
- Confirmed by biopsy
- Systemic management – steroids (prednisolone)- immune suppression

Standard 1 Collaborative Practice and Interdisciplinary Care (2002) AWMA Standards for Wound Management
Standard 4 Best Practice in Wound Care (2002) AWMA Standards for Wound Management
**Diagnosis & Intervention**

8. Neoplastic -

- Rare aggressive tumours
- Originate in chronic wounds – friable tissue, purulent exudate
- Malignancy usually SSC
- 1.5% of Marjolin’s ulcers develop in chronic osteomyelitis
- Diagnosis with biopsy
- Radical resection/ amputation
- Radiotherapy, chemotherapy, cryotherapy not effective
- Education
- Support

---

**Diagnosis & Intervention**

8. Martorell (HT)

- Result of poorly controlled diastolic hypertension.
- Painful - Necrotic edges
- Usually lateral aspect of the lower leg
- Peripheral pulses are present but ischaemia
- Exclude vasculitis or vessel obstruction
- HT control – heal 4-12 months; re-currance is common
- Control Risk factors
- Local wound management - TIME

---

Standard 1 Collaborative Practice and Interdisciplinary Care (2002) AWMA Standards for Wound Management

Peripheral neuropathy

i. Diabetes - most common cause
ii. Alcoholism
iii. Autoimmune disease
iv. Renal failure
v. Nutritional deficiencies
vi. Nerve injuries & adverse drug reactions

Presentation:
The most common distal symmetrical polyneuropathy 'glove and stocking’ neuropathy
• Neuropathy
  o Sensory – loss of pain, pressure, temp awareness
  o Motor – atrophy & muscle weakness - deformities
  o Autonomic – excessive skin dryness, cracks

• Monofilament
• Neuropathy Disability Score
  o Pinprick sensation-sharp/blunt
  o Vibration perception
  o Temperature perception
  o Ankle reflexes

• Education

---

**Diagnosis & Intervention**

9. Neuropathic – diabetic foot ulcer

- **Ischaemia**
  - Decreased or absent pedal pulses - Cool feet and toes
  - Pallor on elevation of limb, reactive hyperaemia on dependency
  - Poor skin and nail integrity
  - Absent hair on feet
  - Wound hypoxia, Excess inflammation

- **ABPI**
- **Toe Pressures**
- **TCO2**
- **Vascular Imaging**

- **Aggressive re-vascularisation**

**Diagnosis & Intervention**

**9. Neuropathic – diabetic foot ulcer**

- **Reduced response to infection**
  - Local swelling or induration
  - Increased exudate, Purulent discharge, Odour
  - Friable tissue – bleeds easily
  - Abscess formation. Delayed healing
  - **Danger** Not always erythema, pain, tenderness
  - Osteomyelitis – probe to bone??

- **Biomechanical abnormalities**
  - Altered gait
  - Altered pressures
  - Ability to reach feet
  - Ill fitting shoes
  - Callous formation

- **Foot Deformity Score (1pt ea)**
  - Small muscle wasting
  - Charcot foot deformity
  - Bony prominence
  - Prominent metatarsal heads
  - Hammer or claw toes
  - Limited joint mobility

---

Diabetics at highest risk of amputation

- History of foot ulceration
- Presence of
  - neuropathy
  - peripheral vascular disease
- Poor glycaemic control
- Foot deformity
  - Pressure
- Poor footwear/ vision


---

**TABLE 1**

THE UNIVERSITY OF TEXAS, SAN ANTONIO CLASSIFICATION

<table>
<thead>
<tr>
<th>Grade</th>
<th>0</th>
<th>I</th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage</td>
<td>A</td>
<td>Pre- or postulcerative lesion completely epithelialized</td>
<td>Superficial wound, not involving tendon, capsule, or bone</td>
<td>Wound penetrating to tendon or capsule</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>Infection</td>
<td>Infection</td>
<td>Infection</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>Ischemia</td>
<td>Ischemia</td>
<td>Ischemia</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>Infection and ischemia</td>
<td>Infection and ischemia</td>
<td>Infection and ischemia</td>
</tr>
</tbody>
</table>
Interventions for Diabetic Foot

- Multi D approach – especially high risk
- Address pain issues?
- Re-vascularise as required
- Eliminate infection/ fungas
- Modify and reduce risk factors
- Control of co-morbidities
- Monitor glycaemic control, HbA1c
- Optimal medication management
- Aggressively debride callous
- Local wound care
- Offload/redistribute pressure
- Regular podiatry
- Social & psychological factors
- Education
  - Protect feet – wear shoes
  - inspect feet and shoes daily
  - hygiene
- Economic aspects

http://footindiabetes.org/system/files/traffic+light+finalx3_1.pdf
Evaluation

Ongoing evaluation of the wound and the underlying aetiology
Is it progressing?
If not – start at the beginning – involve Multi-D team – shared care

Lifestyle changes?
Risk factor modification?
Medication management?

Is the patient and their family coping with the treatment plan?
Does it require changes

Patient education
Ongoing monitoring

Web Sites of Interest

Wounds International (Clinical Guidelines, Made Easy documents, web casts) – free registration
http://www.woundsinternational.com

Australian Wound Management Association (Publications)

National Institute for Health and Clinical Excellence
http://www.nice.org.uk/

The Royal Australian College of General Practitioners – audio pod casts
http://www.racgp.org.au/AM/Template.cfm?Section=AFP_Podcasts&Template=/CM/ContentDisplay.cfm&ContentID=10768

Wounds West – free registration – prints certificate
Core module Pressure ulcer module
Leg ulcer module Burns module
Foot ulcer module

Arterial Leg Ulcers

Inter-Society Consensus for the Management of Peripheral Artery Disease (TASC II) (2007)
Venous Leg Ulcers

Australian Wound Management Association (Publications) – Venous Leg Ulcer Guidelines

Royal College of Nursing UK
http://www.rcn.org.uk/development/practice/clinicalguidelines/venous_leg_ulcers

Diabetic Foot


Diabetic Foot Problems – NICE Pathway (2011)

Foot in Diabetes UK site – guidelines – including Diabetic Foot Risk Stratification & Triage Poster
http://footindia.htmle.org/guidelines

Inlow’s 60 Second Diabetic Foot Screen

International Working Group of the Diabetic Foot
http://www.iwgdf.org/

Wound Management

Dressings.org (data cards on different dressings)
http://www.dressings.org/

European Wound Management Association
http://www.ewma.org/english/english.htm

World Wide Wounds (electronic journals and articles of interest)
http://www.worldwidewounds.com/
TOEHLABPI Learning Package for Staff - References
American College of Cardiology Foundation (ACC) and American Heart Association (AHA) Practice Guidelines (2005) Guidelines for the Management of Patients with Peripheral Arterial Disease


Calianno & Holton (2007) Fighting the triple threat of lower extremity ulcers in Nursing 2007, March


