Management of diabetic foot wounds

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Preface

While there are several clinical practice guidelines for managing diabetic foot problems, none have yet been developed for ASEAN. The ASEAN Plus Expert Group Forum has been formed in November 2012 to address this issue. Its objective is to develop clinical guidelines to raise the standard of health care provided to patients with diabetic foot wounds in ASEAN Plus countries. Such best practices will benefit healthcare professionals treating such individuals. Two experts have been invited from each member country, namely Indonesia, Malaysia, Philippines, Singapore, Sri Lanka and Thailand to serve a term of 2 years. Members include orthopaedic surgeons, vascular surgeons, a general surgeon, a plastic surgeon and endocrinologists. We would like to thank Smith & Nephew Singapore Pte Ltd for their educational support and sponsorship.

Contents

Quick Reference Guide

Introduction

Section 1: Prevention of foot ulcers and amputation

Section 2: Assessment and Investigations

Section 3: Medical Treatment

Section 4: Surgical Treatment

Annexures 1: Assessment Form
Introduction

Diabetes currently affects 366 million people worldwide or 8.3% of the world's adult population. This figure is expected to increase to 9.9% by 2030 (Table 1), owing to environmental factors such as sedentary lifestyles and changing dietary patterns\(^1\). Now the fourth leading cause of death in most developed countries, diabetes has been considered as the “global epidemic of the 21st century”.

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<table>
<thead>
<tr>
<th>Section 1: Prevention of Foot Ulcer and Amputation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Prevent development of diabetic neuropathy.</td>
</tr>
<tr>
<td>• Prevent ulcer development by promoting good care of feet by patients.</td>
</tr>
<tr>
<td>• Encourage patients to go for regular foot screening.</td>
</tr>
<tr>
<td>• Offer early intervention or refer to a specialist when foot problems develop.</td>
</tr>
<tr>
<td>• Prevent below-knee amputation by good control of diabetes and good care of the feet to prevent early foot complications.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Section 2: Assessment and Investigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Perform a thorough assessment of a patient with a diabetic foot problem.</td>
</tr>
<tr>
<td>• Perform general laboratory investigations.</td>
</tr>
<tr>
<td>• Send material for culture.</td>
</tr>
<tr>
<td>• Perform Radiological tests.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Section 3: Medical Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Aim for good glycaemic control in all patients with diabetic foot ulcer.</td>
</tr>
<tr>
<td>• Nutrition should be individualized.</td>
</tr>
<tr>
<td>• Improve the nutritional status in malnourished patients.</td>
</tr>
<tr>
<td>• When patients are kept fasting provide carbohydrate.</td>
</tr>
<tr>
<td>• Prepare the wound bed to facilitate wound healing.</td>
</tr>
<tr>
<td>• Infection should be identified early and managed appropriately to avoid limb loss.</td>
</tr>
<tr>
<td>• Antibiotics should be used appropriately.</td>
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<tr>
<td>• Antibiotics should be used in conjunction with other treatments.</td>
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<tr>
<td>• Look for underlying osteomyelitis in all wounds.</td>
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<tr>
<td>• Use the TIME guide to guide aim of care and dressing selection.</td>
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<tr>
<td>• Choose the appropriate wound dressing based on wound characteristics.</td>
</tr>
<tr>
<td>• Use alternative technology where appropriate to aid wound healing.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Section 4: Surgical Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Perform adequate debridement to remove all devitalised or infected tissue.</td>
</tr>
<tr>
<td>• Perform split skin graft for large granulating wound.</td>
</tr>
<tr>
<td>• Perform minor (distal) amputation where possible.</td>
</tr>
<tr>
<td>• Perform amputations if indicated.</td>
</tr>
<tr>
<td>• Perform rehabilitation early.</td>
</tr>
<tr>
<td>• Perform limb salvage when possible by carrying out revascularisation.</td>
</tr>
<tr>
<td>• Perform primary proximal amputation when limb salvage is not possible.</td>
</tr>
</tbody>
</table>
Foot wounds are very common among diabetic patients, affecting about 15% of all diabetic patients in developed countries. They are a major cause of amputations. Approximately 85% of all amputations begin with a wound. A diabetic patient is up to 40 times more likely to receive a lower limb amputation. Currently, it is estimated that every 20 seconds a leg is lost due to diabetes globally. Lower limb amputations often cause mortality in diabetic patients: 70% of them die within five years after an amputation.

Nomenclature: In this guideline the term ‘diabetic foot wound’ is synonymous with ‘diabetic foot ulcer.’

**Pathogenesis**

To manage Diabetic Foot wounds, one must first understand their pathogenesis – the “Diabetic Foot Triad” (Figure 1). 3 risk factors – Neuropathy, Vasculopathy and Immunopathy – contribute to varying degrees in different patients.

![Figure 1. Diabetic Foot Triad](image)

While in some patients, one component predominates (e.g. dry gangrene due to ischaemia), a combination of two risk factors may be responsible in others (e.g. wet gangrene due to ischaemia and infection). All 3 factors – neuropathy, ischaemia and infection – may be present in some patients.

**Types of wounds**

- **Infective wounds**
  
  Usually found on the dorsum of the foot or in the web space.
Ischaemic wounds
Result from diabetic vasculopathy. Signs of chronic ischaemia are shininess of the skin, loss of hair, increased skin pigmentation and trophic nail changes. However in most diabetic foot ulcers there is a degree of ischemia, which is not severe enough to be apparent but promotes infection and causes delay in healing and increases risk of amputation.

Both infective and ischaemic
Some wounds have features of both infection and ischaemia.

Neuropathic wounds
Usually occur in weight bearing areas as a result of loss of protective sensation and high pressure points from changes in the mechanics of the foot.

Decubitus wounds
Occur when too much pressure is constantly placed on the skin. Common sites include the heel, lateral malleolus and the lateral aspect of the 5th metatarsal.

Classification Systems
For our guidelines, we have adopted the Wagner-Meggitt Wound Classification\textsuperscript{5,6} for classifying the wounds. In addition, the King’s College Classification\textsuperscript{7} is also used.

Wagner-Meggitt Wound Classification
This classification (Table 2 and Figure 7) was first described by Meggitt in 1976\textsuperscript{5} and popularised by Wagner in 1981\textsuperscript{6}. It is a six-grade system that classifies ulcers according to the depth and extent of wound. Advantages of the Wagner-Meggitt Wound Classification include its simplicity in usage. It also provides a guide for practitioners to plan treatment. Disadvantages include the fact that infection is only taken into account in Grade 3 and ischaemia in Grades 4 and 5.
Table 2. Wagner-Meggitt Wound Classification

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description of ulcer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 0</td>
<td>Pre- or post-ulcerative lesion completely epithelialized</td>
</tr>
<tr>
<td>Grade 1</td>
<td>Partial/full-thickness ulcer confined to the dermis, not extending to the subcutis</td>
</tr>
<tr>
<td>Grade 2</td>
<td>Ulcer of the skin extending through the subcutis with exposed tendon or bone. No abscess formation or osteomyelitis</td>
</tr>
<tr>
<td>Grade 3</td>
<td>Deep ulcer with abscess formation or osteomyelitis</td>
</tr>
<tr>
<td>Grade 4</td>
<td>Localised gangrene of the toes or partial foot gangrene</td>
</tr>
<tr>
<td>Grade 5</td>
<td>Whole foot gangrene</td>
</tr>
</tbody>
</table>

Figure 2. Wagner-Meggitt Wound Classification

King’s College Classification

The King’s College Classification (Table 3) is a simple staging system. It is based on the types of clinical presentation of the diabetic foot – ulcer, cellulitis, gangrene and amputation. The advantage of this system is that it is simple to use and is useful for planning the appropriate treatment for each stage. Its disadvantage is that it has not been well validated.

Table 3. King’s College classification

Stage 1. Normal foot

There is no risk factor in the normal foot (Figure 1). There is no neuropathy. Both foot pulses are palpable. There is no deformity, callosity or swelling.
**Stage 2. High-risk foot**

One or more risk factors for ulceration are present – namely sensory neuropathy or ischaemia. In the latter, one or both distal pulses are not palpable. There may be deformity, callosity, previous ulceration or previous amputation in the foot.

**Stage 3. Ulcerated foot**

This stage presents with skin breakdown or an ulcer. Ulceration usually occurs on the plantar surface in the neuropathic foot and on the dorsum of the foot in infection.

**Stage 4. Cellulitic foot**

There is cellulitis with infection of the skin and subcutaneous tissue.

**Stage 5: Necrotic foot**

This is characterized by the presence of necrosis or gangrene (Figure 5). Common sites of involvement are toes (one or more) and heel of the foot. They present as dry gangrene (no superimposed infection) or as wet gangrene (with superimposed infection).

**Stage 6. Major amputation**

Major amputation is defined as one taking place above the ankle joint – namely below knee, through knee and above knee amputation. Causes of below knee amputation include agonising pain in the foot, overwhelming infection in the foot and extreme necrosis or gangrene involving the foot.
Prevention of foot ulcer and amputation

70% of all amputations happen to patients with diabetes mellitus. 85% of the amputations in diabetes patients can be prevented by prevention, organized care given by multi-disciplinary teams, close monitoring, and education of patients.

Recommendation 1: Prevent development of diabetic neuropathy

1. Prevent development of diabetes mellitus in population
2. Achieve early metabolic control in those who have developed diabetes. This encompasses
   i. good glycemic control
   ii. keeping blood pressure under control
   iii. avoidance of smoking and excessive alcohol

   Work in multidisciplinary teams
   Use patient centered approach

Recommendation 2: Prevent development of ulcers by promoting good care of feet by patients

1. Motivate patients to take care of their feet
2. Educate patients on
   a. Importance of appropriate footwear and choosing footwear/ socks
   b. Daily inspection of feet and footwear
   c. Application of moisturizer
   d. Identifying problems in the feet such as infection, blisters, callus

Recommendation 3: Encourage patients to go for regular foot screening

1. Offer annual comprehensive foot examination for all patients with diabetes.
2. More frequent examination will be required for those who have problems.
3. The foot examination should include:
   a. Inspection (footwear, dry skin, callus, fissures, amputations, ulcers, deformities)
   b. Assessment of vascularity
      i. Palpation of dorsalis pedis and posterior tibial pulses are most reliable
      ii. History of claudication may be absent due to neuropathy or patient not walking
      iii. Ankle-Brachial-Pressure Index (ABPI) <0.9. This may be elevated despite poor flow.
Testing for loss of protective sensation (LOPS). This is determined by >1 of the following
  i. Lack of sensation
  ii. Sensory loss on testing (10-g monofilament plus testing any one of the following: vibration using 128-Hz tuning fork, pinprick sensation, or vibration perception threshold)
  iii. Loss of ankle reflexes

4. Risk stratify based on findings (see Table 4 and Figure 3)
   a. Risk factors that are used for risk stratification include:
      i. Previous ulcer or amputation
      ii. Sensory neuropathy
      iii. Peripheral vascular disease
      iv. Deformity or callus
   b. Risk stratification enables patients to be managed in a cost effective manner, with more frequent follow up and more aggressive management for patients with increased risk.

<table>
<thead>
<tr>
<th>Risk category</th>
<th>Definition</th>
<th>Recommended action</th>
<th>Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low risk foot</td>
<td>No risk factors</td>
<td>Foot care education</td>
<td>Annually</td>
</tr>
<tr>
<td></td>
<td>No previous ulceration</td>
<td>Optimize metabolic control</td>
<td></td>
</tr>
<tr>
<td>High risk foot</td>
<td>One Risk Factor</td>
<td>Special footwear</td>
<td>Every 3-6 months</td>
</tr>
<tr>
<td></td>
<td>No previous ulcer</td>
<td>Offer intervention</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Optimize control</td>
<td></td>
</tr>
<tr>
<td>Super high risk foot</td>
<td>Previous Ulceration/Amputation or Two of the risk factors</td>
<td>Special footwear</td>
<td>Every 2-3 months</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Offer intervention</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Optimize control</td>
<td></td>
</tr>
<tr>
<td>Foot emergencies</td>
<td>Ulcer, injury, infection (Vascular, infection, pressure)</td>
<td>Assess depth and VIP Manage as appropriate</td>
<td>Every 1-2 months</td>
</tr>
</tbody>
</table>

Recommendation 4: Offer early intervention or refer to a specialist when foot problems develop

1. If there is LOPS or deformities: Provide special foot wear and monitor closely
2. Shave callus
3. Clip nails
4. If the pulses are not normal evaluate further or refer to vascular specialists

Recommendation 5: Prevent below-knee amputation by good control of diabetes and good care of the feet to prevent early foot complications
Management of diabetic foot wounds

References


Assessment and investigation

Recommendation 6: Perform a thorough assessment of a patient with a diabetic foot problem

In all patients with DFU perform a three-step assessment:

- the patient for general status
- the affected leg
- the ulcer

**Step 1. Assess and document diabetes, its complications and comorbidities**

- Type and duration of diabetes
- Medications used
- Degree of metabolic control
- Look for complications: renal disease, cardiovascular disease (hypertension, dyslipidemia, smoking, angina, myocardial infarction, revascularization, transient ischemic attack, strokes and peripheral vascular disease) or heart failure.

**Step 2. Assess and document status of the diabetic foot**

- presence or absence of sensory symptoms
- rest pain or claudication
- type of foot wear
- foot care habits
- callous or deformities
- previous foot ulcers or infections
- previous surgery including revascularization or amputation
- Evaluate the DFU:
  - Initial wounding event,
  - History of recurrent wounding,
  - Previous wound healing problems,
  - Prior diagnostic tests,
  - Prior therapies and response to them,
  - Functional impact of the wound on the patient,
  - Social history to determine potential adverse impact on wound healing.

**Examine the feet and document**

**Inspection**

*Dermatologic*

- Skin status: color, thickness, dryness, cracking
- Sweating
- Infection: check between toes for fungal infection
- Ulceration
- Calluses/blistering: hemorrhage into callus?

*Figure 5. Rocker bottom deformity in patient*
Musculoskeletal
- Deformity, e.g., claw toes, prominent metatarsal heads, Charcot joint (Figure 5)
- Muscle wasting (guttering between metatarsals) (Figure 6)

Neurological assessment
10-g monofilament + 1 of the following 4 (Figure 7)
- Vibration using 128-Hz tuning fork
- Pinprick sensation
- Ankle reflexes
- Vibration Perception Threshold

Vascular assessment
Foot pulses (Figure 8)
- Femoral
- Popliteal
- Dorsalis Pedis
- Posterior Tibial

Ankle Brachial Index (ABI)
\[ ABI = \frac{\text{Ankle systolic pressure (highest)}}{\text{Brachial systolic pressure (highest)}} \]
- Ankle pressures are taken at the Dorsal Pedis and Posterior Tibial.
- Use the highest of the two ankle pressures and brachial pressures

| 0.8 to 1.2 | Normal |
| <0.8      | Ischaemia |
| <0.5      | Critical ischaemia |

Figure 6. Clawing of toes

Figure 7. Ten grams of force applied until filament bends

Figure 8. Sites for palpating foot pulses
Toe Brachial Index (TBI) when ABI is high (>0.9)  
Figure 10

- 40% of all diabetic patients with an ulcer present falsely high ABI values (ABI>1.3) because of vessel wall calcification

Table 4. Severity of peripheral artery disease (PAD)

<table>
<thead>
<tr>
<th>Type/Severity</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild PAD</td>
<td>Palpable foot pulses/ absent foot pulses with ABI &gt; 0.6*, (TBI&gt;0.7 TcPO2 &gt; 50 of healing mmHg)</td>
</tr>
<tr>
<td></td>
<td>- High probability</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Evaluate the effect of maximal 6-week optimal wound care.</td>
</tr>
<tr>
<td></td>
<td>- Reassess perfusion and consider revascularization when wound healing response is poor.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>*Note: ABI &gt; 0.6 has less predictive value, and in these patients, TCPO2 or toe pressure should be measured.</td>
</tr>
<tr>
<td>Severe PAD</td>
<td>Absent foot pulses, ABI &lt; 0.6</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Low probability of healing</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Optional Toe pressure &lt; 50 mmHg, TcPO2 &lt; 30 mmHg.</td>
</tr>
</tbody>
</table>
Step 3. Examine the DFU and document

Document ulcer characteristics

In assessing a diabetic foot wound, one must describe the characteristics of the wound:

- Site of wound: dorsum / sole / heel / web space
- Size of wound
- Edge of wound: clean-cut / inverted / everted
- Floor of wound: slough / granulation tissue
- Content of wound: exudate / pus

(Contd.)
Investigations

Recommendation 7: Perform general laboratory investigations

1. Screen for anemia and malnutrition (albumin or prealbumin) as they may impair wound healing\(^1\)\(^2\).

2. If infection is suspected consider: C reactive protein, erythrocyte sedimentation rate, cultures (deep tissue cultures including bone fragments/biopsy in the case of osteomyelitis and blood cultures)

3. Assess and optimize metabolic profile: Glycosylated hemoglobin, lipid profile, cardiac and renal evaluation.

   • Do not withhold antibiotics till cultures become available
   • Use clinical judgment

Recommendation 8: Send material for culture

- A culture must be taken before starting antibiotics
- First clean the ulcer and surrounding skin with normal saline
- Press the wound at the edges to squeeze pus from the center portion
- Collect pus from the deepest portion of the wound to avoid contamination
- Send the swab for culture and sensitivity for aerobic and anaerobic organisms

Recommendation 9: Perform radiological tests

1. Plain radiography (of the affected foot and if necessary both sides for comparison) is useful to evaluate for infection, foreign bodies, and deformity including Charcot arthropathy.

2. Look for osteomyelitis.
   - Radiologic changes may lag behind by two weeks in the presence of osteomyelitis\(^1\)\(^2\).
II. MRI may be indicated if there is positive probe-to-bone test\(^1,2\).

III. Other methods to diagnose early osteomyelitis are radioactive labeled scans such as Tc99m exametazime or Indium WBC labeled scans.

**Suspect osteomyelitis early and refer to specialist**

### Multidisciplinary foot care team \(^4,5\)

Each hospital should have a multidisciplinary foot team.

The members of the team should consist of:

- surgeon with expertise in managing diabetic foot problems
- diabetologist
- diabetes specialist nurse
- podiatrist
- tissue viability nurse
- specialist services such as vascular surgery, radiology, clinical microbiology, nephrology and cardiology

### References


Medical treatment

Endocrine control
Poor glycemic control is common among patients with diabetic foot ulcers. The factors that disrupt glucose control include:

- Infection
- Surgical trauma
- Stress

S16  Sri Lanka Journal of Diabetes, Endocrinology and Metabolism
Recommendation 10: Aim for Good glycemic control in all patients with diabetic foot ulcer.

Glycemic Targets:

**In critically ill patients:**
- Target: 140 – 180 mg/dL (7.8 – 10 mmol/L).
- Method: Use intravenous insulin infusion

**In other hospitalized patients:**
- Target: a premeal glucose less than 140 mg/dL (7.8 mmol/L)
- Method: basal insulin, and bolus doses for mealtimes

**In relatively well patients:**
- Target: a premeal glucose less than 130 mg/dl (7.2 mmol/l) if this can be done without increasing hypoglycaemia. HbA1C target of 7% is recommended for most home managed patients provided this could be achieved safely.
- Method: If the patient is stable on oral drugs these may be continued. If the glycaemic control is poor optimize, preferably with insulin.

**Medical Nutrition Therapy**

Recommendation 11: Nutrition should be individualized.

Factors such as body weight, current medical status, and other comorbid conditions, such as obesity, hyperlipidemia, and hypertension should be taken into account when planning a diet. Involve a nutritionist if possible.

Recommendation 12: Improve the nutritional status in malnourished patients.

Recommendation 13: When patients are kept fasting provide carbohydrate.
- Method: Use 5% dextrose or Dextrose saline infusion

**Wound Bed Preparation**

Recommendation 14: Prepare the wound bed to facilitate wound healing.

The wound bed should be prepared for healing to occur effectively\(^1\). Wound bed preparation is considered to accelerate endogenous healing and increase effectiveness of other therapeutic measures\(^2\). Important aspects include debridement, management of bacterial burden and exudate management.
The TIME acronym\(^3\) provides a framework for a structured approach to wound bed preparation.

![TIME acronym image]

Redrawn from Schultz et al, 2003

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1 Sibbald, 2000
2 Paris Advisory Board, June 2002
3 Schultz et al, 2003

**Wound Infection**

**Recommendation 15:** Infection should be identified early and managed appropriately to avoid limb loss.

Diabetic foot wounds often become infected – approximately 60% are infected with anaerobic bacteria. Appropriate treatment varies based on the degree of bacterial growth.

**Table 5. Stages of infection and appropriate treatment.**

<table>
<thead>
<tr>
<th>Infection Stage</th>
<th>Appropriate Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contaminated Wound</td>
<td>No need for antibiotics</td>
</tr>
<tr>
<td>o Bacteria present in wound</td>
<td></td>
</tr>
<tr>
<td>o No clinical reaction</td>
<td></td>
</tr>
<tr>
<td>Colonised Wound</td>
<td>Apply local antimicrobial dressing</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>- Bacteria multiplying in wound</td>
<td></td>
</tr>
<tr>
<td>- No adverse clinical reaction</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Critically Colonised Wound</th>
<th>Apply local antimicrobial dressing</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Heavy bacterial load</td>
<td></td>
</tr>
<tr>
<td>- Delayed healing, Change in wound bed colour, Absent / abnormal granulation tissue, Increased / abnormal odour, Increased serous discharge, Increased pain at wound site</td>
<td></td>
</tr>
<tr>
<td>- No signs of inflammation/cellulitis</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Overt Infection</th>
<th>Start intravenous antibiotics</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Very heavy bacterial load</td>
<td></td>
</tr>
<tr>
<td>- Clear signs of infection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Apply local antimicrobial dressing</td>
</tr>
</tbody>
</table>
Biofilms are resistant films of bacteria enclosed in a matrix of protective slime, which do not respond well to antibiotics. About 60% of all chronic wounds are colonised by biofilms. Biofilms present as a slimy layer over the wound bed. Biofilm-colonised wounds should be managed by cleansing, debridement, application of antimicrobial dressings, and administration of antibiotics.

**Antibiotic Usage**

**Recommendation 16: Antibiotics should be used appropriately.**

Antibiotic treatment risks inducing the development of antibiotic-resistant bacteria. Thus, antibiotics should be used appropriately:

- Local antibiotic creams and pastes are inadvisable as the risk of developing antibiotic-resistant bacteria is high
- Antibiotics choice should be based on culture and sensitivity results
- Osteomyelitis requires high-bone-penetration antibiotics for at least 6 weeks
- Follow up with blood and radiological investigations is important

**Recommendation 17: Antibiotics should be used in conjunction with other treatments.**

Where necessary, antibiotics should be used together with surgical methods and antimicrobial dressings for greater effect:

- Abscesses must be surgically drained
- Osteomyelitis must be managed by excision of infected bone
- Local antimicrobial dressings (e.g. silver) help to combat multi-drug resistant strains

**Osteomyelitis**

**Recommendation 18: Look for underlying osteomyelitis in all wounds.**

Osteomyelitis is infection of the bone, which occurs commonly in patients with diabetic foot problems.

**Diagnosis**

Osteomyelitis should be assumed to be present when a sterile metal probe or a gloved finger on palpation reaches the bone.³

*Suspect osteomyelitis early and refer to specialist*

**Treatment**

Osteomyelitis is difficult to treat and usually requires:

- long-term antibiotic treatment
- surgery to remove the infected bone

**Dressing Selection According to TIME Guide**

**Recommendation 19: Use the TIME Guide to guide aim of care and dressing selection.**
<table>
<thead>
<tr>
<th>Tissue</th>
<th>Aim of care</th>
<th>Exudate</th>
<th>Dressing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Contact layer</td>
<td>Outer dressing</td>
</tr>
<tr>
<td>Necrotic</td>
<td>If vascular supply is good, debride eschar and promote moisture balance</td>
<td>Dry or low</td>
<td>hydrogel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate</td>
<td>hydrocolloid or foam</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heavy</td>
<td>Alginate, foam or hydrofiber</td>
</tr>
<tr>
<td></td>
<td>If vascular supply is compromised, keep dry eschar</td>
<td>Dry</td>
<td>Tulle gauze, film</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Film or gauze</td>
</tr>
<tr>
<td>Sloughy</td>
<td>Deslough, provide moisture balance</td>
<td>Low</td>
<td>Hydrocolloid, hydrogel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate</td>
<td>Alginate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heavy</td>
<td>Foam, hydrofiber</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NPWT</td>
</tr>
<tr>
<td>Granulating</td>
<td>Provide moisture balance</td>
<td>Low</td>
<td>Non adherence material</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate</td>
<td>Hydrocolloid, foam</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gauze or contact layer with pad</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NPWT</td>
</tr>
<tr>
<td>Epithelializing</td>
<td>Provide moisture balance</td>
<td>Low</td>
<td>Non adherence material</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate</td>
<td>Hydrocolloid or foam</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gauze</td>
</tr>
<tr>
<td>Infection</td>
<td>Get rid of infection (biofilm)</td>
<td>Low</td>
<td>Nano-crystalline or ion silver containing material, iodine cream</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate</td>
<td>Silver containing, iodine containing material</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Foam with pad or gauze</td>
</tr>
<tr>
<td>Moisture balance</td>
<td>Maintain moist environment</td>
<td>Low</td>
<td>Film, hydrogel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate</td>
<td>Hydrocolloid, Alginate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heavy</td>
<td>Foam, hydrofiber, NPWT</td>
</tr>
<tr>
<td>Edge</td>
<td>Promote advance of wound edge</td>
<td>Low</td>
<td>Film, hydrogel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate</td>
<td>Hydrocolloid, Alginate, NPWT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heavy</td>
<td>Foam, hydrofiber, NPWT</td>
</tr>
</tbody>
</table>

4 Caputo et al 1994
Categories of Wound Dressings
Recommendation 20: Choose the appropriate wound dressing based on wound characteristics.

<table>
<thead>
<tr>
<th>Category</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Film</td>
<td>Sterile, thin, waterproof, breathable, self-adhesive polyurethane film</td>
</tr>
<tr>
<td>Tulle dressing</td>
<td>Non-adherent dressing</td>
</tr>
<tr>
<td>Hydrocolloid</td>
<td>Adhesive dressing made of natural or synthetic polymer e.g. gelatine, pectin.</td>
</tr>
<tr>
<td>Hydrogel</td>
<td>Amorphous, water-based gels or sheets rehydrates dry necrotic tissue</td>
</tr>
<tr>
<td>Alginate</td>
<td>Forms a soft flexible gel</td>
</tr>
<tr>
<td>Hydrofibre</td>
<td>Retains fluid within the structure of the fibre forming a soft gel</td>
</tr>
<tr>
<td>Polyurethane foam</td>
<td>Available with or without an adhesive border</td>
</tr>
<tr>
<td>Silver dressing</td>
<td>Silver nano-particle or ion impregnated in a non-woven material that releases silver ion slowly</td>
</tr>
<tr>
<td>Iodine dressing</td>
<td>Providone iodine impregnated in a non woven material that releases iodine slowly</td>
</tr>
</tbody>
</table>

Other methods of treatments
Recommendation 21: Use alternative technologies where appropriate to aid in wound healing.

<table>
<thead>
<tr>
<th>Technology</th>
<th>Mechanism</th>
<th>Indication</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative Pressure</td>
<td>Application of negative pressure to a wound in a closed environment.</td>
<td>Open wound with high exudate</td>
<td>Reduces frequency of dressing changes.</td>
</tr>
<tr>
<td>Wound Therapy</td>
<td>Maintains moist environment and prevents desiccation.</td>
<td></td>
<td>Offers temporary wound closure.</td>
</tr>
<tr>
<td></td>
<td>Promotes formation of granulation tissue</td>
<td></td>
<td>Cannot be used in infected wound.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Necrotic tissue should be debrided first.</td>
</tr>
</tbody>
</table>
### Hyperbaric Oxygen
- Provides 100% oxygen to the wound tissue
- For wounds with inadequate perfusion
- Vascular supply is inadequate

| Maggot debridement therapy: Common green bottle fly (Lucilia cuprina) | Digestion of slough by secreting enzymes that dissolve the necrotic tissue and the biofilm | For wounds with slough and necrotic tissue | For patients too ill to undergo surgical debridement |

| Hydrosurgery | Ultra-thin, high-velocity stream of saline to debride with fine precision | For wounds with slough or necrotic tissue | Useful for wound bed preparation |

### References
2. Paris Advisory Board, June 2002

---

### Surgical treatment

#### Debridement
It is the most common operation performed for diabetic foot. Debridement is often left to the residents to perform. However, a good debridement can only be performed by a surgeon experienced in diabetic foot surgery.

**Recommendation 22: Perform adequate debridement to remove all devitalised or infected tissue.**

**Definition**
Debridement is the excision of necrotic, devitalised or infected tissue from a wound, leaving healthy and vascularised tissue behind.¹

**Indications**
- Discharge
- Necrotic tissue
- Slough

**Why Debridement?**
- Devitalised tissue in wound floor harbours bacteria
- Necrotic tissue masks underlying infection
Necrotic tissue is a physical barrier to healing
Bacteria form biofilm on wound floor for protection

Always assess vascularity before attempting debridement
Absence of both foot pulses or ABPI <0.6 should trigger vascular referral

Types of Surgical Debridement

Sharp debridement
Figure 13a and 13b. Using scalpel or scissors to remove devitalised tissue

Ultrasonic debridement
Figure 14. Using low-frequency ultrasound (25 – 42 Hz) and normal saline to remove devitalised tissue

Hydrosurgery debridement
Figure 15. Using high-pressure saline jet to remove devitalised tissue.

Sri Lanka Journal of Diabetes, Endocrinology and Metabolism
Management of diabetic foot wounds

Procedure for Surgical Debridement

• First stage
  o Excise edge of wound
  o Excise floor of wound

• Second stage
  o Flush with normal saline
  o Use new blade to trim edge of wound
  o Excise another thin layer of floor
  o Leave healthy bleeding tissue behind

• Apply dressing to wound

Tips for Debridement

  o Do not leave exposed fascia behind
  o Do not leave exposed tendon behind
    o Fascia or tendon will later form slough
  o Do not leave exposed bone
    o Use negative pressure dressing or
    o Cover with flap

Consent for Procedure

  • Patient may need a second debridement
  • Patient may need a split skin graft for a large wound

Split Skin Grafting (SSG)

Following adequate debridement, diabetic wounds heal. Small wounds heal via secondary closure. Large wounds require split skin grafting. In performing split skin grafting, donor skin is usually taken from the thigh of the patient on the same limb.

Recommendation 23: Perform split skin graft for large granulating wound.

Definition

Application of a skin graft including the epidermis and part of the dermis. Figures 17 and 18.
Osteomyelitis

Prolonged antibiotic therapy of 6 weeks is needed. A peripherally inserted central catheter (PICC) must be inserted for delivery. The type of surgery performed is shown in Table 6.

Table 6. Types of Surgery for OM

<table>
<thead>
<tr>
<th>Site of Osteomyelitis</th>
<th>Surgical Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distal / middle phalanx</td>
<td>Toe disarticulation</td>
</tr>
<tr>
<td>Metatarsal</td>
<td>Ray amputation</td>
</tr>
<tr>
<td>MTPJ (septic arthritis)</td>
<td>Excision of MTPJ</td>
</tr>
<tr>
<td>Lateral malleolus</td>
<td>Ankle fusion</td>
</tr>
<tr>
<td>Calcaneme</td>
<td>Partial/total calcaneotomy</td>
</tr>
<tr>
<td></td>
<td>Below knee amputation</td>
</tr>
</tbody>
</table>

* MTPJ – Metatarsophalangeal Joint

Amputation

Indications

Amputation is performed for:

- Gangrene or necrotic tissue
- Osteomyelitis or septic arthritis

Types of Amputations

- Minor (distal) or
- Major (proximal)
Recommendation 24: Perform minor (distal) amputation where possible.

Minor (Distal) Amputation
The first amputation should preferably be minor or distal.
The mortality rate is significantly higher when a major amputation is performed.4,5
Minor amputations allow tibial weight-bearing.

Pre-Requisites for Minor Amputation

- Must have at least one palpable pulse
- ABI: more than 0.7
- TBI: more than 0.7
Ray amputation

The ray amputation is the most common amputation performed. It is a more viable option of ensuring adequate surgical debridement of the septic margin than a toe disarticulation (through metatarso-phalangeal joint).

Recommendation 25: Perform ray amputation if indicated.

Definition

Amputation through the metatarsal bone removing part of metatarsal and corresponding toe. More than one ray may need to be removed.

Indications

- Wet gangrene of toe
- Osteomyelitis of proximal phalanx or metatarsal head
- Septic arthritis of metatarso-phalangeal head

Trans-Metatarsal Amputation

Recommendation 26: Perform transmetatarsal amputation if indicated

Definition

Amputation through all 5 metatarsal bones of forefoot.

Indication

- Forefoot gangrene
Informed Consent

- Lisfranc’s Amputation – amputation through tarso-metatarsal joints (Lisfranc joint) or
- Chopart’s Amputation – amputation through calcaneo-cuboid and talo-navicular joints (Chopart’s joint)
  May be performed instead of trans-metatarsal amputation, depending on availability of flaps.
- Patient may need below-knee amputation if operation fails

Syme or Pirogoff amputation

Nather et al\textsuperscript{6} considered the Syme or Pirogoff the most proximal amputation that can achieve successful limb salvage. It can be fitted with prosthetic shoes and is end-weight bearing.

Recommendation 27: Perform Syme / Pirogoff amputation if indicated.

Definition

**Syme**
Trans-malleolar amputation of foot through ankle joint.

**Boyd**
Amputation at the ankle with removal of the talus and fusion of the tibia and horizontal cut surface of calcaneus.

**Pirogoff**
Trans-malleolar amputation of foot through ankle joint and fusion of the tibia and distal cut surface of calcaneus.
Indications
- Gangrene of forefoot
- Infection of forefoot

Discussion
Syme Amputation has been advocated for trauma. However, Syme Amputation can also give good results in patients with diabetic foot infections. It is well-known that Syme Amputation should be reserved for patients with at least a palpable posterior tibial pulse and an ankle-brachial index of more than 0.5. However, it has several disadvantages, including instability of the calcaneal flap to the tibial surface due to poor adherence of the soft tissue to the tibial surface. Also, the dissection of calcaneum from the underlying flap in a Syme may lead to devascularisation of the flap. A third disadvantage is that with excision of the calcaneum, a shorter stump is produced, making walking barefoot difficult.

With Boyd and Pirogoff Amputation, the tibio-calcaneal bony fusion gives added stability to the flap. The shortening of the stump is also minimised. The additional length makes it easier for the patient to walk without prosthesis. Nather et al. reported good outcome in all 6 cases undergoing Pirogoff amputation.
Management of diabetic foot wounds

Informed Consent
  o Patient may need below-knee amputation if amputation fails.

Below Knee Amputation (BKA)
This amputation is universally accepted as a failure of limb salvage. A BKA is life-threatening. The peri-operative mortality for BKA is about 10%. It is 30% at one year, 50% at 3 years and 70% at 5 years.  

Recommendation 28: Perform below-knee amputation (BKA) if indicated
Definition
Trans-tibial amputation.

Indications
  o Infection up to ankle
  o Severe ischaemia/gangrene of whole foot
  o Dorsalis pedis and posterior tibial pulses both not palpable
  o ABI < 0.5, TBI < 0.5
  o Rest pain in foot
  o Gangrene or ulcer in heel, not salvageable by a flap

Rehabilitation
Recommendation 29: Perform rehabilitation early.

Rehabilitation:
  o Start on first post-operative day:
    - Straight leg raising exercises
    - Chest physiotherapy
And progress to:
- Hip abduction
- Isometric quadriceps exercises
- Isometric gastrocnemius exercises
- Stump exercises
- Standing with walking frame
- Walking / balancing with walking frame
- Balancing across parallel bars
- Figure of eight stump bandaging three times a day

Above Knee Amputation (AKA)

**Recommendation 30: Perform above-knee amputation if indicated**

**Definition**
Trans-femoral amputation. Figure 38 and 39

**Indications**
- Failed below knee amputation
- Infection up to middle of leg
- Ischaemia up to middle of leg
- Flexion contracture of knee in a patient requiring BKA
Informed Consent

- Patient may need revision AKA if amputation fails

**Limb Salvage**

**Recommendation 31: Perform limb salvage when possible by carrying out revascularization.**

**Definition**
Increasing blood flow and blood supply

**Factors to consider when deciding on vascularisation options**
- **General condition of the patient**
  - Renal function
  - Cardiac function
- **Site and diameter of the vessel** affected, length and severity of occlusion
- **Availability of suitable length of autogenous venous conduit**, i.e. saphenous vein, cephalic vein
- **Outflow** to the foot and **patency** of the pedal arch
- **Severity** of soft tissue necrosis and infection

**Revascularisation Options**

- **Balloon Angioplasty**
- **Bypass Grafting**
Recommendation 32: Perform primary proximal amputation when limb salvage is not possible.

Indications
Patients who:
  o Are immobile or bedridden
  o Have infected ankle joint

Flow chart for Revascularisation

References
### Assessment Form

<table>
<thead>
<tr>
<th>LAST:</th>
<th>FIRST:</th>
<th>MIDDLE:</th>
<th>PIN:</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATE:</td>
<td>SEX:</td>
<td>AGE:</td>
<td>BIRTH DATE:</td>
</tr>
<tr>
<td>ATTENDING MD:</td>
<td>OUT(     ) IN(     )</td>
<td>ROOM #:</td>
<td></td>
</tr>
<tr>
<td>WCC MD:</td>
<td>CONTACT #:</td>
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</table>

#### MEDICAL HISTORY

<table>
<thead>
<tr>
<th>Diabetic History:</th>
<th># of years</th>
<th>Insulin Dependent</th>
<th>Medications:</th>
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<tbody>
<tr>
<td>Type 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type 2</td>
<td></td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Other Illnesses:</th>
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</thead>
<tbody>
<tr>
<td>HTN</td>
</tr>
<tr>
<td>Venous Insufficiency</td>
</tr>
<tr>
<td>CAD</td>
</tr>
<tr>
<td>Renal Disease</td>
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<tr>
<td>CVA</td>
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<tr>
<td>PADD</td>
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<tr>
<td>Others</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Personal History:</th>
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</thead>
<tbody>
<tr>
<td>Smoking</td>
</tr>
<tr>
<td>Alcohol Drinker</td>
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<tr>
<td>Living Alone</td>
</tr>
<tr>
<td>Activity:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BMI-</th>
<th>Ht-</th>
<th>Wt-</th>
<th>Normal</th>
<th>Overweight</th>
<th>Obese</th>
<th>Malnourished</th>
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</table>

#### GENERAL FOOT CARE

<table>
<thead>
<tr>
<th>Right</th>
<th>Left</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feet Clean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Socks/ Hose</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foot wear (appropriate)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interdigital Area-Dry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macerated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nails</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thickened</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fungal Infection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ingrown Toenail</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry and Scaly</td>
<td></td>
<td></td>
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<tr>
<td>Normal</td>
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</table>

#### BIOMECHANICAL

<table>
<thead>
<tr>
<th>Callus Formation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
</tr>
<tr>
<td>Bunion</td>
</tr>
<tr>
<td>Charcot</td>
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</table>
### NEUROLOGICAL ASSESSMENT

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<thead>
<tr>
<th>Symptom</th>
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<th>Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burning Sensation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pins &amp; Needles Sensation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Numbness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leg Pain</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>Intact Protective Sensation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vibration Sense</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reflexes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MONOFILAMENT TEST**

Note: (+) if patient can feel the filament (-) if not.

### CIRCULATORY ASSESSMENT

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Right</th>
<th>Left</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermittent Claudication</td>
<td>Leg Ache/ Heaviness</td>
<td>Swelling</td>
<td></td>
</tr>
<tr>
<td>Rest Pain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leg Wound/ Ulcer</td>
<td>Bulging/ Spider Vein</td>
<td>Hyperpigmentation</td>
<td></td>
</tr>
<tr>
<td>Capillary Refills (Seconds)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Arterial Pulses (0, +, ++)**

- Femoral Artery
- Popliteal Artery
- Dorsalis Pedis Artery
- Posterior Tibial Artery

**ANKLE-BRACHIAL INDEX**

- Brachial Artery
- Posterior Tibial Artery
- Dorsalis Pedis Artery

**ABI (normal/ Abnormal)**

### FINDINGS:

### RECOMMENDATION: